The Use of Telemetry to Monitor the Fetal Heart during Labour: A mixed methods study

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Kylie Watson

School of Health Sciences

Division of Nursing, Midwifery and Social Work

Contents

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List of abbreviations

A-EQUIP	Advocating for Education and Quality Improvement
AMLU	Alongside Midwifery-led Unit
BAME	Black Asian and Minority Ethnic
BMI	Body Mass Index
CAQDAS	Computer Assisted Qualitative Data Analysis Software
CEFM	Continuous Electronic Fetal Monitoring
CTG	Cardiotocograph
CQC	Care Quality Commission
EU	European Union
FH	Fetal Heart
FMLU	Free-standing Midwifery-led Unit
GBS	Group B Streptococcus
GCP	Good Clinical Practice
GP	General Practitioner
GT	Grounded Theory
HDU	High Dependency Unit
HP	Health Professional(s)
IA	Intermittent auscultation
ICM	International Confederation of Midwives
ICU	Intensive Care Unit
LSCS	Lower Segment Caesarean Section
MRC	Medical Research Council
NMC	Nursing and Midwifery Council
NICE	National Institute for Health and Care Excellence
NICU	Neonatal Intensive Care Unit
NIHR	National Institute for Health Research
NHS	National Health Service
OU	Obstetric-led Unit
PCCh	Perceived Control in Childbirth
PPI	Patient and Public Involvement

PRISMA analyses	Preferred Reporting Items for Systematic Reviews and Meta-
RCM	Royal College of Midwives
RCT	Randomised Controlled Trial
RR	Relative Risk
SD	Standard Deviation
SVB	Spontaneous Vaginal Birth
SWCh	Satisfaction with Childbirth
UK	United Kingdom
USA	United States of America
WHO	World Health Organisation

Abstract

Background: Wireless fetal heart rate monitoring (telemetry) is increasingly being used by maternity units in the UK. Guidelines from the National Institute for Health and Care and Excellence recommend that telemetry is offered to any woman who needs continuous monitoring of the fetal heart in labour. There is no contemporary evidence on the use of telemetry in the UK.

Aims: To gather in-depth knowledge about the experiences of women and midwives using telemetry to monitor the fetal heart in labour and to assess any impact that the use of telemetry may have on clinical outcomes, mobility in labour or control and satisfaction.

Study design: A convergent parallel mixed methods design was chosen.

Methods: Qualitative methods included in-depth interviews with 10 women, 2 partners, 12 midwives and one student midwife from two NHS Trusts in the Northwest of England. A constructivist grounded theory methodology was employed for this phase and used both purposive and theoretical sampling. All interviews were audio-recorded and transcribed verbatim. The quantitative phase recruited 161 women from both sites and compared clinical outcome and mobility data from 74 women who used telemetry during labour and 87 women who had conventional wired monitoring. Women also were asked to complete a questionnaire in the postnatal period on control and satisfaction during labour and birth. Questionnaire data was analysed from 128 women, 64 who used telemetry and 64 who had conventional wired monitoring. Both sets of data were integrated to give an overall broad understanding of telemetry use.

Findings: The grounded theory core category was 'Telemetry: A Sense of Normality' and was described by three sub-categories. 'Being Free' described women being more mobile when using telemetry in labour and experiencing greater feelings of control, normality, and support. Telemetry also increased dignity for women as they were able to use the bathroom independently and with ease. 'Enabling and facilitating' described midwives facilitating the use of telemetry, encouraging mobility and using midwifery skills including caring for women in a birth pool. 'Culture and Change' described the different maternity unit cultures and how this impacted on the use of telemetry. Telemetry was viewed as increasing choice and equity for women with more complex pregnancies. Within the quantitative phase there was no difference in the aggregate scores for either the Perceived Control in Childbirth (PCCh) scale or the Satisfaction with Childbirth (SWCh) scale. Sub-group analysis found that women who used telemetry for the majority of the time the fetus was continuously monitored in labour scored a higher aggregate score for perceived control during labour (mean ± SD; 5.3 ±0.8 telemetry vs. 4.9 ± 0.9 wired, $p = 0.047$). Mobility data found that women using telemetry spent more time off the bed in labour and adopted more upright positions for birth.

Conclusions: Both qualitative and quantitative findings confirmed that women were more mobile in labour when using telemetry to monitor the fetal heart and integrated findings also found that telemetry increased feelings of control in labour. The use of telemetry had a positive impact on women who required continuous monitoring in labour and engendered a sense of normality for both women and midwives. The use of telemetry contributes to humanising birth for women requiring more complex care in labour and birth.

Declaration

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I would like to dedicate this thesis to Julie and James Watson, both taken too soon, and who I know would have been incredibly proud.

About the author

The author trained as a direct entry midwife in New Zealand, qualifying in 1997. She worked as an independent midwife for four years providing antenatal, intrapartum, and postnatal care up to 6 weeks for a caseload of around 50 women per year with a ten percent home birth rate. She came to the UK in 2002 for a working holiday and finds herself still here. She spent 10 years working at a large tertiary hospital in London in a number of different roles which included caring for women on a low risk midwifery-led birthing centre, as a co-ordinating midwife on an obstetric-led unit and leading a team of midwives providing caseload care for women with complex pregnancies including cardiac disease, diabetes and hypertension. She completed a Master of Science in Advanced Midwifery Practice in 2007 at King's College London and in 2011 was appointed one of two midwife members of the guideline development group for the National Institute for Health and Care Excellence (NICE) Intrapartum Care for Healthy Women guideline. The author also had a part time role as a research assistant at the Kings' Patient Safety and Service Quality research centre exploring the use of Early Warning Scores in maternity. In 2012 the author moved to Manchester and worked as a co-ordinating midwife, and latterly as a ward manger, on the obstetric-led unit at a large (>9000 births) tertiary maternity hospital.

She is the holder of a National Institute for Health Research (NIHR) Integrated Clinical Academic Training Doctoral Fellowship and has recently been appointed as a Consultant Midwife. The author's skills and interest are in intrapartum care and ensuring women with more complex pregnancies receive care that maximises their potential to experience physiological labour and birth processes.

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Chapter One: Introduction and background to the Thesis

This Chapter will provide an introduction to the thesis including contextual and background information on maternity care in the United Kingdom (UK), monitoring the fetal heart during labour and a rationale for undertaking research on the use of telemetry in active labour. An outline of Chapters will also be given.

1.2.1 Overview of Maternity Care Provision in the United Kingdom.

Giving birth is a major life event, both physically and psychologically, and is the most common reason for women's admission to hospital in the UK (Kelly and Lee, 2017). Almost all maternity care in the UK is provided by the National Health Service (NHS) free at the point of care, and during 2017-2018 there were just under 700,000 births to women under the care of the NHS in England and Wales. Pregnancy and birth in the UK is generally regarded as very safe (Brocklehurst et al., 2012; Department of Health, 2016) with both perinatal and maternal mortality rates having fallen significantly in the last two decades (Draper et al., 2018; Knight et al., 2018). All NHS trusts in the UK have local clinical guidelines for antenatal, intrapartum and postnatal care and these are typically based on national guidelines developed by the National Institute for Health and Care Excellence (NICE) and on international guidelines such as those developed by the World Health Organisation (WHO).

1.2.1.1 Antenatal Care

When a woman discovers she is pregnant, she will normally contact a registered midwife or General Practitioner (GP) to arrange her antenatal (pregnancy) care. Midwives in the UK are educated to degree or diploma level and their practice is regulated by the Nursing and Midwifery Council (NMC). Standards for training programmes for midwives leading to midwifery registration are set down in European Union law (Nursing and Midwifery Council, 2018a). Healthy women without any risk factors or underlying medical issues (often called 'low-risk') will usually have their antenatal care from a midwife and have around eight appointments in adherence with national and WHO guidelines (World Health Organisation, 2016; NICE, 2017). For women who develop complications or have

any underlying medical issues (often called 'high-risk') such as diabetes or hypertension care will usually be shared between midwives and an obstetrician. This type of care may involve extra antenatal appointments and additional monitoring of the fetus through more frequent ultrasound scans.

1.2.1.2 Intrapartum Care

Intrapartum care (care provided from the onset of labour until the birth of the baby) is also provided in the UK by registered midwives and clinicians from other specialties, such as obstetrics and anaesthetics, if needed. Current policies and practice guidance recommend that women should receive one-to-one midwifery care in established labour (NICE, 2014; Cumberlege, 2016). Women may choose to birth in one of four locations; at home, in a stand-alone midwifery-led unit (at a separate location from a hospital), in an along-side midwifery-led unit (within a hospital) or in an obstetric led unit. Not all women are given all four options of place of birth however, with only 42% of women in the most recent Care Quality Commission (CQC) Maternity Survey stating they were given the option to birth in a midwifery-led setting (Care Quality Commission, 2018). Midwifery-led units tend to be more home-like environments and care is focused on birth without medical intervention. Home or midwifery-led units are particularly suitable for low risk women having their second or subsequent baby as intervention rates are lower and maternal/fetal outcomes are no different than in an obstetric-led unit (NICE, 2014). For low-risk women having their first baby, planning birth in a midwifery-led unit is also suitable for the same reasons. However, birth at home for women having their first baby has been reported to increase in the risk of an adverse outcome marginally (Brocklehurst et al., 2012; NICE, 2014). Some healthy women choose to labour and birth in an obstetric-led unit and women with more complex pregnancies or underlying medical conditions are advised to birth in this type of setting where medical staff (including anaesthetic and neonatal) are available 24 hours per day. Despite the majority of women being identified as low-risk at the start of labour (NICE, 2014) the most recent figures for place of birth indicate that around 87% of women give birth in an obstetric-led setting, 9% in an along-side midwifery-led unit, 2% in a free-standing midwifery-led unit and 2% at home (Cumberlege, 2016). The reasons for the seemingly high number of women giving birth in obstetric-led settings are many and complex but may include; non-availability of midwifery-led settings due to organisational factors such as staffing and financial pressures, lack of provision of education for women around birth choices and evidence for each setting, women choosing to birth in a setting with medical support, previous birthing

experiences, increasing levels of complexity, and a greater number of interventions such as induction of labour (Coxon et al, 2017). This is reflected in the latest maternity statistics for the UK which report that during 2017-18 that onset of labour for women was 52% spontaneous, 32% induction and 16% elective caesarean section compared to rates of 69%, 20% and 11% respectively for the years 2007-08 (NHS Digital, 2018). The overall caesarean section rate in the UK is steadily increasing; mode of birth rates indicate that for 2017-18 spontaneous vaginal birth occurred for 59% of women, instrumental birth 13%, and caesarean section 28% of women (either elective or emergency) (NHS Digital, 2018). In 2007-2008 these figures were 63%, 12% and 25% respectively.

1.2.1.3 Postnatal Care

Postnatal care (care after the baby is born) in the UK is also provided by midwives, initially in the place of birth and thereafter at home. Postnatal care provision has changed over the last decade. Midwives have responsibility for women until 28 days postnatal, but women will generally receive only two postnatal visits at home by a midwife up to when the baby is ten days old. Many women are also asked to attend postnatal clinics in the community rather than have care at home. A health visitor will provide care for the woman and baby one midwifery care ceases. Women are advised to have a postnatal examination with their GP at around 6 weeks after the baby is born. Breastfeeding rates in the UK are one of the lowest in the world with only around 24% of babies exclusively breastfeeding at 6-8 weeks of age, dropping to 1% at 6 months (Unicef, 2018)

The study undertaken for this thesis is focused on intrapartum care, and more specifically, monitoring the fetal heart during labour. Auscultation of the fetal heart in utero has been used as a method to confirm fetal life for over 100 years. Listening to the fetal heart (FH) was first documented in 1818 by a Geneva surgeon, Francois Mayor, who claimed that he could hear fetal heart tones by placing an ear on the maternal abdomen (Gültekin-zootzmann and Saling, 1975). This was followed by Kergaradec who claimed in 1822 to have heard fetal heart sounds with a stethoscope (Gültekin-zootzmann and Saling, 1975). The Pinard stethoscope (Figure 2) was developed in 1876 and became widely used in Europe, the United States of America (USA) and the UK. By the 1960s, both portable Doppler devices (Figure 3) and electronic fetal monitors, called cardiotocographs (CTG), had been developed and were in use (Harrison, 2004).

Figure 2 Pinard stethoscope

Figure 3 Portable Doppler

Monitoring of the FH during labour includes identifying the baseline rate and monitoring for any abnormalities such as decelerations. Decelerations of the FH that occur with a uterine contraction and are short lasting (sometimes called early decelerations) are generally not ominous. Prolonged decelerations, or those that occur after a contraction - called 'late' decelerations - are more likely to be associated with hypoxia and may lead to long-term problems such as hypoxic ischaemic encephalopathy (brain injury caused by lack of oxygen) and/or cerebral palsy (Finer et al., 1981; Hirsch, 2019). Current recommendations (NICE, 2014) are that for women identified as low-risk (and therefore at low risk of the fetus becoming hypoxic), the FH should be monitored intermittently with either a Pinard or Doppler.

This is done every 15 minutes, for one minute, following a contraction (to monitor for 'late' decelerations) in the first stage of labour and every five minutes, for one minute, during the second stage (when the fetal head is getting compressed and more likely to result in concerning decelerations of the FH).

Continuous electronic fetal monitoring (CEFM) in the form of a cardiotocograph (CTG) involves the use of two transducers (one to monitor the FH and one to monitor uterine activity) attached to the woman's abdomen via leads and connected to a larger machine (see Figure 4). A continuous record of the FH and uterine activity is printed out.

Figure 4 Cardiotocograph (CTG)

CEFM is recommended for women who enter labour with an underlying medical or fetal condition that may cause the fetus be at an increased risk of hypoxia, for example pre-eclampsia, diabetes or a small for gestational age fetus (NICE, 2014). It is also recommended if complications develop during labour such as abnormalities heard on auscultation with a Pinard or Doppler, an antepartum haemorrhage, or the passing of thick meconium (faecal material, present in the intestines before birth), which may indicate fetal compromise. It is estimated that approximately 60 per cent of the 680,000 babies born in the UK each year will be continuously monitored at some point during labour (NICE, 2014). The purported advantage of CEFM is that the FH and uterine activity can be continuously recorded showing trends over time. The CTG printout of the FH can be systematically assessed and categorised according to a set of criteria (NICE, 2014) and further diagnostic assessment undertaken if indicated (such as fetal blood sampling to give a pH level of the fetal blood and indication of acidosis and therefore hypoxia). Women also report deriving a sense of reassurance from hearing the fetal heart (Beck, 1980; Barber et al., 2013).

The advent of CEFM over 50 years ago heralded a belief that early detection of asphyxia would reduce the rates of adverse events such as cerebral palsy, and perinatal death (Nelson et al., 2016; Alfirevic et al., 2017; Hirsch, 2019). Monitoring using a CTG rapidly became widespread, without any good quality evidence of its effect on fetal outcomes (Hirsch, 2019). A Cochrane systematic review of 13 trials involving over 37,000 women of both low and high risk (Alfirevic et al., 2017) found that CEFM during labour reduced the rate of neonatal seizures but did not find differences in 'cerebral palsy, infant mortality or other standard measures of neonatal wellbeing' (p2). The significance of neonatal seizures without long-term neurological consequences is unclear. The occurrence of seizures, however, is distressing for parents and increases workload on neonatal units (Hill, 2016). There is good evidence that CEFM during labour increases the rates of Caesarean section and instrumental vaginal births (Alfirevic et al., 2017). CEFM during labour is a screening tool rather than a diagnostic test (Grimes and Peipert, 2011) and the analysis of CTG patterns have high false-positive rates leading to increased intervention (such as fetal blood sampling or urgent birth) when clinicians believe there may be a problem. The interpretation of CTG recordings are also prone to inter- and intra-observer differences; that is, different interpretations being given on the same CTG recording by the same person and also by a different person (Rei et al., 2016). In the most recent Each Baby Counts Report it was identified that of 1136 babies that either died during or shortly after birth, or had severe brain injuries, CTG interpretation and/or its subsequent management was identified as a significant or contributory factor in 30% of babies (RCOG, 2017). The use of computerised decision support software for CTG analysis has been proposed as a solution to the issues with CTG interpretation and subsequent management and was investigated in a large (over 46,000) randomised controlled trial comparing computerised analysis with CEFM alone. The trial did not find a difference in the primary outcome of poor neonatal outcome (Brocklehurst et al., 2017). Furthermore, a follow-up paper identified that computerised interpretation of CTGs was only valid in 34% of cases with an adverse outcome (Steer et al., 2018) demonstrating the poor sensitivity of CTG monitoring and complex nature of interpretation.

Further disadvantages of CEFM are that the women may be left alone for periods of time as medical and midwifery staff rely on the increasing use of centralised fetal monitoring, where the CTG trace can be viewed on a central screen away from the labour room. Additionally and importantly for this study, mobility is reduced (due to the presence of wires) and discomfort increased with CEFM (Garcia *et al.*, 1985;

Hansen *et al.*, 1985; Hindley *et al*, 2008; Mangesi *et al*, 2009). The transducers on a conventional CTG are not waterproof and this combined with the presence of wires means that women are not able to use water for pain relief during labour, either in the shower or in a birthing pool. This, combined with decreased mobility, may lead to increased requirements for pain relief such as epidural analgesia (Lawrence et al., 2013). Despite the lack of high quality evidence on the use of CEFM and the risks and benefits derived from its use, it continues to be widely used in modern maternity care. As maternal complexity and interventions such as induction of labour are increasing then CEFM is set to rise.

1.3.1 Telemetry to monitor the fetal heart

Telemetry is defined as 'the science or process of collecting information about objects that are far away and sending the information somewhere electronically' (Cambridge University Press, 2018). Monitoring the fetal heart by telemetry also employs two transducers on the abdomen, similar to conventional wired CTG, but information about the FH and contractions is transmitted wirelessly. Telemetry is not a new phenomenon and literature from the late 1970s describes its use during labour (Flynn and Kelly, 1976; Flynn et al., 1978; MacLennan and Green, 1979). This older telemetry was cumbersome and required women to carry a battery pack around with them and for the fetus to be monitored with a fetal scalp electrode. Advancing technology has meant that modern telemetry is more flexible in use, there is no battery pack required, and recordings are of better quality. Telemetry equipment may be purchased integrated within a conventional CTG machine or as an adjunct to an existing CTG machine. Cost varies from approximately £5000 for adjunct equipment up to approximately £13000 for a complete CTG machine with integrated telemetry. With modern telemetry, women can be freely mobile and, as the transducers are waterproof, can use a birthing pool (see Figure 5).

Both mobility and the use of a birthing pool may shorten the length of labour and reduce epidural and caesarean section rates (Cluett et al., 2011; Lawrence et al., 2013) Current UK intrapartum guidelines (NICE, 2014) recommend that all women having CEFM in labour should be offered telemetry and that further research should be undertaken Telemetry is a way of monitoring the fetal heart continuously that can potentially be offered to women to facilitate increased choice and labour mobility.

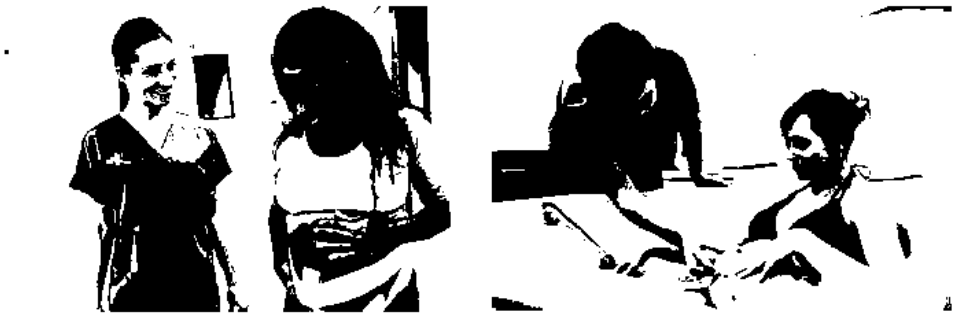


Figure 5 Telemetry to monitor the fetal heart in labour

As part of the preliminary work for a successful NIHR PhD fellowship application a national survey of UK maternity units on the use of telemetry was undertaken (Watson *et al*, 2018). The main aim was to determine how many maternity units were providing telemetry as an option for women and in what circumstances it was used. A total of 168 maternity units were sent an online survey to complete and the response rate was 62% (n=104). Of the units responding, 63% (n=65) had at least one telemetry machine and 50% of units that did not, were planning on purchasing some in the next 6 months. Respondents reported that telemetry was mostly used for women having had a previous Caesarean section, with meconium stained liquor, and having their labour induced. Respondents were asked about which aspects of labour they felt could be positively influenced by telemetry. The top two scoring elements were mobility in labour and satisfaction. Maternity units also highlighted some issues with the telemetry machines such as lack of signal resulting in poor quality recordings, and units not being charged. The majority of respondents were positive about telemetry and felt that it could enable more choice for women with more complex pregnancies.

A service evaluation by a maternity unit that introduced telemetry in 2014 as standard for all women requiring CEFM in labour (Morrall and Beach, 2017) showed an increase in spontaneous vaginal birth from 59.9% in 2013-4 to 64.7% in 2016 -7. Whilst recognising that this was service evaluation and not a research study, and therefore not setting out to test any cause and effect, the figures are of interest and women and midwives responded positively to the use of telemetry. The authors comment that 'it has demonstrated how a simple intervention, generated by feedback from user experience, can improve outcomes and engender a cultural shift to promote normality in a complex care labour ward' (Morrall and Beach, 2017, p60).

It is important to acknowledge recent policy publications and reports, as well as changing demographics of both the maternity workforce and women it is caring for. Maternity care has shifted in the recent decade in response to increasing concerns from women about quality and experience, and national policy driven by safety and a focus on reducing high stillbirth rates in relation to other comparable countries (NHS England, 2016). Much of maternity care policy and organisation has a direct impact on care during labour including monitoring the fetal heart.

1.4.1 Maternity policy and reports

The landscape that maternity services operate within is constantly shifting, changing and reacting to policy publications and reports that influence the direction of travel. One of the most significant reports, and one that has influenced a number of subsequent maternity publications, is The Report of the Morecambe Bay Investigation (Kirkup, 2015). The report details an independent investigation into care that women and babies received at Morecambe Bay NHS Trust, from 2004 – 2013 '20 instances of significant or major failures of care…were associated with three maternal deaths and the deaths of 16 babies at or shortly after birth' (Kirkup, 2015, p7). The findings highlighted a 'seriously dysfunctional' maternity unit that included clinical, investigatory and communication failures at every level and a group of midwives that perused normal birth 'at any cost' (ibid, p 7). The wide ranging report made 44 recommendations which included 26 for the wider NHS. Major recommendations included undertaking a review of national maternity services and ensuring incident reporting and investigation should have clearer standards. The report also had a direct consequence for the Supervision of Midwives, leading to the recommendation that regulation and supervision of midwives should be separated (Parliamentary and Health Services Ombudsman, 2013). Supervision of Midwives was replace by a new model called A-EQUIP (Advocating for Education and Quality Improvement) which seeks to 'facilitate a continuous improvement process that values midwives, builds their personal and professional resilience and contributes to the provision of high quality care' (NHS England, 2017a)

In February 2016 the National Maternity Review report was published which set out to 'assess current maternity care provision and consider how services should be developed to meet the changing needs of women and babies' (NHS England, 2017b). The report, titled 'Better Births: Improving outcomes of maternity services in

England' set out a vision for modern maternity services 'that delivers safer, more personalised care for all women and every baby, improves outcomes and reduces inequalities' (Cumberlege, 2016, p4). The report sets out seven recommendations which are highlighted in Figure 1.

Key Recommendations from Better Births **(Cumberlege, 2016, p 8-12)**

- Personalised care, centred on the woman, her baby and her family, based around their needs and their decisions, where they have genuine choice, informed by unbiased information.
- Continuity of carer to ensure safe care based on a relationship of mutual trust and respect in line with the woman's decisions.
- Safer care, with professionals working together across boundaries to ensure rapid referral, and access to the right care in the right place; leadership for a safety culture within and across organisations; and investigation, honesty and learning when things go wrong.
- Better postnatal and perinatal mental health care, to address the historic underfunding and provision in these two vital areas, which can have a significant impact on the life chances and wellbeing of the woman, baby and family.
- Multi-professional working, breaking down barriers between midwives, obstetricians and other professionals to deliver safe and personalised care for women and their babies.
- Working across boundaries to provide and commission maternity services to support personalisation, safety and choice, with access to specialist care whenever needed.

Figure 1: Recommendations from Better Births

The Maternity Transformation Programme (NHS England, 2017b) has been tasked with implementing and achieving the vision set out by Better Births via nine different work streams. Two further publications, Saving Babies Lives (O'Connor, 2016) and Safer Maternity Care (Maternity Safety Programme Team, 2016) focus attentions on safety in maternity care and reducing the stillbirth rate in the UK.

1.4.2 Midwifery workforce

In their most recent State of Maternity Services Report, the Royal College of Midwives reports that even taking into consideration a slight reduction in birth numbers, the NHS is short of 3,500 midwives (Royal College of Midwives, 2018). Despite increasing numbers of new graduate midwives, the numbers of new registrants has not kept pace with the numbers of midwives leaving employment, in part due to an increasingly older age profile of midwives and ongoing issues with retention. There is evidence that midwives are experiencing high levels of stress and burnout and in a recent report on the work, health and emotional lives of midwives (Hunter et al., 2018) 66.6% of midwives responding to a survey stated they were thinking about leaving the profession. There are also fears about the impact that Brexit may have on midwives from the European Union (EU) coming to work in the UK with only 33 midwives arriving in the UK from other parts of the EU in the last year where previously this number was in the hundreds (Bonar, 2018). These factors all impact on the provision of intrapartum care for women in the UK with many Trusts experiencing high vacancy rates for nursing and midwifery staff and unable to guarantee that all women will receive one-to-one care in established labour. The most recent Care Quality Commission Survey of women's experiences of maternity care reported that 29% of women were left alone by midwives or doctors at a time that worried them during labour, birth or immediately after the birth, although this was a drop from 34% in 2015 (Care Quality Commission, 2018).

1.4.3 The changing demographic of women giving birth

A stretched midwifery workforce is also providing intrapartum care for women with more complex needs during pregnancy and birth. Obesity in the general population has increased markedly over the last twenty years and this is reflected in the rising number of obese and overweight women giving birth (Denison et al., 2018). Obese women are more likely to experience pregnancy and labour related complications and a significant increase in maternal morbidity and mortality (Denison et al., 2018). Women are also giving birth later in life with the fertility rate for women over forty reaching 16.1 births per 1000 women, the highest rate since 1949 and representing an 80% increase since 2001 (Office for National Statistics, 2017). Older women experience more complications in pregnancy (Knight et al., 2018) and indeed the number of women with medical conditions and more complex pregnancies is increasing year on year (Cumberlege, 2016; Royal College of Midwives, 2018) which leads to increasing levels of interventions such as induction of labour. Increasing rates of induction of labour may also be attributable to greater detection

of growth restricted fetuses and testing hypotheses around fetal movements and the prevention of stillbirth (Norman et al., 2018). Greater numbers of women experiencing more complex pregnancies and interventions such as induction of labour directly impacts on the place of birth that woman can choose (typically in an obstetric-led setting) and the type of fetal monitoring that is recommended during labour (typically continuous electronic fetal monitoring by cardiotocograph). These factors are crucial to the topic of this thesis which is focused on continuous monitoring of the fetal heart in labour.

Continues electronic fetal monitoring during labour is rising as more women experience more complex pregnancies and induction of labour. Whilst the researcher acknowledges that questions should continue to be asked about the evidence base for CEFM and justification for its widespread use, there will still be a large cohort of women requiring this type of monitoring. This study is aimed at understanding how a different type of CEFM, namely telemetry, could have an impact on experience and outcomes for women.

The researcher is a midwife with over twenty years of clinical experience, and has worked as an independent midwife and at two of the largest teaching hospitals in the UK. She has cared for both low-risk healthy women birthing at home and women with more complex needs birthing on obstetric-led labour wards. She has a strong belief and passion in women of all risks being able to have a labour and birth experience that promotes physiology as far as possible. The researcher was part of the National Institute for Health and Care Excellence (NICE) guideline development committee that published the guidelines on Intrapartum care for healthy women and babies (NICE, 2014). Evidence on the use of telemetry in labour was examined within the guideline development process and piqued the interest of the researcher into undertaking further research into its use.

The existing evidence base for telemetry is limited and the majority of studies are over 30 years old when both the technology, and how women were cared for in labour, was different. There are a number of untested hypotheses concerning the use of telemetry. Evidence shows that women who are upright and ambulant in the first stage have a shorter labour, are less likely to have a Caesarean section and/or an epidural (Lawrence et al., 2013). Evidence also shows that immersion in water during labour may reduce use of epidural analgesia compared to labour on land (Cluett et al, 2018). It is unknown whether use of telemetry means that women *are*

more upright and ambulant, have less epidural pain relief, or more likely to labour in water. Neither is it known whether the use of telemetry has an impact on control and subsequent satisfaction with labour, or if midwives care for women differently when they are offered, or express a preference for, telemetry. Given that a large number of UK maternity units are using telemetry there is a need to evaluate any impact that its use may have. This thesis presents a mixed methods study exploring women's and midwives' experiences of using telemetry to monitor the fetal heart during active labour and any effect on outcomes such as control and satisfaction during labour. It is the only contemporary study of the use of telemetry in the UK and presents original and unique findings.

1.6.1 Chapter One: Introduction and Background

This Chapter describes the context of maternity care within the United Kingdom and presents a summary of policy documents which shape this care. A background to monitoring the fetal heart is provided including descriptions of continuous fetal heart rate monitoring and telemetry. A rationale is given for undertaking research on the use of telemetry to monitor the fetal heart in labour.

1.6.2 Chapter Two: Literature Review

This Chapter presents a description of differing types of literature reviews and then offers three separate reviews of literature pertinent to monitoring the fetal heart during labour; women's experiences of monitoring the fetal heart during labour, health professional's views of monitoring the fetal heart during labour and the use of telemetry to monitor the fetal heart in labour. Search terms, along with inclusion and exclusion criteria, are given for each search followed by a description of included studies, synthesis of findings and a discussion. Following the literature review, justification is given for undertaking the research and specific study aims and objectives outlined.

1.6.3 Chapter Three: Research Methodology

This Chapter gives a description of the philosophical underpinnings of research and methodological paradigms that may be used including positivism/post positivism, interpretivism/constructivism, participatory and pragmatism. The justification of choosing a mixed methods paradigm is given along with descriptions of differing mixed methods designs. A brief discussion of qualitative methodologies is provided followed by an in-depth description of grounded theory methodology. Quantitative

methodologies are also presented including experimental and observational research and the justification for the quantitative methodology chosen for the study. Integration in a mixed methodology paradigm is also discussed.

1.6.4 Chapter Four: Research Methods

This Chapter outlines in-depth the methods used in both phases of the mixed method study. A rich description is given of each site used for recruitment to the study and then study design, sampling, recruitment, data collection, and data analysis are all given for both the qualitative and quantitative phases. This is followed be sections on ethical considerations and rigour within the study.

1.6.5 Chapter Five: A Grounded Theory of Telemetry Use

This Chapter presents the grounded theory of using telemetry to monitor the fetal heart in labour. Characteristics of the participants are given followed by a description of the overall grounded theory, 'A Sense of Normality'. The three sub-categories of 'Being Free', 'Enabling and Facilitating' and 'Culture and Change' are described in-depth and include verbatim quotes from both women and midwives.

1.6.6 Chapter Six: Observational cohort analysis and findings

This Chapter presents quantitative analysis of an observational cohort of 161 women, 74 who used telemetry during labour and 87 who had conventional wired monitoring. Baseline characteristics are given for both groups and then analysis is presented of questionnaire data that examined control and satisfaction in labour. Clinical outcome data were also analysed and the results presented followed by analysis of mobility in labour data.

1.6.7 Chapter Seven: Integration of findings and discussion

This Chapter integrates findings from both the qualitative and quantitative phases of the study and presents a discussion of the overall findings and the implications for women when using telemetry to monitor the fetal heart in labour. The discussion includes telemetry and the benefits of mobility during labour, its impact on control and satisfaction during labour, and its impact on dignity, normality, human rights and humanising birth.

1.6.8 Chapter Eight: Conclusions

This Chapter includes a discussion of the strengths and limitations of the study, a reflection on the research process, the unique contribution that this study has made, planned future work and recommendations.

Maternity care in the United Kingdom is considered safe and provided free at the point of care within the National Health Service by midwives, obstetricians and other health professionals when needed. The changing demographic of the workforce along with increasing complexity of women giving birth in the UK sets the context for maternity care that is driven by policy focused on safe, personalised care and excellent cross-boundary and multi-professional working. The number of women requiring more complex care is increasing which is leading to increasing numbers of women requiring continuous monitoring of the fetal heart in labour. Conventional wired monitoring can enforce immobility for women and increase discomfort. Monitoring the fetal heart using telemetry removes the necessity for wires but there is no contemporary evidence on whether it has any impact on women's experiences in labour or on clinical outcomes or control and satisfaction. The use of telemetry has increased as technology has improved and research into its use, including the experiences of women, is justified and required. The following Chapter will present a literature review of relevant literature on fetal monitoring in labour and telemetry.

Chapter Two: Literature Review

A literature review aims to describe the existing body of evidence on a topic of interest, quality appraise this evidence and then synthesise the findings to form a coherent view on the literature (Cronin et al., 2008). Gaps in the body of evidence will be highlighted during this process and give strength to justification for the planned study. The literature review was divided into three parts; women's views on monitoring the fetal heart in labour, health professionals' views on monitoring the fetal heart in labour, and the use of telemetry to monitor the fetal heart in labour.

There are a number of different types of literature reviews used to synthesise evidence within the health care literature. Traditionally viewed as near the top of the hierarchy, the systematic review poses a specific clinical question, sets out clear reproducible methods (including search strategies), has specific inclusion and exclusion criteria, and presents statistical findings from primary studies; more commonly randomised controlled trials (Cronin et al., 2008; Centre for Reviews and Disseminations, 2009). Related to this is a meta-analysis where each statistical finding is merged to calculate an overall effect size and new interpretation of the combined results (Whittemore and Knafl, 2005; Cronin et al., 2008). The contribution that these types of reviews have made to evidence-based healthcare is acknowledged, however criticism centres on the discounting of qualitative literature (as it is seen as not being as rigorous and generalizable as experimental reports) and the contribution that qualitative literature giving voice to participants can make to the body of evidence, particularly in health care. A traditional narrative/structured review also synthesises literature but may not have such strict pre-specified research questions, criteria or methodology and is more pragmatic and flexible.

A different, and evolving, type of review is the integrative review where all types of studies, irrespective of methodology, are viewed as being potentially relevant. Whittemore and Knafl (2005) describe integrative reviews as 'the broadest type of research review methods allowing for the simultaneous inclusion of experimental and non-experimental research in order to more fully understand a phenomenon of concern' (p547). This type of literature review can address limitations of other reviews with narrow specifications for inclusion of literature (for example only randomised controlled trials). Hawker et al (2002) also discuss the review of

disparate literature, and how to quality appraise and score heterogeneous evidence. When considering literature centred on fetal monitoring in labour, it became apparent there were many different approaches, methodologies, and study designs published which therefore informed the type of review. It was also decided that three separate reviews of literature were needed which would then be synthesised as a whole at the end. So as to not discount any particular approach and to draw on the full range of evidence a structured, integrative approach was adopted for all three reviews using a checklist devised by Hawker et al (2002) and detailed in Appendix 1. To ensure rigour and validity for reviews an organised approach to inclusion criteria, search strategies, critical appraisal, data extraction and analysis was used. An overall discussion and synthesis is presented following the three reviews which are outlined below.

2.2.1 Women's experiences of fetal monitoring

This review aimed to identify literature centred on women's views, beliefs and experiences of fetal monitoring in labour. The review synthesised evidence on how women view the way their fetuses are monitored in labour, informed consent about monitoring and any contribution different types of monitoring has on labour experience or care.

2.2.2 Health Professional's Views of Fetal Monitoring

To determine the extent and breadth of literature on health professional's views of fetal monitoring in labour a separate review was conducted. Professionals included midwives, nurses, obstetricians and managers. The synthesis provided an in-depth understanding of the different health professional views on monitoring in labour including advantages and disadvantages of each type and effects on decision-making, information-giving, trust and influence on care provision.

2.2.3 Telemetry to monitor the fetal heart in labour

This review collated literature on using telemetry in labour including the evidence base for use, influence on outcomes and views of women and health professionals.

In all reviews, the PICO (Population, Intervention, Comparison/Context and Outcomes) approach (Centre for Reviews and Disseminations, 2009; Methley et al., 2014) was used to develop a comprehensive search strategy. The PICO tool was chosen for its comprehensiveness, whilst recognising that some qualitative literature may not be indexed appropriately (Methley et al., 2014). Additional strategies,

highlighted below, were employed to ensure maximum chance of qualitative literature being obtained. The following electronic databases were searched between January and March 2017. A further search was undertaken in June 2019 to update the review and additional papers incorporated. Applied Social Sciences Index and Abstracts (ASSIA), British Nursing Index (BNI), The Cochrane Library, Cumulative Index to Nursing and Allied Health Literature) (CINAHL) Plus, Excerpts Medica dataBASE (EMBASE), Medical Literature Analysis and Retrieval System Online (MEDLINE), PsycINFO and Maternal and Infant Care/MIDIRS. In addition, since the review needed to include relevant qualitative and cross sectional studies, back-chaining of reference lists in papers was performed as well as searches in Google Scholar and Web of Science. The summary of the three search strategies are presented in the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) format (Liberati et al., 2009).

Critical appraisal of literature is vital to evaluate the quality of research studies. Many different critical appraisal tools (CATs) exist; one paper (Katrak et al., 2004) identified 121 different tools. Some CATs are design specific, for example for quantitative or experimental studies, and others are more generic, giving a tool that covers different research designs. There has been some criticism in the literature of critical appraisal tools (CATs) and debate over which items should be contained within them (Crowe and Sheppard, 2011). Many CATs are criticised for 'lack of any empirical basis of tool construction, established validity of item construction, and the lack of a gold standard against which to compare new critical tools' (Katrak et al., 2004).The tool developed by Hawker et al (2002) was used to assess the literature for all three reviews. This tool was developed by the authors in order to critically appraise literature from different sources and paradigms. Despite some limitations, such as minimal testing for construct reliability (Crowe and Sheppard, 2011) this CAT was felt by the researcher to be a one that could be used to appraise together the disparate literature in all three searches. The original paper contains a clear guide for use and allowed papers to be scored in different areas and give an overall score of quality. The CAT (Appendix 1) includes 9 separate areas within the study for consideration; abstract and title, introduction and aims, method and data, sampling, data analysis, ethics and bias, results, transferability, implications and usefulness. A score ranging from 1 – 4 was allocated for each. Hence a calculated summed score indicating methodological rigour was calculated for each study (9

very poor; 36 very good). This scoring method gave a clear indication of strengths and weaknesses for each study in each area. Further bands were developed to enable ranges of scores to be grouped: 9 - 15 very low quality, 16 – 23 low quality, 24 – 30 moderate quality, 31 – 36 high quality. Tables for the sub-scores and total for each study are given in Appendices 3, 5 and 8. Tables summarising each study are presented in Appendices 2, 4 and 7.

2.5.1 Inclusion/exclusion criteria

The inclusion criteria for this search were:

- Relevant primary and review studies
- Studies reporting women's experiences, views or perceptions of fetal monitoring in term labour as a primary aim
- Peer reviewed papers
- Full text available
- No date restrictions (as literature was limited)

The exclusion criteria for this search were:

- Not written in English (due to time constraints and expense)
- Papers concerned with the antenatal period or pre-term labour (as these conditions are different than with term labour)
- Papers comparing continuous electronic fetal monitoring with fetal cardiac ST analysis – STAN (as both types of monitoring are wired)

2.5.2 Search terms

Search terms in Table 1 were used in the OVID platform (Psychinfo, EMBASE, ASSIA, Maternal and Child Health). Parameters were combined with the Boolean Operator AND for the final search

Parameter	Search terms	
Population	Wom#n.mp OR	Mother*.mp OR
	Parent*.mp OR	Maternal.mp OR
	Patient*.mp OR	
Intervention	Cardiotocography/ OR	F?etal distress.mp OR
	Fetal monitoring/ OR	F?etal heart rate.mp OR
	Fetal distress/ OR	Electronic f?etal monitoring.mp OR
	F?etal heart/ OR	F?etal electrocardiograph.mp OR
	Cardiotocography.mp OR	F?etal heart.mp OR
	F?etal monitor*.mp OR	Auscultation
Comparator	Any other monitoring	
Outcome	Experience*.mp OR	Attitude*.mp OR
	Perception*.mp OR	Reaction*.mp OR
	Acceptance.mp OR	Satisfaction.mp OR
	View*.mp OR	Opinion*
	Preference.mp OR	

Table 1 Search Terms for Women's' Experiences of Fetal Monitoring in Labour

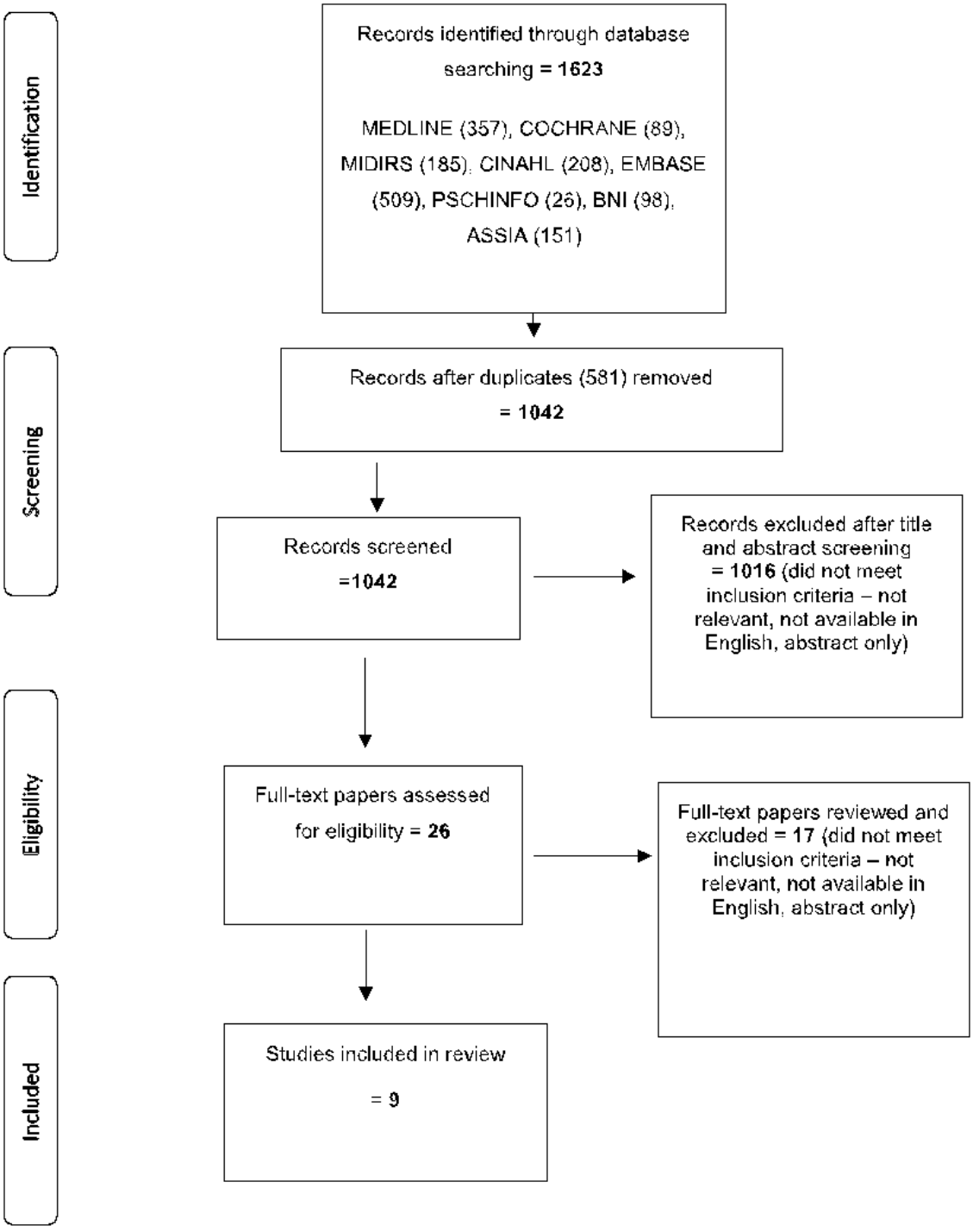
During the initial search it was found that entering the search terms shown above separately gave a large number of irrelevant papers. The search strategy was modified to include the proximity search term **ADJn** where *n* represents the number of words that could appear between the keyword/phrase. All population and outcome search terms were cross tabulated; for example the search (wom#m* adj2 experience*).mp was used. A total of 54 lines of search terms were used in the final search. For the EBSCOhost platform (MEDLINE, and CINAHL) almost similar search terms were used with the exception of Outcome where the combined search within the platform 'Views or perceptions or attitudes or opinions' was used.

2.5.3 Results

Search results are presented in Figure 6. In total 1623 papers were identified meeting inclusion criteria. Once duplicates had been removed the remaining 1042 titles and abstracts were screened. Papers were excluded (a total of 1016) for a

number of reasons including not being available in English, not focused on monitoring during labour and the full article not being available. Full text papers were available and screened further for potential inclusion and from the 26 papers a final 9 were included for final quality appraisal and review. See Appendix 2 for a table of excluded papers

Figure 6 PRISMA diagram for Women's Experiences of Fetal Monitoring in Labour



2.5.4 Summary and Quality Appraisal

In total 9 studies were identified as meeting the inclusion criteria (for summaries and scoring see Appendix 2 and 3). Two studies were embedded within randomised controlled trials (Garcia et al., 1985; Hansen et al., 1985), one study was prospective cross-sectional (Mangesi et al., 2009), one study used mixed methods (Barber et al., 2013), and the remaining five studies were descriptive observational using interviews with a combination of closed and open-ended questions (Starkman, 1976; Shields, 1978; Beck, 1980; Molfese, 1982; Hindley et al., 2008). Three studies were from the USA, two were from UK, and there was one each from Canada, Ireland, Denmark, and South Africa. Six of the nine studies identified were from the years 1976 – 1985 and the most recent three studies were published in 2008, 2009 and 2013; a twenty-three year gap in relevant publications. Quality appraisal took into consideration the relevance that earlier studies (the oldest being 41 years previous) would have to current care provision in labour. It may be deemed appropriate to discount apparently out-dated studies but many of the findings (Starkman, 1976; Beck, 1980) were similar to more recent studies and so it was felt appropriate to include them whilst bearing in mind some of the major differences in context.

The range of scores using the Hawker checklist were from very poor (13) to high quality (33). The five oldest studies all scored 20 and below, whilst two of the most recent studies (Hindley et al., 2008; Barber et al., 2013) scored 30 and 33. The lower rated papers were scored lower for mostly methodological and ethical issues. Five out of the first six papers published from 1976 – 1985 scored one mark only for ethics (out of a possible four). These papers (Starkman, 1976; Shields, 1978; Beck, 1980; Molfese, 1982; Hansen et al., 1985) made no mention of any ethical issues such as informed consent, confidentiality or sensitivity, giving an indication of how research practice, governance and reporting has improved vastly in recent years. Issues surrounding validity of questionnaires, interview schedules, specifying inclusion and exclusion criteria, sampling techniques, transcription and analysis methods were frequently not mentioned. The majority of the studies also failed to discuss limitations of the work or issues of bias.

2.5.5 Description of studies

2.5.5.1 Embedded within Randomised Controlled Trials

(Garcia et al., 1985) was methodologically sound and of moderate overall quality, scoring 30. The study was set in a large Irish hospital with 8000 births per year and

assessed views of CEFM and intermittent auscultation (IA) among 200 women within a randomized controlled (RCT) trial with 13000 participants. The study addressed the following deductive hypotheses: a) that women monitored with CEFM feel more restricted in their movements during labour and delivery; b) that the attention of midwives, doctors and husbands may be divided between the monitor and the mother so that mothers who receive CEFM report they receive less support; c) that CEFM will be more reassuring than IA; d) that the presence of the monitor will lead mothers to ask more questions of staff, and that staff will volunteer more information. Two subsamples of 100 women were selected at random from each arm of the study to complete a semi-structured questionnaire. Groups were comparable. All 200 women were asked the same initial questions about monitoring and at the end of the questionnaire women were asked specifically about the type of monitoring they had been allocated. Analysis was done comparing the groups of women as to the method they were allocated. An issue with the larger study was that women receiving IA were not asked to consent to being in the study as this was 'usual care'; it is unclear whether women taking part in the questionnaire were consented to take part.

(Hansen et al., 1985) aimed to gain pregnant women's views on fetal surveillance techniques. The study was also part of a much larger Danish RCT (Randomised Controlled Trial) investigating clinical effects of CEFM versus IA. Women were interviewed at 36 weeks to discuss the main trial and their knowledge of fetal surveillance during labour, the source of their information and preference between CEFM and IA. This study was low quality; there was no mention of any ethical issues and some of the analysis was not clear.

2.5.5.2 Mixed methods study

Barber et al (2013) was the most recent paper and scored moderately (30) in quality appraisal. The study was conducted in three hospitals in the Northwest England and aimed to investigate whether the use of CEFM during labour increased or reduced anxiety levels. The study was part of a pilot RCT investigating whether the use of decision-support software in addition to CEFM had any influence on outcome (primarily perinatal morbidity and mortality). In the quantitative arm, 275 women from one maternity unit, who had been randomized in the trial, were asked to volunteer their anxiety levels using a Visual Analogue Scale for Anxiety. The anxiety levels were given in early labour, active labour and within 48 hours postpartum. Correlation of scores between phases was calculated using appropriate statistical tests. The qualitative phase recruited 18 women in the postpartum period from 2

other centres and used semi-structured interviews to ask about experiences of birth, and monitoring, and about being recruited into a trial. Purposive sampling was employed to ensure even split between women who had CTG only and CTG plus decision support. Framework analysis was used following coding. A large number of verbatim quotes were used from the women to strengthen context and validate findings. Minimal information was given on where and how long after the birth the postnatal interviews had taken place and despite purporting to be a mixed methods study there was no indication of how each phase of the study had influenced the other.

2.5.5.3 Prospective Cross-sectional

This small study (Mangesi et al., 2009) was conducted in a tertiary level hospital in South Africa. The aim was to assess which of three different methods of monitoring the fetal heart in labour was preferred by women in labour. The three methods were a fetal stethoscope, a wind-up fetal Doppler and a CTG machine. Women were approached in active labour and verbal consent taken. Each of the three methods was performed and participants asked to choose which of the three methods they were most comfortable with. The study was of low quality as the intervention was applied over a very short period and there were limited details about how or when women were asked about their preference.

2.5.5.4 Descriptive observational

The remaining five reported studies (Starkman, 1976; Shields , 1978; Molfese , 1982; Garcia et al., 1985; Hindley et al., 2008) all used interviews (both open and closed ended questions) with women about their thoughts, reactions and views of fetal monitoring in labour. The four earliest papers scored very low or low in quality appraisal. The Hindley (2008) paper was the highest scoring publication (33). The four low scoring papers all interviewed women in the post-natal period and overall aims were very similar; to assess psychological effects of new monitoring technology including attitudes and reactions. All four studies assessed participants' reactions by determining positive or negative attitudes and scoring them. Starkman (1976) also included general questions about antenatal information given about monitoring, whether staff gave explanations about the monitor and whether there was an effect on interactions with their husbands. Likelihoods of relationships between positive and negative reactions to the monitor were assessed in relation to demographic variables. Shields (1978) used a "Mood and Feelings" inventory, containing 8 negative and 6 positive words, to assess general attitudes. Beck (1980) divided responses into initial reactions to monitoring and then subsequent reactions

taking into account the overall birth experience. Responses were categorized into positive, negative or neutral. Open ended questions were also used and these were analysed thematically. The Molfese study (1982) interviewed women from both a university medical hospital and a community hospital. They developed a questionnaire that contained 61 statements derived from comments and findings reported in the Starkman and Shields studies and a Likert scale was used to assess women's agreement on previously published reactions to monitoring. All four of these studies had minimal to no information about consent, qualitative analysis methods, validation of questionnaires, and sampling and recruitment details. Of note with all of these studies is that the majority of women had internal uterine transducers to monitor contractions and often a fetal scalp electrode to monitor the fetal heart. CEFM was also used frequently for low risk women experiencing a normal labour and birth, reflective of the perception of 'new technology' and the panacea it was held up to be.

The most methodologically sound and relevant paper in this review (Hindley et al., 2008) sought to investigate the degree of choice pregnant women at low risk had in making informed decisions on fetal heart rate monitoring during labour. Women at low obstetric risk (n=63) were approached from two hospitals to complete antepartum (n=63) and postpartum questionnaires (n=38). Demographic details were comparable. A questionnaire was adapted from a previously validated tool using themes identified from a literature review and developing questions more specific to fetal monitoring. The questionnaire was piloted with a group of women attending antenatal classes. The antenatal questionnaire contained 28 items designed to elicit information on knowledge and preferences for fetal monitoring in labour whilst the postpartum questionnaire had 21 items. The paper used a number of verbatim quotes from interviews to give context and validate findings. More information could have been provided on which women in the postnatal group received each type of monitoring and the reasons why. A strength identified in the study was reflection on who and why the 38 postnatal questionnaires were returned and how this may have biased results.

2.5.6 Synthesis of Findings

The study findings were synthesised using a thematic synthesis approach (Lucas et al., 2007). Lucas reports that the strength of this type of analysis 'lie in its potential to draw conclusions based on common elements across otherwise heterogeneous

studies' (p 4) which is the case with this group of studies. Subthemes were identified within the studies which were then grouped into broader natural themes.

The six themes identified were; 'monitor as provider of extra clinical information', 'communication with others', 'mechanical medicalisation', 'psychological effects', 'influence on attitudes', and 'choice and preferences'. The themes and sub-themes are outlined in Table 2.

Theme	Sub-theme	Papers
Provider of extra clinical information	Contractions	Starkman, 1976; Beck, 1980; Hansen, et al, 1985; Barber et al, 2013.
	Dilation	
	Heartbeat	
Communication with others	Birth partners	Starkman, 1976; Garcia et al, 1985; Barber et al, 2013.
	Competition for time	
	Health professionals	
Mechanical medicalisation	Discomfort	Starkman, 1976; Shields, 1987; Beck, 1980; Molfese et al, 1982; Garcia et al, 1985; Hansen et al, 1985; Hindley et al, 2008; Mangesi and Woods, 2009; Barber et al, 2013.
	Wires	
	Immobility	
	Privacy	
	Noise	
Psychological Effects	Reassurance/security	Starkman, 1976; Shields, 1987; Beck, 1980; Molfese et al, 1982; Garcia et al, 1985; Barber et al, 2013.
	Anxiety	
	Positive/negative feelings	
	Control	
Influences on Attitudes	Prior pregnancy loss	Starkman, 1976; Beck, 1980; Molfese et al, 1982.
	Income	
	Age	
Choice and Preferences	Decision making	Garcia et al, 1985; Hansen et al, 1985; Hindley et al, 2008; Mangesi and Woods, 2009
	Information	
	Informed consent	

Table 2 Themes and sub-themes identified from women's' experiences of monitoring literature

2.5.6.1 Monitor as provider of extra clinical information

Many of the participants in the studies viewed the monitor as being a provider of extra information about their fetus and body during labour (Starkman, 1976; Beck, 1980; Hansen et al., 1985; Barber et al., 2013). This information was used by the women, and sometimes the birth partner to tell when a contraction may be starting or ending; women are often unable to feel contractions with pain relief such as an epidural or the monitor may indicate a contraction is coming before the woman starts to feel it. The monitor was viewed as being able to give useful information to health professionals such as when examinations or interventions were needed. For example if the fetus showed signs of hypoxia then this may have indicated that the cervix was fully dilated. One respondent perceived that the monitor had saved her baby's life as it 'told the doctor when to do a Caesarean' (Beck, 1980, p 352). It should be noted that for the earlier studies, fetal monitoring was a relatively new innovation and the technology was viewed as remarkable by women in the studies. Women reported that the presence of the noise of the fetal heart beat was able to increase surveillance, give further information about the baby and be an extra check (Beck, 1980; Hansen et al., 1985). It was fascinating to recognise that in both the oldest study (Starkman, 1976) and the most recent study (Barber et al., 2013) women noted that the ability to see a contraction coming on the digital readout before being able to feel it was of benefit.

2.5.6.2 Monitor influence on communication with others

Garcia et al (1985) hypothesised that the presence of a fetal heart rate monitor in the room would divert attention of midwives, doctors and birth partners away from the woman and that less support would be perceived. In their study this hypothesis was not supported. However, there was a suggestion that women were more often left alone by staff for short periods if they had CEFM and that the monitor competed for attention of the woman with birth partners and health professionals; it was the printout that was looked at and scrutinised before the woman. Starkman (1976) found contradictory outcomes in relation to the women's communication and interactions with her birth partner. Some women found the presence of the monitor of benefit in that the birth partner had more involvement by knowing when contractions were coming and experience was shared. Others perceived negative consequences such as the partner having to leave the room when the monitor showed fetal heart rate problems (this however may be a consequence of the era when birth partners, mostly husbands, were only present in the room at certain times and not at others, such as when being examined). Barber et al. (2013) also

reported on communication with birth partners noting 'several women (or their partners if interviewed) reported that the monitor helped reassure the father too, and could generate a sense of involvement because they could see a contraction coming and support their partner appropriately' (p 398).

2.5.6.3 Monitor as mechanical medicalisation

All nine of the studies reported on women's discomfort whilst the monitor was on, mostly related to the two straps that are required to go around the abdomen to hold transducers in place. Starkman (1976) identified one of its themes as 'The Fetal Monitor as a "Mechanical Monster"' (p274). One women reported that she 'felt like a battery being charged with all those wires and connections' (Shields, 1978, p 2111). Two papers reported on women's dissatisfaction with the wires 'dangling between legs' (Starkman, 1976; Barber et al., 2013) and six of the papers (Starkman, 1976; Beck, 1980; Garcia et al., 1985; Hansen et al., 1985; Hindley et al., 2008; Mangesi et al., 2009) discussed women's dissatisfaction with enforced immobility and restriction of movement caused by the monitor and feelings of being tied to the bed (Beck, 1980). The hypothesis posed by Garcia et al (1985) that women monitored with EFM feel more restricted in their movement during labour and delivery was confirmed in being statistically significant. The authors also investigated the extent to which this increased pain or need for analgesia but found no significant difference between groups allocated to CEFM versus IA. Some women in the Garcia et al. (1985) study also reported that auscultation was painful. Auscultation of the fetal heart would have been done with a fetal stethoscope or Pinard rather than a portable Doppler during the 1970s and 1980s, and this requires a certain degree of pressure on the abdomen to listen to the fetal heart clearly.

Barber et al. (2013) reported that one woman took her monitor off as she felt so restricted but other women expressed 'varying degrees of resignation' (p 400) about being monitored and accepted the disadvantages of being monitored needed to be weighed up against the reasons for it and benefit to the fetus. Of relevance to this PhD study, some of the women in Barber's (2013) study would have preferred a portable wireless monitor and one woman had heard it was available in other hospitals. Hansen (1985) compared women's views of CEFM versus IA and found that 58% of the group that preferred IA thought that the lack of belts and sensors was a major advantage.

2.5.6.4 Monitor and psychological effects

Two studies presented contradictory results around feelings of reassurance when the fetal heart was being monitored continuously in labour. Beck (1980) found that many women in their study 'remarked that they felt secure after they had been on the monitor for a while because it was reassuring to hear the baby's heartbeat' (p 352). In comparison to this, Garcia et al. (1985) did not find that CEFM was more reassuring than IA and there were no differences in control or anxiety levels in the two groups although questions around these issues were not specified. Garcia (1985) noted that the reassuring presence of staff and birth companions was more reassuring for women than the type of monitoring used in labour. Further mention of anxiety was also detailed specifically in relation to the fetal scalp electrode used on the fetus' head and anxiousness when hearing the heartbeat change (Beck, 1980; Garcia et al., 1985).

Earlier studies focussed on assessing whether women felt positively or negatively about CEFM. Starkman's (1976) structured interviews with 25 women found that there were 14 positive responses to the monitors, 10 negative responses and 1 with no response. Shields (1978) found 22/30 women in the positive range and 8/30 in the negative; 2 were highly positive and 3 were highly negative. A criticism of these studies is that reasons for the women's responses were examined at a very superficial level – they were not truly qualitative in nature and only required women to give dichotomous responses to questions. Of the fifty women in the study by Beck (1980) 56% had a neutral response to the monitors and equal numbers had positive and negative feelings. Molfese (1982) reported that overall most women found that EFM was a positive part of the labour and birth process.

2.5.6.5 Influences on attitudes to monitoring

Four of the papers used statistical tests to determine if any variables were associated with positive or negative attitudes to continuous fetal monitoring in labour. Results were often contradictory. Starkman (1976) found a significant relationship between women having a positive response to fetal monitoring if they had experienced a prior pregnancy loss. Shields (1978) did not identify correlations with any background variables such as ethnicity, age or marital status. Using Chi-square analysis Beck (1980) found that there was a significant relationship between age and initial responses to monitoring with older women reacting more positively than younger women. However, the cut-off for a woman being defined as older was 24 years (the mean age of participants). The mean age of women giving birth in 2015 in the United Kingdom was 30.4 years (Office for National Statistics, 2018) so

this result needs to be treated cautiously. The authors also found that married women reacted more positively to monitoring than unmarried women. Molfese (1982) reported contradictory findings for women birthing at an urban hospital medical centre compared to a rural community hospital. At the urban hospital women of lower income were more likely to view monitoring positively than those with a higher income whereas the opposite was true of the rural hospital. Reasons for this were not explored. It should be noted that all four of these papers scored very lowly in quality appraisal including low marks for transferability, generalizability, and sampling.

2.5.6.6 Choice and preferences about monitoring

Arguably one of the most crucial themes arising from the thematic synthesis is that of women's preferences for monitoring during labour and issues around information provision and informed consent. Three papers (Garcia et al., 1985; Hansen et al., 1985; Hindley et al., 2008) specifically looked at this. Garcia et al (1985) asked women which method of monitoring they would prefer if they had another baby. Women who experienced CEFM would have had an initial fetal heart assessment using a Pinard or Doppler so would have had experience (albeit briefly) of this method also. Only eight per cent of women who had CEFM said they would prefer auscultation next time, whilst 32 per cent of those who had auscultation would prefer CEFM the next labour (Garcia et al., 1985). The authors comment that this comparison should be treated with caution for two reasons. Firstly, that the discomfort of auscultation may have prompted women preferring another method, and that secondly, 'women express a wide range of attitudes towards technology in childbirth and sophisticated techniques may be seen by some as more reliable and informative' (p 85). This resonates with the almost ubiquitous use of CEFM in the 1980s and not seriously challenged until more recently.

Hansen et al (1985) asked women to given an opinion on CEFM and IA and preferences; 28.1% were undecided, 39.5% preferred CEFM and 32.4% preferred IA. A high rate in each group of women who had their preferred surveillance method would have preferred the same in a future birth. Only 42% of women who preferred auscultation but had CEFM would have preferred it again in a next birth. These results point to a suggestion that IA is a preferred method of monitoring in labour but given that the paper is quantitative in nature and many of the results were not significant then it needs to be interpreted with caution.

Of more relevance, a recent UK study (Hindley et al, 2008), focused on women at low obstetric risk and their preferences for monitoring. In the antepartum survey the majority of respondents (56%) wished to have a combination of intermittent EFM and CEFM. As these were all low risk women this indicates that there was a lack of information given to women on which method is recommended (and why) during labour. Intermittent EFM (where the CTG transducer is used to listen to the FH intermittently rather than with a Pinard or Doppler) is not a recommended way to auscultate the fetal heart in labour (NICE, 2014). All 20 women who had CEFM had either an epidural or narcotic analgesia but unfortunately it was not made clear if any of these women had IA initially and then had CEFM due to having an epidural. Of the postnatal responses, 61% of women had received some form of fetal monitoring but there was no indication given as to the reasons for this.

Women were asked by Hindley et al (2008) if they felt that having choice and being in control was of importance in the ante and intrapartum period – 97% (61/63) felt that it was. Women were also asked if midwives had facilitated choice about fetal monitoring in labour antenatally – 94% (59/63) said that they had not been given a choice and only 40% (25/63) said that they had been given enough information to make a choice. In the postnatal survey only 39% of women (15/38) felt that they had been given an informed choice about the type of monitoring in labour.

2.5.7 Discussion

Literature on women's views of fetal heart rate monitoring in labour is relatively sparse, of varying quality and spans 40 years. Due to the heterogeneity of the work it is difficult to draw particularly strong conclusions. Stronger themes present throughout the publications are that women find continuous EFM uncomfortable and enforce immobility. Women perceive the CTG machine as able to provide extra information about a labour for health professionals, themselves and their birth partners but there is no agreement on whether the monitors cause more or less anxiety or reassurance, or result in more or less support from staff or birth partners. Women highly value being given information and choice about types of monitoring during labour but are often not given this choice, either antenatally or during labour.

2.6.1 Inclusion/exclusion criteria

The inclusion criteria for this search were:

- All relevant primary and review studies
- All studies reporting health professionals (including midwives, nurses, obstetricians, nurse-midwives) experiences, views or perceptions of fetal monitoring in labour as a primary aim
- Peer reviewed papers
- There were no data restrictions
- Papers where the full text was available

The exclusion criteria for this search were:

- Papers not written in English (due to time constraints and expense)
- Papers concerned with the antenatal period or pre-term labour
- Papers comparing continuous electronic fetal monitoring with STAN (fetal cardiac ST analysis).

2.6.2 Search Terms

Search terms listed in Table 3 were used in the OVID platform (Psychinfo, EMBASE, ASSIA, Maternal and Child Health). Parameters were combined with the Boolean Operator AND for the final search.

Parameter	Search terms	
Population	Midwife*/ OR	Nurse*.mp OR
	Nurse*/ OR	Obstetrician*.mp OR
	Obstetrician*/ OR	Manager.mp OR
	Manager*/ OR	Health professional*.mp
	Midwives.mp OR	
Intervention	Cardiotocography/ OR	F?etal distress.mp OR
	Fetal monitoring/ OR	F?etal heart rate.mp OR
	Fetal distress/ OR	Electronic f?etal monitoring.mp OR
	F?etal heart/ OR	
	Cardiotocography.mp OR	F?etal electrocardiograph.mp OR
	F?etal monitor*.mp OR	F?etal heart.mp OR
		Auscultation.mp
Comparator	Any other type of monitoring	
Outcome	Experience*.mp OR	Attitude*.mp OR
	Perception*.mp OR	Reaction*.mp OR
	Acceptance.mp OR	Satisfaction.mp OR
	View*.mp OR	Opinion*
	Preference.mp OR	

Table 3 Search Terms for Health Professionals' Views of Fetal Monitoring in Labour

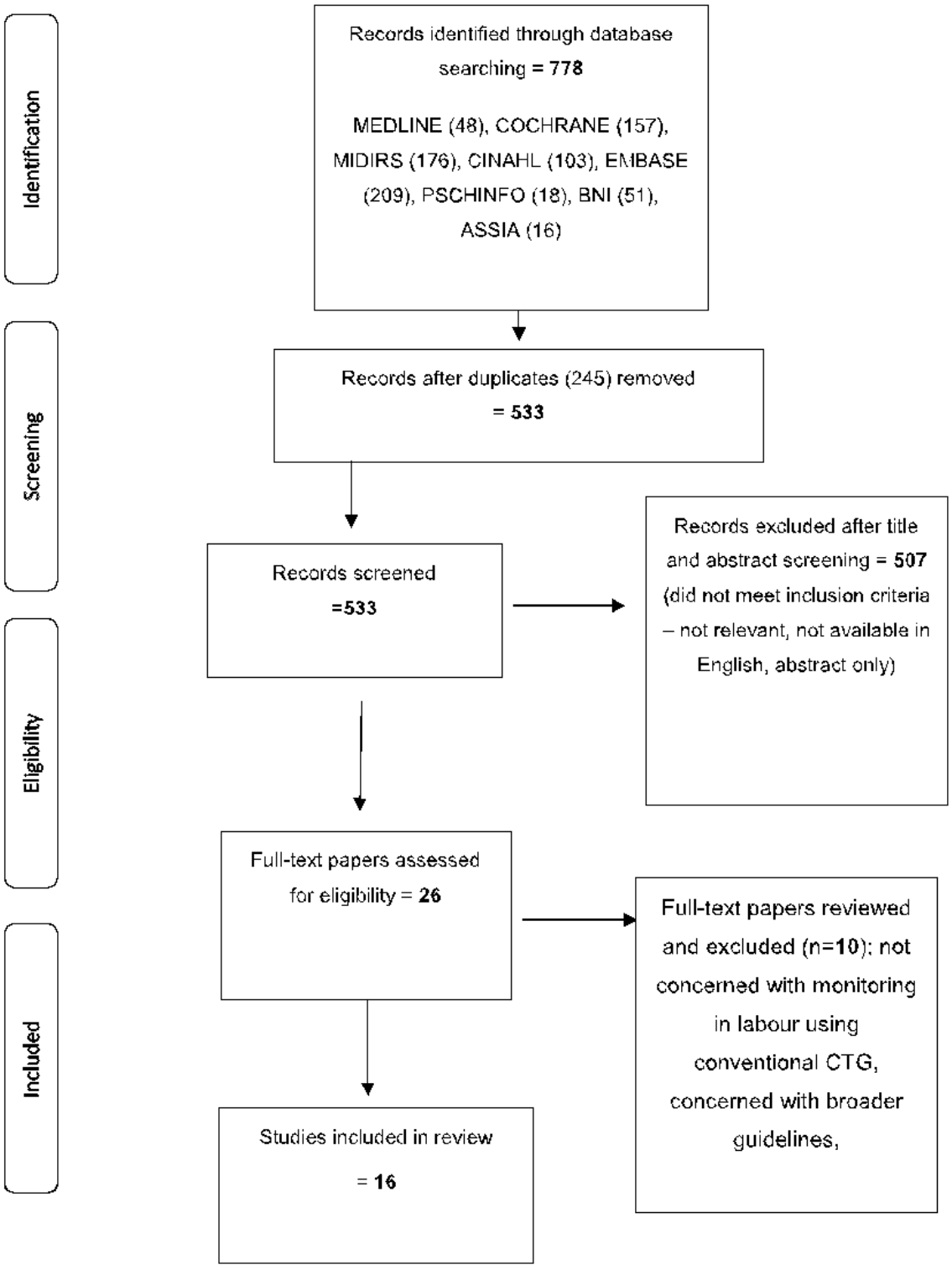
Twenty lines of search terms were used in the final search. For the EBSCOhost platform (MEDLINE, and CINAHL) almost similar search terms were used with the exception of Outcome where the combined search within the platform 'Views or perceptions or attitudes or opinions' was used. Parameters were combined with the Boolean Operator AND for the final search.

2.6.3 Results

Search results are presented in the Figure 7. In total 778 papers were identified that met the search criteria. Once duplicates had been removed, the remaining 533 titles and abstracts were screened. Papers were excluded (a total of 494) for a number of reasons including not being available in English not focused on monitoring during

labour and the full article not being available. Full text papers were available and screened further for potential exclusion. From the 26 papers 16 were included for final quality appraisal and review. Full text papers were excluded for not having fetal monitoring as the main concern of the paper, focused on change management rather than health professional views, and publications on health professionals views on broader themes such as intrapartum care. See Appendix 5 for a table of excluded papers.

Figure 7 PRISMA diagram for Health Professionals Views of Fetal Monitoring in Labour



2.6.4 Summary and quality appraisal

In total 16 papers, including one systematic review (Smith et al., 2012), were identified for the review of health professionals' (HP) views and experiences of fetal monitoring during labour (See Appendix 4 and 5 for summary tables and scores). The results of one study were reported across two publications (Sinclair, 2001; Sinclair and Gardner, 2001) and the results from another study were reported across three publications (Hindley and Thomson, 2005; Hindley et al., 2006; Hindley and Thomson, 2007). All 11 studies included in the systematic review were identified and included in this literature review. An additional paper was also identified (Rattray et al., 2011) that was not included in the systematic review. Two new papers (Hill, 2016; Rosenbaum et al., 2018) were identified when the search was re-run during the final writing phase of this thesis. There were eight quantitative questionnaire surveys (Cranston, 1980; Dover and Gauge, 1995; Birch and Thompson, 1997; Sinclair, 2001; Sinclair and Gardner, 2001; Walker et al., 2001; McKevitt et al., 2011; Rosenbaum et al., 2018), and three qualitative studies resulting in five papers (Hindley and Thomson, 2005; Hindley et al., 2006; Blix and Ohlund, 2007; Hindley and Thomson, 2007; Rattray et al., 2011). One paper used both semi-structured interviews and observations of women in labour (Altaf et al., 2006) and a further paper reported on a questionnaire followed by in-depth interviews (McKevitt et al., 2011). Of the primary studies two were from the US, four were from England, two were from Northern Ireland and there was one each from Australia and Norway.

Compared to papers reporting women's views of fetal monitoring, these papers were not as old and generally scored higher using the Hawker checklist. Scores ranged from very low (Birch and Thompson, 1997) to high quality (Blix and Ohlund, 2007; Smith et al., 2012) with 12 out of the 15 papers all scoring 30 or above. Thirteen of the sixteen papers were published after the year 2000 and higher scores were given for well-designed studies that reported findings clearly and exhibited good transferability and implications for current UK practice. In total 1262 participants were recruited into the studies. Of interest is that whilst literature was searched seeking all health professionals' views only 87 doctors (of varying grades) participated across all studies, the remainder being midwives or registered nurses.

2.6.5 Description of studies

2.6.5.1 Systematic review

The systematic review (Smith et al., 2012) scored highly (34 out of a possible 36) and aimed to explore professional views of fetal monitoring during labour. The review searched relevant databases and identified 11 studies including 1194 participants. Data synthesis was by thematic analysis and the studies were appraised using a quality framework assessment

used by the Evidence for Policy and Practice Information and Coordinating (EPPI) Centre at the Institute of Education in London. Four main themes emerged from the data: 1) reassurance, 2) technology, 3) communication/education, and 4) midwife by proxy. A different quality assessment tool was used, however the ratings of assessment were similar in the systematic review and the literature review presented here (that is, papers that scored low/high on the Hawker checklist were also given a low/high rating in the EPPI quality framework). A table was presented identifying key findings from each paper and which themes were identified by the review authors as being crucial. Quotes were used within the paper to illustrate themes and an excellent discussion was provided integrating themes and findings as well as discussing implications for practice.

2.6.5.2 Quantitative survey questionnaires

There were eight papers that used questionnaires or surveys to assess health professionals (HP) views. One paper used interviews in addition to a questionnaire (McKevitt *et al*, 2011) but is included in this summary section. Scores using the Hawker checklist ranged from 23 to 33 and response rates, when given, ranged from 48% to 60%. The majority of questionnaires used Likert scales to assess attitudes of respondents and analysis of responses was performed using a range of statistical tests including one way ANOVA, factor analysis, frequencies, correlations and descriptives. A summary of the papers is presented in Table 4.

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Author/year	Aims	Data collection tool	Response rate	Participants and location	Hawker score
Cranston, 1980	Nurse attitudes towards fetal monitoring	Questionnaire – Likert scale (24 items). Postal.	Not given	124 RGNs working in labour and delivery units from 14 hospitals in Missouri, US.	26
Dover & Gauge, 1995	Survey midwives attitudes and practices related to intrapartum fetal monitoring – preferred methods, what factors influenced choice of methods	Questionnaire – Likert scale (20 items). Also asked to rank preferred methods of monitoring for women at low and high risk and to state agreement or not with unit policy on FH monitoring. Postal.	48%	117 midwives from two units (teaching and district)	33
Birch & Thompson, 1997	Audit of attitudes to, and practice of, monitoring the fetal heart during labour	Questionnaire – no details	50%	41 hospital midwives 19 community midwives 18 team midwives 2 midwife managers 5 junior doctors 5 middle grade doctors 4 consultants 2 unidentified	23
Sinclair, 2001	Identify midwives attitudes to technology, specifically the CTG	Questionnaire – 45 items plus Likert (25 items) attitude. Postal.	60%	446 midwives	31

Sinclair & Gardner, 2001	Explore midwives perception of the use of technology in childbirth	Questionnaire – 45 items plus Likert (25 items) attitude. Postal.	60%	446 midwives (same midwives as above)	28
Walker et al, 2001	Midwives attitudes to intermittent auscultation in labour	Questionnaire – Likert scale (18 items)	Convenience sample	150 nurses from 5 labour and delivery units in Michigan	32
McKevitt et al., 2011	Examine midwives and doctors attitudes to the use of CTG machine in labour	Questionnaire (Likert -adapted from Sinclair, 2001). Open-ended questions at end. Postal.	Midwives 53% Doctors 58%	29 midwives 11 doctors	30
Rosenbaum et al., 2018	Describe the use and experiences of with external fetal monitoring devices among obstetrical providers	Cross-sectional survey questionnaire. On-line. Open-ended questions at the end.	63%	54 obstetricians 9 midwives 78 nurses	32

Table 4 Summary of quantitative survey papers

2.6.5.3 Qualitative papers

Eight of the included studies used in-depth interviews as either the main data collection tool or in addition to either a questionnaire (McKevitt et al., 2011), or structured observations (Altaf et al., 2006). Hindley and colleagues sought to investigate midwives' attitudes, values and beliefs on the use of intrapartum fetal monitoring. Three separate papers were published from this study; the first focussing on informed choice for women (Hindley and Thomson, 2005), the second on monitoring women at low obstetric risk (Hindley et al., 2006), and the third on the spectre of litigation for midwives (Hindley and Thomson, 2007). The papers were rated of high quality. Two hospitals in the North West of England were used as sites and midwives who had experience of fetal monitoring in labour were purposively sampled. In total 58 midwives were recruited and interviewed by two researchers. A semi-structured interview guide was developed and included advantages and disadvantages of monitoring, decision-making, influence of research on practice, definition of risk status, implementation of guidelines, and the effects of technology on practice and birth, and issues around informed choice. The interviews were analysed using a general thematic analysis however the authors commented that if they had more time a grounded theory methodology would have been used and this would have strengthened the work.

In their grounded theory (GT) study Blix and Ohlund (2007) explored 'what information and knowledge the labour admission test is perceived to provide and what meaning the test carries in the daily work of practising midwives' (p48). They interviewed 12 midwives, working on four different labour wards using purposive followed by theoretical sampling (although it was unclear which interviews were from a theoretical sample and why, and this affected the Hawker score). The interviews lasted 30 – 90 minutes and the authors used analysis described by Strauss and Corbin (1998). The study scored highly (34 out of 36) as the analysis was very much grounded in the data, biases were acknowledged and a core category was described well.

Rattray et al. (2011) also employed GT methodology for a study set in Australia, which 'explored midwives' decision-making processes related to the use of continuous electronic foetal monitoring on low risk labouring women' (p 65). Following identification of low-risk women who had CEFM in labour, five midwives caring for these women were interviewed using purposive and theoretical sampling (again without a clear distinction given in the paper). A score of 30 was given for this

paper; theoretical sensitivity was strong with the researchers' previous knowledge and experience as midwives offering assistance with development of theory. Audit trails were kept and 'provisional theories were constantly questioned and tested against raw and coded data' (p 67).

McKevitt et al. (2011) used interviews as part of their study. Although not specifically labelled as mixed methods, the authors used interviews to confirm findings from questionnaires (which could be called an explanatory mixed method technique). Interviews were conducted with six midwives and two doctors who had completed the questionnaire and gave consent. A purposive sample was chosen from a combined group of doctors and midwives that identified two participants from each age group. It was not clear how it was decided the split of midwives to doctors and in which age groups. Semi-structured interviews that lasted 20-30 minutes were analysed thematically and transcripts were reviewed by all members of the research team as well as the participants (to confirm agreement that they provided a true reflection of the interview). This paper also scored 30. It was noted that expert opinion was obtained to verify the analysis of the interviews but it was not clear who this was.

Altaf (2006) used semi-structured interviews as data collection in conjunction with structured observations of women in labour and midwives caring for them. Despite labelling the study as qualitative in the abstract the structured observations involved completion of checklists by a medical student (the primary author) who it was claimed had 'extensive training and experience in fetal monitoring' (p 410). The main aim of the study was to examine deviations from recommended practice (as set out by NICE) and gather insight into why these deviations occur. Twenty interviews were undertaken with midwives of varying grades and experience using a constant comparative technique. It was not clear whether any theoretical sampling was done according to GT principles and the paper scored moderately.

In the final and most recent paper Hill (2016) used semi-structured interviews to identify experiences of midwives using intermittent auscultation in labour. Interviews from 8 midwives of varying experience and care provision models were analysed using a phenomenological framework. Four main themes were identified and the study scored highly for being a well-designed, ethically sound paper that acknowledged strengths and weaknesses of the study.

2.6.6 Synthesis of Findings

Five themes were identified in the synthesis of findings on HP views of fetal monitoring: 'reassurance and safety', 'technology', 'mechanical medicalisation', 'education and research', and 'competing midwifery priorities'. The systematic review by Smith et al (2012) identified four themes similar themes from the literature but an additional theme (competing midwifery priorities) was identified centred on midwifery specific issues related to fetal monitoring in labour.

2.6.6.1 Reassurance and safety

A number of papers found that HP viewed CEFM as providing reassurance that all was well with the fetus as well as 'proof' that it was 'coping' with labour (Sinclair and Gardner, 2001; Altaf et al., 2006; Blix and LS, 2007; Hindley and Thomson, 2007; McKevitt et al., 2011). Hill (2016) also found that midwives recorded the fetal heart rate heard by auscultation on a CTG print out (using a CTG transducer rather than a Doppler or Pinard) to provide 'proof' and defend practice. Some older papers found that HP felt using CEFM was safer than intermittent auscultation (IA) and believed that use of CEFM had decreased perinatal morbidity and mortality (Cranston, 1980; Birch and Thompson, 1997). Cranston (1980) found that 96% of HP felt that CEFM could decrease perinatal morbidity and mortality rates. Contrary to this, and perhaps reflecting on more recent evidence that the use of EFM has had no impact on perinatal morbidity or mortality, two of the more recent papers found that HP did not think that CEFM was essential for safe births (Sinclair, 2001; McKevitt et al, 2011). However the findings may have been related to more philosophical positions with Dover and Gauge (1995) finding a statistical correlation between midwives who prospectively viewed childbirth as a normal event and disagreeing that CEFM was a safer method than IA. A further subtheme was the finding that use of CEFM would guard against 'missing something' if IA was used and fear of consequent criticism and litigation (Sinclair and Gardner, 2001; Hindley et al., 2006; Hindley and Thomson, 2007).

Three of the studies found that HP viewed CEFM as being reassuring for the women they were caring for (Cranston, 1980; Birch and Thompson, 1997; Sinclair and Gardner, 2001) as well as for the HP (Birch and Thompson, 1997; McKevitt et al., 2011). However Sinclair (2001) and McKevitt (2011) found that HP (85% and 80% respectively) would not always trust the EFM recordings over their own clinical observations and assessments of labour progression.

2.6.6.2 Technology

The literature highlighted differing opinions on the role of technology in childbirth ranging from faith to scepticism. Cranston (1980) conducted a survey of 124 registered nurses in which 88% of respondents thought that CEFM could not be matched by IA and 76% thought that CEFM was indicated for normal labour as complications could occur at any time. However it was evident that there was a change over time with Walker (2001) finding that 74% of labour and delivery nurses disagreed that CEFM should be standard care for low risk women. McKevitt (2011) also found that HP had more awareness around CEFM being recommended for high-risk women only. Three papers presented the view that HP viewed CEFM as more scientific and more authoritative than IA, increased professional status and validated technology use (Hindley and Thomson, 2005; Altaf et al., 2006; Blix and Ohlund, 2007). This was tempered by some HP views that the use of technology and specifically CEFM was undermining midwifery skills and devaluing the art of midwifery (Altaf et al., 2006; McKevitt et al., 2011). However, in the largest study within this review, of 446 midwives in Northern Ireland (Sinclair, 2001) 'the anecdotal position that midwives are becoming dependent on technology such as CTGs as their personal skills are argued to be undermined' was addressed, and factor analysis 'indicated a rejection of the notion of any dependency, over-reliance or blind trust' (p 603). Other findings were that HP found that CEFM lacked credibility in terms of evidence, and was used unnecessarily (Sinclair, 2001; Sinclair and Gardner, 2001; Altaf *et al.*, 2006; McKevitt *et al*, 2011), and led to increased intervention rates (Sinclair and Gardner, 2001; McKevitt *et al*, 2011). Intermittent auscultation was viewed by midwives in two papers as being low technology, fostering closeness with the woman and aligned with a more 'natural birth' (Hindley et al., 2006; Hill, 2016). The American based study by Rosenbaum (2018) reported on the time that nurse/midwives spent interacting (meaning adjusting the belts or transducers to get a better recording) with EFM monitors during a shift. They found that in a labour and delivery setting 75.9% of nurse/midwives spent over an hour interacting with the monitors in a 12 hour shift. Participants also reported some women more challenging to monitor that others including obese patients, multiple gestation and early gestation (Rosenbaum et al., 2018).

2.6.6.3 Mechanical medicalisation

A number of interview studies reported that HP viewed CEFM as being a discomfort for women and increased their anxiety (Altaf *et al.*, 2006; McKevitt *et al*, 2011; Rosenbaum *et al.*, 2018). However, Sinclair (2001) found that the statement 'I

believe that using a CTG increases a mother's anxiety' was evenly split between agreeing (40%) and disagreeing (40%). CEFM was viewed as being restrictive, dehumanising and women ending up 'tied to the bed' (Hindley *et al*, 2006; McKevitt, Gillen and Sinclair, 2011), as well as being associated with increased pain relief (Hindley *et al*, 2006) due to an inability to mobilise freely. Midwives in particular expressed views that the CTG machine became the focus of attention and that medical colleagues relied on the interpretation of the CTG alone rather than undertaking a full clinical assessment of the woman as well as fetal heart rate findings (Altaf et al., 2006).

2.6.6.4 Education and research

Issues around education for HP on fetal monitoring was raised in five of the papers (Dover and Gauge, 1995; Sinclair and Gardner, 2001; Altaf et al., 2006; McKevitt et al., 2011; Hill K, 2016). Of concern was reference to HP not receiving adequate training on interpreting a CTG. In the study by Dover and Gauge (1995), 59% of midwives stated they had not received any formal education in CTG interpretation, whilst 55% of respondents from the Sinclair and Garner study (2001) felt that training had not prepared them for interpreting a CTG. In contrast to this, midwives interviewed in the Altaf (2006) study were generally satisfied with training. Hill (2016) found that midwives did not feel that there was enough updating on IA like there was for CEFM. Two of the studies reported from participants that multi-professional training was needed for all staff on monitoring of the fetal heart (Sinclair and Gardner, 2001; McKevitt et al., 2011). McKevitt (2011) reported that with limited evidence on benefit of CEFM for women or babies then more research was needed. Rosenbaum (2018) asked respondents in their survey what features of a CEFM monitor would be most useful and these included enhanced fetal heart rate accuracy, greater ease of use and improved portability with wireless capability.

2.6.6.5 Staffing ratios

Four papers (Dover and Gauge, 1995; Walker et al., 2001; Rattray et al., 2011; Hill, 2016) highlighted issues centred on staffing ratios and fetal monitoring in labour. Dover and Gauge (1995) found that 72% of respondents agreed or strongly agreed that the method of FHR monitoring chosen was more likely to be continuous when staffing was poor. The view that the CTG monitor is able to be a 'babysitter' for the woman and fetus was expressed by midwives (Rattray et al., 2011; Hill, 2016). Rattray (2103) reported that 54% of the HP thought that not being able to provide one-to-one care prevented IA. Intermittent auscultation was viewed as being more time consuming than caring for a woman on a CTG. This is despite when women

are placed on CTG monitors and left without the continual presence of a midwife then no one is able to interpret the recording in real time in the room. The more recent advent of centralised fetal monitoring may play a part in this, as the CTG is able to be viewed from outside the room and may be contributing to women being left alone in labour (Brown et al., 2016).

2.6.6.6 Competing midwifery priorities

Despite the literature review being focused on health professionals' views of fetal monitoring in labour it became apparent that there was a large amount of literature centred solely on midwifery views. Some of the competing priorities and tensions midwives' experience when making decisions about fetal monitoring in labour was highlighted. McKevitt (2011) investigated whether there was a difference between midwife and doctor attitudes to the CTG. They found no evidence to reject the null hypothesis that there was no difference between doctors and midwives attitudes towards CTG use in labour. They did find however that 83% of midwives agreed with the statement that the use of CTG can lead to unnecessary intervention, but 64% of doctors disagreed with the statement. In five of the papers (Hindley and Thomson, 2005; Altaf et al., 2006; Blix and Ohlund, 2007; Hindley and AM, 2007; Rattray et al., 2011) midwives referred to medical opinion on CTG interpretation being paramount and that the medical profession carried more dominance and power in relation to fetal monitoring opinions and interpretations.

A further theme identified around midwifery views was the finding of a theory-practice divide for midwives. Attitudes expressed by midwives in interviews were not always borne out in behaviour. For example, Dover and Gauge (1995) found that whilst midwives very clearly stated that low risk women should be monitored by IA, in the regional unit where some of the midwives worked, 83% of women in labour were continuously monitored (a rate that the authors felt was high for women that were both low and high risk). This conflict between theory and practice was also identified by Thompson and Birch (1997) and Rattray (2011) who found that 'the midwives decided the most appropriate way to monitor the well-being of the labouring woman and foetus according to their own personal clinical risk schemas.....not necessarily congruent with clinical guidelines' (p 67). Decision-making for midwives about when and how to monitor the fetal heart in labour was not taken in isolation but influenced by workload, risk management, fear of litigation, and medical dominance (Hindley and Thomson, 2005; Altaf et al., 2006; Rattray et al., 2011). In terms of informed choice for women about fetal monitoring, this was influenced by the power of the midwife who filtered information given to the woman

about fetal monitoring in order to influence the woman's decision-making; indeed Hindley and Thomson (2005) refer to 'the rhetoric' of informed choice. Women were identified as trusting of midwives knowledge and therefore passive in decision-making (Rattray et al., 2011). Whilst midwives are promoted as advocates for normality and rejecting unnecessary medicalisation and increased technology in birth, this position was seen as increasingly difficult when working within complex systems.

2.6.7 Discussion

Literature on health professionals' views of fetal monitoring in labour was of moderate to high quality and generated many divergent themes. Studies reported a conflict between expressed opinions, knowledge and theory, and practice. There was evidence that CEFM continued to be used for low risk women despite evidence to the contrary. A number of reasons were cited for this including fear of litigation, organisational culture, and decision-making in complex and increasingly busy labour wards where staffing ratios may impact on care provision. CEFM was thought to be both reassuring and anxiety provoking for women but there was agreement on it being uncomfortable and restrictive. Themes from the review highlighted some of the barriers and facilitators to different types of monitoring and emphasised that on-going multi-professional education, as well as education for women, is crucial.

2.7.1 Inclusion/exclusion criteria

The inclusion criteria for this search were:

- All relevant primary and review studies.
- All studies reporting clinical outcomes and/or women's/health professionals experiences of using telemetry to continuously monitor and print out the fetal heart in labour.
- Peer reviewed papers.
- There were no date restrictions.
- Papers where the full text was available.

The exclusion criteria for this search were:

- Papers not written in English (due to time and expense involved in translation)

- Papers reporting on technical specifications or configurations of monitoring systems.
- Papers concerned with the antenatal period, pre-term labour, monitoring at home or telemetry monitoring of different parameters (for example partial pressure of oxygen).
- Papers where only abstracts were available.

2.7.2 Search terms

Search terms in Table 5 were used in the OVID platform (Psychinfo, EMBASE, ASSIA, Maternal and Child Health) AND EBSCOhost platform (MEDLINE, and CINAHL). Parameters were combined with the Boolean Operator AND for the final search. Due to author's knowledge that there was only a small amount of literature published on the use of telemetry use in labour a broad search was required and the comparator and outcome search terms were therefore excluded for this search.

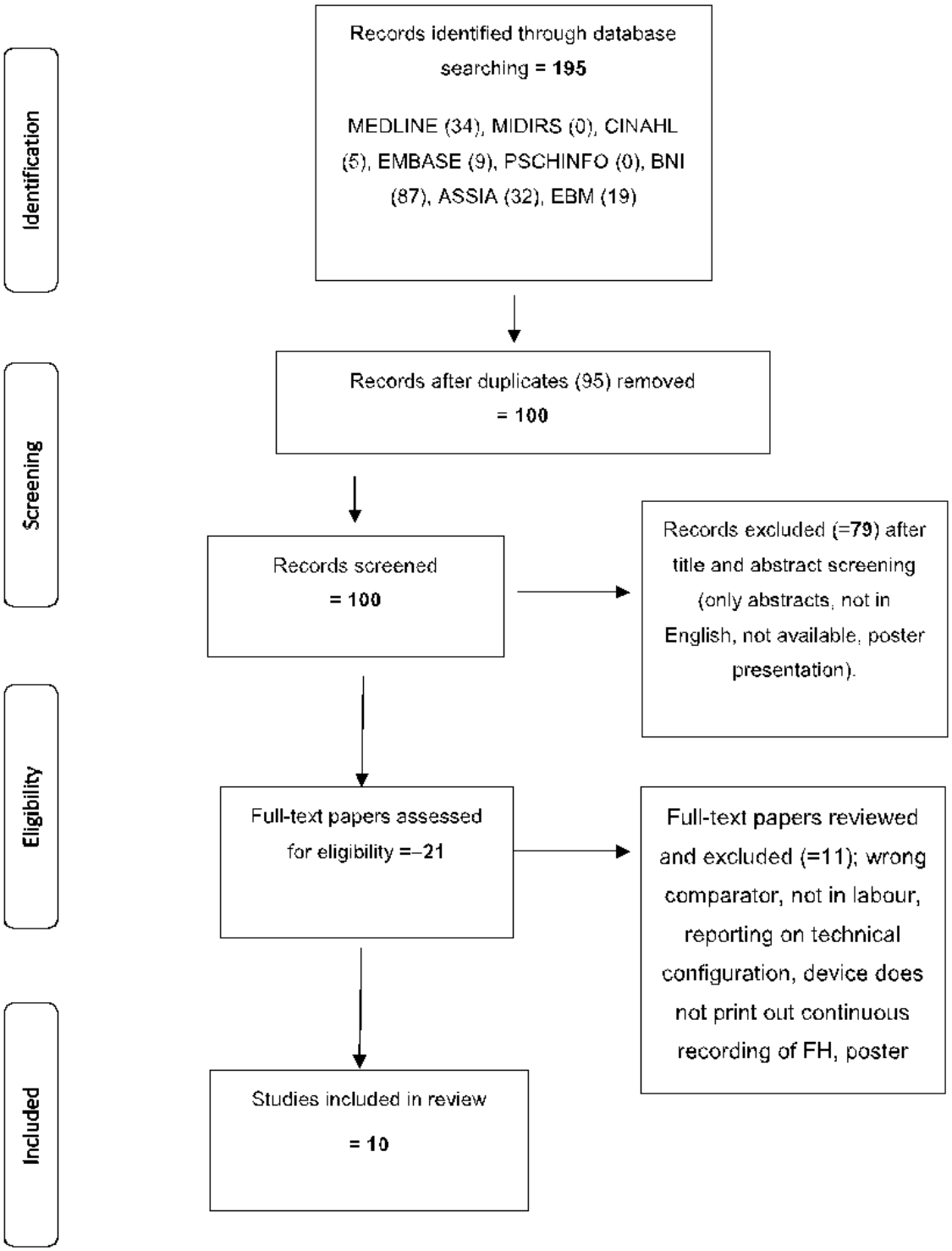
Parameter	Search terms
Population	Labo?r.mp OR
	Childbirth/ OR
	Childbirth.mp OR
	Birth/ OR
	Birth.mp
Intervention	Telemetry/ OR
	Telemetry.mp
	Wireless monitor.mp
	Corless.mp
	Radiotelemetry.mp
Comparator	-
Outcome	-

Table 5 Search terms used for Telemetry to Monitor the Fetal Heart in Labour

2.7.3 Results

Results from the search are presented in Figure 8. In total 195 papers were identified as being relevant from the initial searches of all databases. Once duplicates had been removed the remaining 100 titles and abstracts were screened. Papers were excluded (a total of 79) for a number of reasons including: not being in English, not relating to telemetry in pregnancy/labour, and full texts being unobtainable (generally due to being over 40 years old). Twenty-one full text papers were screened further and of these 10 were included for final quality appraisal and review. Reasons that full text papers were excluded were use of a different recording parameter (fetal oxygen partial pressure), telemetry being used in the home, and papers that reported technical specifications of telemetry systems rather than clinical or women centred outcomes. Four new papers were identified when the search was re-run whilst the researcher was writing up this thesis. The four papers were excluded as one of them was testing functionality of a new device on women who were not in labour, and three other papers were concerned with a wireless fetal heart rate monitor being used in Uganda and Tanzania which showed the fetal heart rate electronically as a single number without a continuous print-out of the fetal heart rate. The applicability of these low-resource settings also justified exclusion. See Appendix 8 for a table of excluded papers.

Figure 8 PRISMA diagram for Telemetry to Monitor the Fetal Heart in Labour



2.7.4 Summary and critical appraisal

The ten papers identified ranged in publication year from 1976 – 2018. Seven of the papers were randomised controlled trials conducted in the UK (Flynn et al., 1978; Calvert et al., 1982), Finland (Haukkamaa et al., 1982), Canada (Hodnett, 1982), Australia (MacLennan et al, 1994), and France (Karraz, 2003; Frenea et al., 2004). Two other observational cohort studies were from the UK (Flynn and Kelly, 1976) and Australia (MacLennan and Green, 1979). One paper was a survey from the UK (Watson et al, 2018). This paper is authored by the researcher and her supervisors and is included as Appendix 6.

Six out of the ten papers scored very low or low quality (ranging from 10–18) using the Hawker (2002) checklist (see Appendix 7 and 8 for summaries and scores). Many of the low scoring papers included major flaws in terms of study design (including poor randomisation techniques) and were also downgraded for transferability to modern telemetry use. For example, seven of the ten papers involved all women having their membranes artificially ruptured to apply a fetal scalp electrode to facilitate monitoring by telemetry, as this was the manner in which the telemetry systems worked prior to around 1998 (Taylor et al., 1998). Women were also required to carry a battery pack around with them. After around 1998 it became possible to monitor the fetal heart abdominally with a telemetry system. The three most recent papers were given scores of 28 (MacLennan et al, 1994), 30 (Karraz, 2003), and 33 (Frenea et al., 2004). These papers reported on better designed studies with acknowledgement of some bias, justification of sample size and clear reports of results, and implications for practice.

2.7.5 Description of studies

2.7.5.1 Randomised Controlled Trials

Three of the studies specifically compared the use of conventional cardiotocography (CTG) with telemetry (Calvert et al., 1982; Haukkamaa et al., 1982; Hodnett, 1982). Calvert et al (1982) aimed to assess the 'effect of telemetry on the pattern of labour, outcome and attitudes of patients' (p 285). Haukkamaa (1982) sought to examine length of labour and analgesia requirements for women monitored with telemetry and Hodnett's (1982) main aim was to investigate maintenance of control in labour. Two of the studies had their primary comparison as ambulation versus recumbence in labour (Flynn et al., 1978; MacLennan et al., 1994). The main outcomes of these studies were whether ambulation in labour had any impact on length of labour, need for analgesia or mode of birth. Women ambulating were monitored with telemetry

and those recumbent were monitored conventionally. The most recent randomised controlled trials (Karraz, 2003; Frenea et al., 2004) investigated ambulatory epidurals; telemetry was used to monitor ambulant women whilst conventional CTG was used to monitor women in a recumbent position. These studies sought to understand if being mobile with epidural anaesthesia had any advantages in terms of length of labour, mode of birth or pain scores. A major potential bias with all of the studies investigating ambulation compared to recumbence is that women may have behaved differently knowing the study was about ambulation rather than if it was about telemetry, leading to selection bias (Bowling, 2014). Details of randomisation, inclusion and exclusion criteria and data collection for all seven randomised controlled trial papers are given in Table 6.

Author, year	Total Number of women	Randomisation technique	Inclusion Criteria	Exclusion criteria	Data collection	Comments	Quality score
Telemetry compared to conventional CTG							
Calvert et al, 1982	**200** 100 telemetry (could walk, or sit in chair). 45/100 got out of bed. 100 conventional - lateral position in bed	Whether hospital number was odd or even	>37 weeks Spontaneous labour At least 2.5cm dilated.	Previous LSCS, stillbirth or neonatal death	Questionnaire 24 hours after birth (pain anxiety comfort, mobility) – linear analogue scale 0-100. Clinical outcomes from notes.	All women had artificial rupture of membranes and a fetal scalp electrode applied to the vertex. Vaginal examination every 2 hours.	17
Haukkamaa, 1982	**60** 31 telemetry (32% induction of labour) 29 conventional (24% induction of	Matched for age and parity then random allocation to either group – no details	38 – 42 weeks	None given	Women monitored pain score every 30 mins (0-10). Questionnaire 2 hours after birth. Clinical outcomes	All women had artificial rupture of membranes and a fetal scalp electrode applied to the vertex	14

	labour)				from notes.		
Hodnett, 1982	**30** 15 telemetry 15 conventional	Randomly assigned to either group – no details	Low risk, no other details	None given	Kept a written record of amount of time spent out of bed – no details on how. Labour Agentry Scale + interview by author. Clinical outcomes from notes.	All women had artificial rupture of membranes and a fetal scalp electrode applied to the vertex. Only included those who had a normal birth but women were selected antenatally.	18
Ambulation (telemetry) compared to recumbence (conventional CTG)							
Flynn et al, 1978	**68** 34 ambulation 34 recumbent	Random allocation to ambulation or recumbent – no details	Expressed an interest in ambulation in labour.	None given	Clinical outcomes from notes.	All women had artificial rupture of membranes and a fetal scalp electrode applied to the vertex. Transmitter worn around waist. Women not allocated to telemetry were told there were no more machines available. Vaginal	17

						examination every 2-3 hours.	
MacLennan et al, 1994.	**196** 96 ambulant 100 recumbent – 45 degrees or lateral	Balanced variable blocks with stratification by parity.	Spontaneous labour, singleton fetus, cephalic presentation, 37-42 weeks, 3cm dilated or more	IV fluids, hypertension, epidural, narcotic or fetal distress before entry, induction of labour.	After labour each woman completed a visual analogue scale rating satisfaction (0-10). Clinical outcomes from notes.	All women had artificial rupture of membranes and a fetal scalp electrode applied to the vertex.	28
Ambulation with epidural (telemetry) compared to recumbence with epidural (conventional CTG)							
Frenea et al, 2003.	**61** 30 – Ambulation, asked to walk at least 15 minutes of each hour. Returned to bed at full dilatation. 31 – recumbent in dorsal or lateral	If requested epidural then randomly allocated to ambulate or recumbent group using sealed numbered envelopes once first dose of	Uncomplicated, term, spontaneous labour or induction of labour. Singleton, cephalic presentation, 3-5cm dilated	Unfixed cephalic presentation, more than 5cm dilated, contraindication to epidural, multiple pregnancy, previous LSCS,	Level of pain assessed using visual analogue scale (0-100) – mean pain VAS score calculated. One day after birth women questioned about side effects and overall satisfaction using a 4 level scale.	Amniotomy only if slow progress. All women had intermittent top-up epidurals.	33

	position.	epidural in.		breech presentation, fetal distress			
Karraz et al, 2003	**221** 141 ambulant – walked for 20 minutes after epidural 74 – non-ambulant, supine or lateral.	Randomly divided into two groups – no details how. 2:1 allocation ambulatory versus non-ambulant.	Uncomplicated pregnancies, spontaneous labour or induction of labour, 36-42	Previous LSCS or pre-eclampsia. Excluded if delivered within 15 mins of having epidural.	Visual analogue pain score before epidural insertion and 20 min after each injection. Clinical outcomes from notes.	Amniotomy only if slow progress. All women had intermittent top-up epidurals. Only conducted in day time as authors felt that at night women less likely to walk as would be tired.	30

Table 6 RCT Study Characteristics

2.7.5.2 Observational cohorts

Two papers reported observational cohort studies (Flynn and Kelly, 1976; MacLennan and Green, 1979). The first of these (Flynn and Kelly, 1976) was the earliest paper in the review and was given a score of 14, as reporting was purely descriptive. This paper reported on outcomes for 30 women in spontaneous labour who had been monitored using telemetry. All women had their membranes ruptured to attach a fetal scalp electrode and a radio transmitter was worn around the woman's waist whilst being monitored. Women returned to bed for the second stage of labour. Data were collected on length of labour, ambulation, and whether or not oxytocin was required. Women were also interviewed but the focus was not clear. MacLennan and Green (1979) was the lowest scoring paper (10) and included technical specifications about the monitoring equipment but also reported on 300 'favourable' women that had used telemetry during labour. However, there was no description of sampling, context, characteristics of the cohort, how data were collected, and no mention of any ethical considerations. Again all women had their membranes ruptured to attach a fetal scalp electrode and a radio transmitter was carried by the woman.

2.7.5.3 Survey

The paper by Watson et al (2018) reported on a national survey of maternity units in the UK on the use of telemetry. The survey aimed to 'gather information from maternity units on whether they offered telemetry, gain a sense of how often it is was used, the women for whom it was used and whether there were any perceived advantages or disadvantages to using telemetry for women in labour' (Watson et al, 2018, p 15). An online survey was sent to 168 Heads of Midwifery within the UK. The online survey had a response rate of 62% (total number of units 104). Sixty-three percent of responding units reported having at least one telemetry machine that could be used to monitor the fetal heart in labour. Forty-five percent had between one and three machines, 12% had between four and six machines and 6% of units had more than six machines. Of the 39 maternity units that did not have telemetry 50% were intending on purchasing some on the next six months.

2.7.6 Synthesis of findings

2.7.6.1 Clinical Outcomes

A meta-analysis was performed within the Intrapartum Care for Healthy Women and Babies guideline (NICE, 2014) on clinical outcomes for telemetry. Whilst it is acknowledged that there is a great deal of heterogeneity between the studies, many

risks of bias, and that many of them were conducted in conditions that are vastly differently from how women are cared for in labour today, the combining of comparative data and results may give a better overall picture of any effect that telemetry has, rather than viewing individual papers and summarising results. For some outcomes only one paper was able to be used as the outcome of interest was only reported within that paper. There was one statistically significant finding from the meta-analysis; for women who were monitored by telemetry, the use of epidural analgesia was significantly less when compared to women who were monitored with conventional CTG. The pooling of results found that 71/276 (25.7%) of women in the telemetry arms had an epidural for pain relief and 102/278 (36.7%) of women in the conventional arms had an epidural (RR 0.71, 95% CI 0.57 to 0.9). The absolute effect was 106 fewer epidurals per 1000 women (from 37 fewer to 158 fewer). This finding prompted NICE to conduct a health economic analysis on the use of telemetry in labour which concluded that there would be a cost saving to Trusts if women using telemetry were less likely to have an epidural for pain relief (NICE, 2014). This analysis included low risk women only (estimating that 5% of low risk women would develop risk factors and need continuous fetal monitoring during their labour). Overall there was no significant difference in the total length of labour between women monitored with telemetry compared to conventional monitoring. However, one study (Flynn et al., 1978) found that the first stage of labour was a mean of 2.6 hours shorter for women monitored with telemetry compared to those with conventional CTG.

2.7.6.2 Degree of mobility

Six studies reported on the effects of telemetry on mobility (Flynn and Kelly, 1976; Flynn et al., 1978; Calvert et al., 1982; Haukkamaa et al., 1982; Hodnett, 1982; MacLennan et al., 1994). Two papers (Karraz, 2003; Frenea et al., 2004) asked women to ambulate regularly as part of the intervention so these were not included in this theme. The percentage of women monitored with telemetry getting out of bed during labour (for any length of time) ranged from 39% (MacLennan et al., 1994) to 100% (Hodnett, 1982). Hodnett (1982) found that women in the telemetry group spent a significantly longer time out of bed compared to the conventional group. Mean time in the telemetry group was 142.7 minutes (range 30 – 300) and the mean time in the conventional group was 8.7 minutes. MacLennan (1994) found the 39% of women that ambulated with telemetry spent a mean time of 1.5 hours upright and Haukkamaa (1982) found that the time spent upright for the telemetry group ranged from 10% to 90% of the first stage. In all of the studies women

monitored with telemetry were asked to return to the bed for the second stage. There is no information on which positions were used for birth, although it may be justified to assume that most women gave birth in a supine position given the publication dates and conventions of care in labour at this time.

2.7.6.3 Women's views and acceptability of telemetry

Three of the studies (Calvert et al., 1982; Hodnett, 1982; MacLennan et al., 1994) attempted to measure satisfaction with telemetry using different scoring systems. MacLennan (1994) found no difference between the two groups in satisfaction using a scoring system of 0 – 10, Calvert (1982) found no difference between the two groups in reassurance, or restriction from monitoring using a scoring system of 0-100. Hodnett (1982) did find a difference between the two groups when using the Labour Agentry Scale (a validated instrument measuring expectancies and experiences of control during childbirth) with women using telemetry having a higher overall score. Hodnett (1982) also found that women using telemetry felt that telemetry had a significant positive effect on labour experience (93% of telemetry group compared to 33% of conventional group) and maintenance of control during labour (67% of telemetry group compared to 27% of conventional group). Hodnett (1982) had only 15 women in each arm and there was no justification of sample size in terms of ability to detect significant differences so caution should be applied to interpreting these results. Calvert (1982) asked women who had experienced monitoring to compare their experiences. Of the telemetry group 15/28 (54%) found the current method preferable to their previous labour that was monitored conventionally. In terms of restriction 15/28 (54%) of women in the telemetry arm felt less restricted than in a previous labour.

2.7.6.4 Survey findings

In the survey conducted by Watson et al (2018) 24% of respondents reported that more than ten women would use telemetry per week on their unit. Seventy-five percent of units stated that less then 24% of women would use a birthing pool with telemetry. Problems with the machines were reported by 52% of respondents and they included transducers becoming lost or broken, transducers not being charged, loss of contact resulting in poor quality recording and connectivity issues. Respondents were asked for which women was telemetry used most used. The most frequent group was women having a previous lower segment caesarean section (49%) followed by induction of labour (22%), meconium in labour (17%) and raised body mass index (12%). Free text comments were also included with one maternity unit that cared for over 5000 women per year stating 'we use telemetry as

standard for women requiring electronic fetal monitoring (Watson et al, 2018, p 17). A further questions asked was 'Which aspects of labour are positively influenced by the use of telemetry?' (ibid, p 17). Mobility in labour was the highest scoring response (31%) followed by satisfaction (28%), pain relief (13%), mode of birth (10%), labour progress (10%) and length of labour (6%).

2.7.7 Discussion

The majority of literature on the use of telemetry to monitor the fetal heart in labour is out-dated and much of it not relevant to contemporary UK practice. Many of the studies were poorly designed and contained significant biases and limitations. Any evidence that telemetry has an influence on clinical outcomes is mainly weak and the majority of studies were not powered to detect any real differences. A recent survey identified that the majority of maternity units do have telemetry for use in labour and midwives identified that it could have a positive influence on some labour outcomes. There is a distinct lack of good quality qualitative research into the experiences of women and midwives using telemetry, and quantitative research investigating any influence on clinical outcomes. Overall, women were found to react positively to telemetry and there were a number of suggestions of benefit that warrant further investigation such as increasing mobility, decreasing epidural use and increasing control.

The integrated literature review provided valuable insights into the views of women and HP on fetal monitoring in labour and the use of telemetry. CEFM provided reassurance for women and this 'reassurance effect' was mentioned in six of the nine studies on women's experiences; women liked hearing the fetal heart beat in labour and it provided a sense of security. However, CEFM was also found to increase levels of anxiety and fear for some women, mainly associated with hearing the fetal heart sounds coming from the monitor (Starkman, 1976; Shields D, 1978; Beck, 1980; Hodnett, 1982; Barber et al., 2013). One study however, did not find a difference in anxiety levels when comparing CEFM to IA (Garcia et al., 1985). Extra information that CEFM could provide about the fetus was viewed positively for some, and increased surveillance was linked to reassurance and safety (Beck, 1980; Barber et al., 2013). CEFM influenced communication in different ways between women, birth partners and health professionals and was a theme in the majority of studies. The valuable source of information about labour, such as when

a contraction was starting, facilitated communication with birth partners (Beck, 1980) and women felt that the CTG facilitated decision-making for and with health professionals (Starkman, 1976; Shields, 1978). A theme from all of the nine studies in the review of women's experiences was that of CEFM being a discomfort and enforcing immobility; the straps were restrictive and women felt 'tied to the bed'. Garcia (1985) found that the CTG significantly restricted of movement women and Hindley (2008) found that CEFM increased use of pain relief. Women expressed differing preferences for monitoring but highly valued being given information in labour. This was often not forthcoming and resonates with other choice issues in childbirth such as place of birth (Houghton et al., 2008) and choice of pain relief (Lally et al., 2008).

Health professionals' views of fetal monitoring varied across the studies and identified some important themes. CEFM offered professionals a sense of reassurance that the fetus was well and ensured that there was legitimised 'proof' that ruled out any compromise (Sinclair, 2001; Altaf et al., 2006; Blix and Ohlund, 2007; Hindley and AM, 2007; McKevitt et al., 2011). This was viewed as protection against litigation and recrimination if there was to be an adverse event (Sinclair and Gardner, 2001; Hindley et al., 2006; Hindley and AM, 2007). The faith in CEFM contributing to safety and outcomes dwindled over time with later studies highlighting views of some HP that CEFM was used inappropriately and increased levels of intervention (Sinclair, 2001; Sinclair and Gardner, 2001; Altaf et al., 2006; McKevitt et al., 2011). These themes were also linked to those of the use of technology in childbirth. Some papers linked the use of technology to increasing professional status (Hindley and Thomson, 2005; Altaf et al., 2006; Blix and Ohlund, 2007) whilst others expressed views that the use of technology was undermining midwifery skills and devaluing the art of midwifery (Altaf et al., 2006; McKevitt et al., 2011). Midwives in particular viewed the lower technology of IA as allowing proximity to women and aligned with a more natural birth (Hindley et al., 2006). Many of the papers reported that HP viewed CEFM as being a discomfort to women, dehumanising and restrictive (Altaf et al., 2006; Hindley et al., 2006; McKevitt et al., 2011). CEFM was also felt to divert the focus of attention away from women and be given priority over other clinical assessments of women in labour (Altaf et al., 2006). Interestingly this theme was not apparent in the women's perspectives. Midwives also expressed the view that CEFM was used in place of IA when staffing ratios were poor (Dover and Gauge, 1995; Walker et al., 2001; Rattray et al., 2011). The advent of centralised fetal monitoring (where CTG traces

from each room in a labour ward are able to be viewed on a large screen in a central office within the delivery unit) may be playing a part in women being attached to CTG machines and left for periods of time whilst midwives care for other women and with the knowledge that the CTG can be seen from outside the room. In a recent national survey of women's experiences in labour (Care Quality Commission, 2019) 12% of women reported being left alone at a time that worried them during labour and this may be linked to the rise in centralised monitoring. A crucial theme around CEFM was that midwives decision-making around fetal monitoring in labour took place within a complex system involving hierarchical systems, conflicting philosophies, fear of litigation, and staffing scenarios where evidence-based care (such as one-to-one support in labour) was not able to be facilitated (Hindley and Thomson, 2005; Altaf et al., 2006; Rattray et al., 2011). This manifested in a theory-practice divide for midwives and resulted in tensions and conflicting opinions (Birch and Thompson, 1997; Rattray et al., 2011).

Integration of the literature on women's and HP views of monitoring confirmed that women valued highly being given information about fetal monitoring but this was influenced by how much and what type of information was given by HP. Women felt that the views of HP were trustworthy and this influenced decision-making but there was also evidence that the way some information was given to women influenced the type of monitoring received (Hindley and Thomson, 2005; Rattray et al., 2011). This resonates with other choice issues in childbirth such as place of birth (Houghton et al., 2008) and choice of pain relief (Lally et al., 2008). There was agreement within both sets of literature that CEFM can be a reassurance to women and midwives but may also increase anxiety and intervention. CEFM was overwhelmingly viewed as being a discomfort for women and reduced the ability to mobilise during labour.

Whilst it would be sensible to assume that telemetry would facilitate increased mobility in labour and consequently have an effect on outcomes such as length of labour or type of pain relief used, the current literature does not provide strong evidence for this. However, the literature is out-dated and the telemetry used in the majority of studies very different to telemetry used in modern maternity units. Outcomes for mobility in labour varied across the studies and the way it was measured differed. There was some evidence that telemetry may reduce the length of labour for women (Flynn et al., 1978) and evidence from a meta-synthesis that the use of telemetry reduces epidural use (National Institute for Health and Clinical Excellence, 2014). There was also some evidence that telemetry had a positive

effect on labour experience and increased feelings of control (Hodnett, 1982) and that women felt less restricted (Calvert et al., 1982). The studies were mostly small in size, of poor quality and the majority of telemetry used required all women to have a fetal scalp electrode in place. Recent survey results of telemetry use in the UK (Watson et al, 2018) indicated that telemetry is being used in maternity units for women who require CEFM and that it may have a positive influence on mobility, satisfaction and length of labour.

A review of the literature on fetal monitoring views and telemetry has revealed a number of gaps that justify further research being undertaken. The majority of literature on women's views of fetal monitoring was published in the 1980s when the use of CEFM in labour was seen as being beneficial for all and a technological advancement. There is a need to revisit and explore further women's views of monitoring particularly in light of the evidence base around outcomes with CEFM, centralised fetal monitoring and modern telemetry. The literature revealed that HP decision-making on fetal-monitoring is complex and there are tensions between the type of care midwives wish to provide and the realities of working in busy labour wards. There is no peer-reviewed literature on HP views of telemetry and how it is used in practice, or how decisions are made about who it is used for. There is no contemporary evidence about the use of telemetry in labour including any influence it may have on feelings of control and satisfaction in labour, mobility, or labour outcomes. No good quality qualitative research has been done on the use of telemetry and there is no literature on the use of water and telemetry. There is an external call for research to be undertaken in this area within research recommendations from NICE (2014), as well as a call from the recent Cochrane Review on fetal monitoring in labour who call for research to be undertaken on the use of mobility in labour (Alfirevic et al., 2017). Justification for undertaking this research is strong and the researcher is driven by exploring new technology that has the potential to improve labour experiences for women who require continuous fetal heart rate monitoring. The researcher has had personal experience of using telemetry when caring for women in labour and has seen both the potential benefit and some of the disadvantages, such as loss of contact and charging issues. She has also seen a lack of enthusiasm for telemetry from some midwives and was curious to explore all issues around its use.

Following from the literature review and identifying substantial gaps in the literature on fetal monitoring and the use of telemetry the following aims and objectives were identified for this study:

2.10.1 Study Aims

To gather in-depth knowledge about the experiences of women and midwives using telemetry to monitor the fetal heart in labour and to assess any impact that the use of telemetry may have on clinical outcomes, mobility in labour or control and satisfaction.

2.10.2 Study Objectives

1. Collect and analyse in-depth interview data from women and their partners using telemetry to monitor the fetal heart in labour, and midwives caring for them.

2. Collect demographic and clinical data (such as length of labour, use of pain relief, type of birth) and perceived control and satisfaction from a group of women using telemetry and compare this to a group of women using conventional wired monitoring. To also collect data on mobility during labour for women using telemetry and women using conventional wired monitoring.

3. Integrate both sets of data to draw conclusions on any impact the use of telemetry may have for women giving birth in the United Kingdom.

Chapter Two has presented an integrative literature review of women's views and experiences of fetal monitoring, health professional views and experiences of fetal monitoring in labour, and literature on the use of telemetry to monitor the fetal heart in labour. The literature review has revealed substantial gaps that justify the research being undertaken and the aims and objectives of the study to be undertaken have been outlined. The following Chapter will discuss differing research methodologies and present the chosen methodology for the study.

Chapter Three: Research Methodology

This Chapter presents the research questions around telemetry use that followed on from review of the literature and personal clinical experience. Justification for the research on telemetry to be undertaken is given. The study aims and objectives are outlined along with an overview of the philosophical realms of research and differing paradigms within the research world that could underpin methods used to answer the research questions. Reasoning is given for the research paradigm and subsequent methodologies chosen for the study along with elements of rigour that need to be considered for each methodology.

Decisions made about how to answer a research question are intrinsically linked to philosophical stances, in relation to our own ontological and epistemological beliefs. Ontology is defined as 'the nature of the world and what we can know about it' (Ritchie & Lewis, 2014, p16) and concerns both physical and social reality. Higher level questions about how we know the world include whether our beliefs exist independently of external realities (realism) or whether socially constructed meanings lead to reality (relativism). Staller (2012) views ontology, epistemology, methodology and method as existing in layers vertically, from the most philosophically abstract (ontology) at the top, filtering down to actions (methods, for example the type of sampling used), at the bottom. Epistemology is centred on the question of 'how is it possible to know about the world?' (Ritchie & Lewis, 2014, p16) and relates to the justification and collection of knowledge. An epistemological stance is crucial to identify at the outset of any research undertaken as this philosophical thread should run throughout any study and will influence the overall strategy, methods and analysis (Carter and Little, 2007; Houghton et al., 2012; Staller, 2012).

The epistemological stance of research can also be called a paradigm, or worldview, and is a set of shared philosophical assumptions, including beliefs and assumptions about knowledge, that guide inquiry (Creswell and Plano Clark, 2011). Historically, there has been a focus on the dualist quantitative/qualitative split in paradigms; sometimes referred to as 'the paradigm wars' (Andrew & Halcomb, 2009; Denzin, 2010; Feilzer, 2010). The post-war period viewed the two paradigms

as wholly exhaustive and entirely exclusive of each other. However, this thinking has developed over recent decades and Andrew and Halcomb (2009) observe wisely that 'no paradigm explains all the facts, indeed many paradigms can theoretically account for the same set of data' (p17). However in a post-modern framework (that is, taking social realities into account), Creswell and Plano Clark (2011) identify four worldviews, which 'provide a general philosophical orientation to research....and can be combined or used individually' (p 40). These four worldviews and their characteristics are shown in table 7 and further description is given in the following sections.

Paradigm	*Post-positivist*	*Constructivist*	*Participatory*	Pragmatist
Characteristics	Determination	Understanding	Political	Consequences of actions
	Reductionism	Multiple participant meanings	Empowerment and issued oriented	Problem centred
	Empirical observation and measurement	Social and historical construction	Collaborative	Pluralistic
	Theory verification	Theory generation	Change oriented	Real-world practice oriented

(adapted from Creswell and Plano Clark, 2011, p 40)

Table 7 Characteristics of Paradigms used in Research

3.3.1 Positivism/Post positivism

Positivism can be traced back, in the literature at least, as far as 1637 when Descartes wrote about objectivity, evidence and 'the search for truth' (Ritchie and Lewis, 2014. p8). It is focused on seeking the truth through testing of *a priori* hypotheses using scientific, objective, value-free study. Positivism holds that there is one truth to be found aligned with cause, effect, and reductionism. Variables and observations are able to be measured and the researcher maintains an independence from that which is being researched. Post-positivism amends this stance slightly and accepts that the background and knowledge of the researcher

can affect what is being observed, but the biases are recognised and accounted for (Creswell and Plano Clark, 2011). Positivism/Post-positivism is most associated with quantitative research, generation of numerical data and stringent testing of hypotheses. Within health research, positivism aligns with the evidence-based healthcare movement which, for many health professionals, holds the double-blind randomised controlled trial (RCT) as gold standard evidence and places any other type of research on an inferior level (Goldenberg, 2006). The ability to minimise bias, and use large and representative samples that can lead to generalisation, is seen as a strength of this paradigm (Tariq and Woodman, 2013). However, the predominance of the RCT as being the only way of generating robust evidence is increasingly being challenged by some within the research community. One viewpoint is that RCTs are lacking in their ability to provide robust answers to questions of health and illness where patients receive care in complex contextualised systems rather than the controlled environment of the RCT (Goldenberg, 2006; Greenhalgh & Papoutsi, 2018). Post-positivist research takes this criticism into account and as Clark (1998) states, it 'need not exclude either qualitative (that is, non-numerical) data or 'truths' found outside quantitative method; acceptance of this is crucial to rejecting the strict dichotomy often drawn between the qualitative and quantitative paradigms' (p 1245). Post-positivism acknowledges that the researcher helps shape the research process.

3.3.2 Interpretivism/Constructivism

Interpretivism contends that 'knowledge is produced by exploring and understanding the social world of the people being studied, focusing on their meanings and interpretations' (Ritchie and Lewis, 2014, p17). The qualitative research tradition is aligned with interpretivism and constructivism, which attest broadly that meanings and reality are socially constructed, both for the researcher and participant (Higginbottom and Lauridsen, 2014). Research in this form of enquiry is developed from the bottom-up, 'from individual perspectives to broad patterns and, ultimately, to broad understandings' (Creswell and Plano Clark, 2011, p40). This research paradigm is inductive rather than deductive. Research within nursing and midwifery has recognised the value of this paradigm and its vital place in exploratory work. This type of research also has the ability to produce rich non-numerical data that describe behaviours, perceptions, interactions and the contexts within which healthcare is received and delivered. Theory generation may also be applicable to other contexts outside that which is being studied (Tariq and Woodman, 2013). This paradigm is not without its own criticism, centrally that qualitative research lacks

rigor, is highly subjective and the small number of participants in many studies render generalisability difficult (Tobin and Begley, 2004; Ritchie and Lewis, 2014).

3.3.3 Participatory

Participatory research works with communities and groups using participants' knowledge, perspectives and experience as a basis for improvement and change (Cornwall and Jewkes, 1995; Creswell and Plano Clark, 2011). Collaboration is the key to this type of research and is often based on political issues, injustices and marginalisation within society. Participatory research can also have its focus on organisational change and can be combined with appreciative inquiry (Martyn et al., 2019). Much of the methodology is drawn from mainstream disciplines (but more associated with qualitative research) and the main difference is that power lies with the groups involved in the research; planning, design, analysis and dissemination is done co-operatively (Cornwall and Jewkes, 1995). The challenges with participatory research are that distractors argue lack of credibility and rigor and that there may be unintended negative consequences for marginalised participants (Cornwall and Jewkes, 1995).

3.3.4 Pragmatism

At the heart of pragmatism is recognition that the research question should be answered with the most appropriate research method or methods (Onwuegbuzie & Johnson, 2004). Pragmatism lets go of the dichotomy between quantitative and qualitative views and 'sidesteps the contentious issues of truth and reality, accepts, philosophically, that there are singular and multiple realities that are open to empirical enquiry and orients itself toward solving practical problems in the "real world"' (Feilzer, 2010, p8). This pluralistic stance views that different ontological and epistemological positions have many commonalities and should be used collectively to advance the understanding of problems being studied (Feilzer, 2010; Creswell and Plano Clark, 2011). Indeed, Ritchie and Lewis (2014) discuss using both quantitative and qualitative approaches and methods as part of a social researchers 'toolkit' (p 15) as a pragmatic way to answer the research question(s). The pragmatic researcher acknowledges that there are absolutes and unknowns in the way the world is understood; objectivity and subjectivity, control and ambiguity (Feilzer, 2010). Mixed methods are generally aligned with the pragmatic paradigm. Onwuegbuzie and Johnson (2004) acknowledge some of the weaknesses of pragmatism, chiefly that it 'fails as a solution to many philosophical disputes' (p 19).

The overarching epistemological stance adopted for this study is one of ***pragmatism***. Justification for this is two-fold. Firstly, from a personal perspective, doing research in a pragmatic way, oriented in the real world, using the tools and methods that are going to best answer a question resonates with me. I do not believe that there is only one way of seeing the world or obtaining knowledge from it and see the benefit in a convergence of differing epistemological stances. I have been exposed to many different types of research throughout my career and have seen the benefit of different approaches to answering research questions. The contributions that many different types of research, based on differing philosophical viewpoints have made to nursing and midwifery in particular is recognised. Secondly, from a research design point of view adopting a pragmatic approach towards research on a very clinically oriented subject is appropriate when there is very little known about telemetry use in modern maternity units within the UK. A purely post-positivist stance would conclude that the best research question and design around telemetry would be focused on whether it has any clinical impact for women and testing this via a RCT. However, questions around personal experience and social realities of how telemetry is used are also vital to understanding more about its use, potential impact on labour and birth and further direction for research. The different contexts and cultures within maternity units and their influence on telemetry use may also be important to explore. A deeper and contextual understanding of telemetry use was required which ensured issues could be explored from different angles; this was addressed using pragmatism and a ***mixed method*** approach. Feilzer (2010) describes *uncovering differing layers of a phenomenon* in relation to this approach which seemed a particularly good fit for the use of telemetry in labour.

Mixed methods research has evolved over the last two decades (Creswell and Plano Clark, 2011) and differing definitions have been proposed that incorporate mixing methods, philosophy, and interpretation. Integration is vital and two separate studies that investigated the same research question using quantitative and qualitative methods would *not* be mixed methods. Creswell and Plano-Clark (2007) define mixed methods research in terms of both the methodology and method:

> *As a methodology it involves philosophical assumptions that guide the direction of the collection and analysis and the mixture of qualitative and*

quantitative approaches in many phases of the research process. As a method it focuses on collecting, analysing, and mixing both quantitative and qualitative data in a single study or series of studies (p5)

There is recognition in mixed methods research that the strengths and weaknesses of both quantitative and qualitative methods can be identified and used advantageously to advance understanding of complex issues, particularly in health care research (Onwuegbuzie & Johnson, 2004; Tariq & Woodman, 2013). Following on from their definition, Creswell and Plano-Clark (2011) describe a set of core characteristics that define mixed methods research and these are presented in Figure 9.

Definition of Core Characteristics of Mixed Methods Research (Creswell and Plano Clark, 2011)

- Collects and analyses persuasively and rigorously both qualitative and quantitative data (based on research questions);
- Mixes (or integrates or links) the two forms of data concurrently by combining them (or merging them). Sequentially by having one build on the other, or embedding one within the other;
- Gives priority to one or to both forms of data (in terms of what the research emphasizes):
- Uses these procedures in a single study or in multiple phases of a program of study
- Frames these procedures within philosophical worldviews and theoretical lenses; and
- Combines the procedures into specific research designs that direct the plan for conducting the study.

Figure 9 Core characteristics of mixed methods

3.5.1 Justification for choosing mixed methods

Reasons for choosing mixed methods are numerous. The use of mixed methods can 'augment investigative capabilities and provide richer data than can a discrete method alone' (Larkin, Begley, & Devane, 2014, p8). The method can address complex research questions more comprehensively than one method alone and using both quantitative and qualitative data findings can complement each other and

lead to greater understanding (Creswell and Plano Clark, 2011; Tariq and Woodman, 2013). As well as complementarity other reasons may include; development - using results of one phase to inform another; initiation - using areas of incongruence to generate new insights; expansion -examining different aspects of the research question and; triangulation - using data to corroborate findings (Tariq and Woodman, 2013). Mixed methods were chosen for this study for all of these reasons. There is little contemporary evidence about the use of telemetry in the UK and therefore exploratory work was needed to understand in-depth how it was used and the experiences of women and midwives using it. As highlighted above, it would have not been appropriate or wise to conduct a large-scale randomised-controlled trial on telemetry when little was known about the potential areas of impact it may have or the broader social understanding of how telemetry works in practice. Mixed methods allowed examination of many aspects of the use of telemetry in labour and the integration of results ensures the potential for larger more specific future work. Choosing a mixed methods design also exposed the researcher to different types of methodologies, designs, data collection and analysis.

One criticism of mixed methods research is that combining diverse worldviews is problematic as they relate to different and incompatible ways of viewing and understanding the world (Creswell and Tashakkori, 2007; Tariq and Woodman, 2013). Pragmatism has sought to counter this and ignores the dichotomy between main positivist and constructivist paradigms and places the research question and best ways of answering it at the centre of any study. Within this overarching pragmatic approach, differing worldviews may be used during the study as was the case here. Further criticism is that the time taken to complete two different pieces of work may be time consuming particularly if one, or both phases, take longer to complete than expected. This can be a drain on resources. Findings from each phase may also contradict each other but this may also be seen as a strength of the study (Creswell and Plano Clark, 2011).

3.5.1 Mixed method designs

When and how to integrate different methods is a key decision to be made in mixed methods research. Options include mixing during interpretation (at the final step once all data is collected), data analysis (when qualitative and quantitative strands are mixed during analysis), data collection (where the results of one strand affect collection of the next strand of data) and mixing at the level of design (such as embedding a particular strand within a larger study) (Sandelowski, 2002; Creswell

and Plano Clark, 2011). In addition, the priority of each strand needs to be decided; will both qualitative and quantitative methods have equal priority or will one be given emphasis over another? Different options are presented in Figure 10.

Figure 10 Mixed method design matrix (Onwuegbuzie and Johnson, 2004)

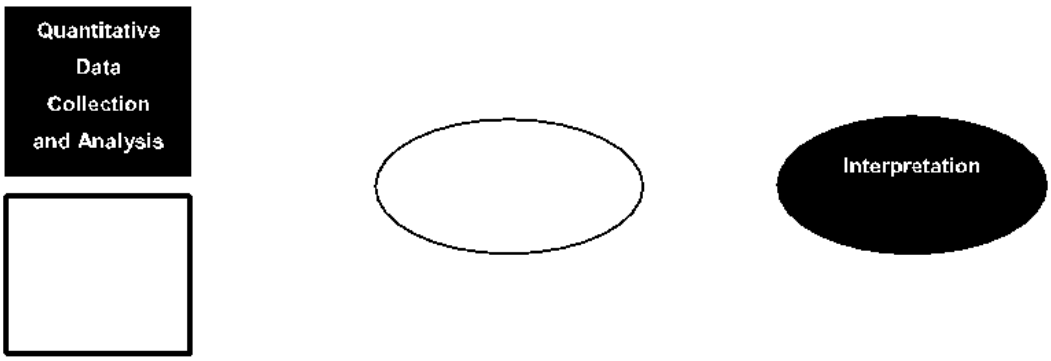
		Time Order decision	
		Concurrent	Sequential
Paradigm Emphasis Decision	Equal status	QUAL + QUAN	QUAL ⟶ QUAN QUAN ⟶ QUAL
	Dominant status	QUAL + quan QUAN + qual	QUAL quan qual ⟶ QUAN QUAN ⟶ qual quan ⟶ QUAL

Key: "qual" stands for qualitative, "quan" stands for quantitative, "+" stands for concurrent, " " stands for sequential, capital letters denote higher priority or weight, and lower case letters denote lower priority or weight

The design matrix identifies different design options for a mixed methods study and allows researchers to select a design that will best match the research question and provide a framework. The four main designs are as follows (Creswell and Plano Clark, 2011):

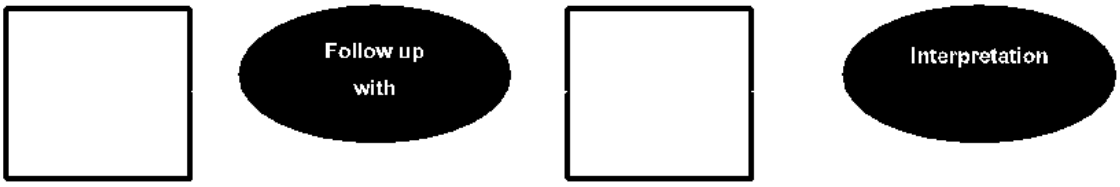
1. Convergent parallel design – both quantitative and qualitative strands are undertaken at the same time, with either equal status or one more dominant than the other, and results are mixed during interpretation (Figure 11).

Figure 11 Convergent parallel design



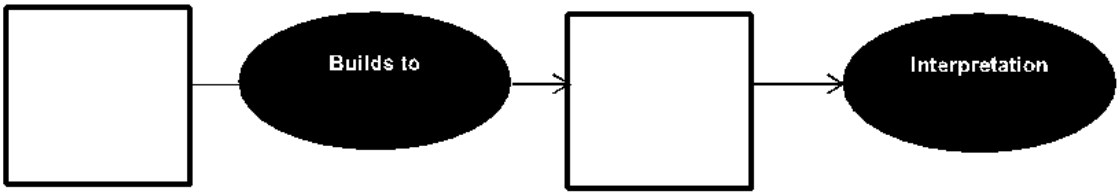
2. Explanatory sequential design – quantitative work is undertaken followed by qualitative work that seeks to explain initial quantitative results (Figure 12).

Figure 12 Explanatory sequential design



3. Exploratory sequential design – qualitative strand is undertaken first, the findings of which helps to design to subsequent quantitative strand (Figure 13).

Figure 13 Exploratory sequential design



4. Embedded design – a qualitative strand occurs within a larger quantitative design or a quantitative strand occurs within a qualitative design (Figure 14).

Figure 14 Embedded design

3.5.2 Choosing a mixed methods design

A ***convergent parallel mixed methods*** design was chosen for the study. This method is the most well-known mixed methods approach and involves both quantitative and qualitative data being collected at the same time and 'merging the results of the two phases into a final interpretation' (Creswell and Plano Clark, 2011, p 77). This method results in different data being collected on the same topic and both sets of data being analysed separately using typical analytic methods for quantitative and qualitative analysis (Tariq and Woodman, 2013) . Findings from both sets of data can be compared and contrasted and the strengths and weaknesses of both types of methodologies acknowledged (Onwuegbuzie and Johnson, 2004).

Strengths of this type of design are that it makes intuitive sense, that it is efficient and that teams of researchers with different skills can collaborate on the different phases in the research (Creswell and Plano Clark, 2011). Some of the challenges are that different skills are needed for each type of phase, that there may be very different sample sizes, merging of the data may be difficult and there is the possibility that the two sets of data contradict each other (Sandelowski, 2002; Creswell and Plano Clark, 2011).

For this study, qualitative interviews aligned with a constructivist paradigm were undertaken alongside a quantitative cohort designed and analysed with a more post-positivist worldview. Whilst the researcher acknowledged that collecting both sets of data was important for the research topic, the qualitative strand was given marginally more dominance that the quantitative strand; it was felt that gaining both women's and midwives perspectives on the use of telemetry was where the largest

gap in the literature was and of more importance in understanding. Time constraints when undertaking a PhD were also taken into consideration when choosing the mixed methods design and collecting both sets of data around the same time ensured the time for data collection was used to maximum effect.

This mixed methods study addressed the use of telemetry to monitor the fetal heart in active labour. The purpose of a convergent parallel mixed methods design is to collect both qualitative and quantitative data and to converge the two forms of data 'to bring greater insight into the problem than would be obtained by either type of data separately' (Creswell and Plano Clark, 2011, p154). The two concurrent phases of the study were as follows:

Qualitative phase: Undertake in-depth interviews with women and midwives using telemetry to explore experiences of the use of telemetry. A constructivist paradigm using grounded theory (Charmaz, 2014; Glaser & Strauss, 1967; Higginbottom & Lauridsen, 2014) was used.

Quantitative phase: Collection of clinical data such as length of labour, use of pain relief and perceived control and satisfaction from a group of women using telemetry was undertaken and compared to a group of women having conventional wired monitoring in labour.

Merging phase: Synthesis and integration of both sets of data to give an overall broad, deep and contextual understanding of telemetry use.

A convergent parallel mixed methods design uses qualitative research methods in the first phase of the study. Qualitative research is broadly defined as 'a naturalistic, interpretive approach concerned with understanding the meanings which people attach to phenomena (actions, decisions, beliefs, values etc.) within their social worlds' (Ritchie & Lewis, 2014, p 3). Qualitative research covers a wide range of approaches but similarities are that data collected is in-depth, detailed and rich, and involves close interaction between the researcher and participants. Sample sizes are usually small in size and data can be collected in a number of ways including interviews, observations, focus groups, narratives and document analysis. Analysis of data tends to allow categories to emerge inductively rather than being forced into

pre-determined hypotheses. As qualitative research has evolved and generated more interest within the wider research community many different approaches have arisen including the use of social media and video technology (Onwuegbuzie, Leech, & Collins, 2010). It is widely agreed that there are three main protagonists of qualitative research; phenomenology, ethnography, and grounded theory. Other arenas include discourse and narrative analysis, case study and critical theory (Ritchie and Lewis, 2014)

Phenomenology is both a higher level philosophy as well as a research methodology (Baker et al., 1992; Dowling, 2007; Gill, 2014) and seeks to understand the lived human experience and 'essential nature' of individuals in particular circumstances of interest (Thorne, 2000). There are several different schools of phenomenology, based on particular philosophical viewpoints derived from the philosophy of Husserl and developed by Heidegger and latterly Gadamer (Dowling, 2007), but all are common in developing rich descriptions of experience without questioning objective reality.

Ethnography is derived from anthropology and concerned with interpreting the social world of people through immersion in communities and observing behaviour, culture and beliefs (Thorne, 2000; Ritchie and Lewis, 2014). Within a healthcare setting ethnography centres on 'how different social and cultural groups understand and enact health and illness (Thorne, 2000, p 69). Ethnographic research places the researcher 'in the field' to collect data and observe behaviour and relationships (through observations, interviews and focus groups) to describe communities and cultures (Green and Thorogood, 2004; Sinead Ryan, 2017). Different types of ethnography include feminist, critical, positivist, constructivist and digital (Sinead Ryan, 2017).

This study set out to examine the use of telemetry during labour in-depth as very little was published or known how it is utilised within maternity units in the UK. Whilst both ethnography and phenomenology were considered it was felt that the study was not seeking to determine what a lived experience was of using telemetry in labour, nor did it initially set out to observe cultural conditions, beliefs and practices on labour wards. However, the culture of maternity units in the study did become an emerging theme and may lead to further ethnographic work. Social interactions and processes are a crucial part of how care is delivered and received during labour; it was felt that collecting and analysing data that recognised this and also ensured theory was generated from the data of how telemetry use occurs

would be the best fit for the study. Therefore grounded theory was chosen as the methodology for the qualitative phase of the study.

3.7.1 Grounded Theory

Grounded theory looks to develop and draw theory from the data rather than testing any particular predetermined framework, hypothesis or *a priori* assumptions (Bowling, 2014; Dunne, 2011; Glaser, 1999; Wimpenny & Gass, 2000). The origins of grounded theory began with sociologists Glaser and Strauss' seminal work on end of life care: *The Awareness of Dying* (Glaser & Strauss, 1965). Throughout the decades, grounded theory has developed to include differing 'foundational worldviews that serve as the overarching compass in the research process' (Higginbottom and Lauridsen, 2014, p12). These differing views are highlighted briefly below.

Traditional GT (sometimes referred to as Glaserian after its founder) adopts a post-positivist paradigm and assumes the researcher has an independent role and discovers the truth – a theory waiting to be uncovered (Charmaz, 2014; Polacsek et al., 2018a). The development of GT was ground-breaking in its time, as it gave a voice to qualitative research that was methodical and systematic which aligned with the positivist characteristics of traditional research (Dunne, 2011). The second main approach was that developed by Corbin and Strauss who somewhat rejected the notion that there is a 'pre-existing reality out there' and evolved traditional GT to include acknowledgement of multiple perspectives and the context in which participants operate(Mills et al., 2006). Constructivist grounded theory (CGT), developed by Charmaz established this further in wholly recognising that there is no one true reality; instead researchers make sense of the data with subjective interpretations that 'cannot separate themselves and their experiences from their research' (Higginbottom and Lauridsen, 2014, p11). Researchers using constructivist grounded theory must consider their own place in the world, interactions with others and social position in relation to the research (Charmaz, 2009). Charmaz's approach is flexible, rooted in pragmatism (which aligns with the overall epistemology of the study) and acknowledges any influence the researcher's world view has on theory development (Creswell, 2007). Constructivist grounded theory is particularly useful in nursing and midwifery research as the participant's voice is key, aligning with many fundamental principles such as partnership and advocacy (Higginbottom and Lauridsen, 2014, p11).

3.7.2 Grounded theory and symbolic interactionism

Grounded theory is rooted in interpretivism, of which symbolic interactionism is a branch (Polacsek et al., 2018a). Of note, the precursor to symbolic interactionism is pragmatism (Chamberlain-Salaun et al., 2013; Charmaz, 2014) which aligns with the overall epistemological stance of the work presented in this thesis. Symbolic interactionism, as a sociological perspective, is largely based on work by Blumer, a sociologist from the University of Chicago, which was a crucial melting pot for sociological theory in the early 20th century (Charmaz, 2014). Symbolic interactionism is a cyclical process and views the way that human's learn and understand symbols and meanings, occurs through social interaction. This social interaction then leads to further interpretations and actions which are modified through prior learning. (Crooks, 2001; Charmaz, 2014). Consequences of these new actions leads to future choices, interaction and action; therefore both past, present and future are inexorably linked. Milliken and Schreiber (2012) state that 'locating the research methodology within symbolic interactionism provides a means for investigation not only of the social world but also of the contextualized processes by which human beings construct and engage with their social worlds' (p 686). The theoretical perspective of symbolic interactionism as both a theory and method aligns closely with the use of grounded theory (Handberg et al., 2015) and Charmaz (2014) states that the two 'fit, complement, and can advance each other' (p 277).

Grounded theory, based in symbolic interactionism, is an ideal method to use when undertaking research in women's health (Crooks, 2001). Much research related to health and illness is centred on the biomedical model with hypotheses being proposed and tested within a post-positivist framework often with an unconscious male bias (Shansky, 2019). Crook (2001) states 'to provide meaningful evidence-based care to women as researchers, we need to attend to women's experiences, their own understanding of health-related issues, and the social interactions within which they gain meaning an insight about their situation' (p12). Constructivist grounded theory that acknowledges symbolic interactionism as a fundamental tenet ensures that women's voices are heard, the relationship between the women and the researcher is acknowledged, theory is constructed together and the lens brings into focus the women's perceptions, preferences and concerns (Crooks, 2001).

3.7.3 Literature review and grounded theory

The use of literature in a grounded theory study is a contentious area. Questions around how and when the existing literature should be reviewed are many and there

are different opinions within differing GT views. For traditional grounded theorists, the view by Glaser is that broad reading around the topic of interest should not be undertaken prior to commencing the research. Reasons for this are that the researcher may become 'contaminated' by extant theories and hypotheses that will affect the way the research is conducted and analysed (Birks and Mills, 2011; Dunne, 2011; Charmaz, 2014). Other reasons given are that researchers will be unable to develop their own ideas if exposed to other work, new literature may be published in the time that the research is being undertaken, or the researcher may be 'awed out' by the work of others and reduce their confidence (Dunne, 2011). However, for many researchers undertaking GT this premise is unworkable; to believe that a researcher will come to a project with a clean slate or be a 'theoretical virgin' (Dunne, 2011) is anathema. Most researchers will come to a topic of interest with some knowledge of the area that will have been informed by practical or personal involvement and through awareness of literature on the subject area. For many students undertaking their own research, a literature review will have been a requirement of obtaining any funding or approvals. Many GT scholars, including Charmaz, acknowledge this and Dunne (2011) reports on the advantages of doing a literature review, namely: it can provide rationale and justification for doing a study, it can highlight gaps in existing literature, it can 'contextualise the study and orient the researcher '(p 116) and can help with theoretical sensitivity (see below). If undertaking a review of the literature before undertaking the research and adopting a 'middle ground' as advocated by Dunne (2011) then researchers are recommended to remain keeping an open mind about the data so that new and possibly contradictory findings are not ignored (Charmaz, 2014).

A review of the literature was conducted for this project and reported in a previous Chapter. I acknowledged the work of Glaser in relation to reviewing the literature and one of the reasons, though not the major one, for rejecting this approach in favour of Charmaz was so that a literature review could be undertaken. The main literature review on fetal monitoring and telemetry was undertaken early on in the study and updated for the current thesis. Once a theory was beginning to generate around telemetry use then new literature that had not been considered in the initial literature review was accessed. This literature was treated as 'data' and contributed to the final grounded theory, an approach discussed by Charmaz (2014).

3.7.4 Grounded theory construction and sampling

Despite differences in the three main approaches to grounded theory they all have similarities in the way that a theory, grounded in and developed from the data, is generated. The main features of grounded theory generation, with definitions, are outlined in figure 15 below:

Common approaches in Grounded Theory

(Mills et al., 2006; Birks and Mills, 2011; Charmaz, 2014; Higginbottom and Lauridsen, 2014; Polacsek et al., 2018a)

- Theoretical sensitivity: the researchers awareness of the data, ability to identify concepts that are relevant and/or irrelevant and consequent interaction with the participants and questions asked
- Purposive sampling: predetermined criteria for recruitment of first set of participants
- Theoretical sampling: once data analysis begins emergent theories are used to guide further sampling which continues until categories are saturated.
- Constant comparison: data is collected and analysed simultaneously
- Coding and categorisation of data: all approaches include initial, intermediate and advanced coding moving to an advanced level of abstraction and theory generation
- Theoretical memos: these written thoughts are fundamental to grounded theory and record the researcher's thoughts and ideas about the developing theory
- Theoretical integration: the final phase of analysis where foundations of the theory are constructed, categories are saturated, variations are accounted for and literature is woven into the findings.

Figure 15 Common approaches in Grounded Theory

Further specific details of how these steps were followed and utilised to generate a grounded theory of telemetry use will be given in the research methods chapter (Chapter 4).

The quantitative phase of the parallel mixed methods design used a post-positivist approach. As outlined in 3.3.1 a post-positivist quantitative approach looks to use

numerical data and test hypotheses to reject or support them; this is in opposition to positivism which would seek to find the absolute 'truth' (Leavy, 2017). Quantitative approaches look for objectivity and control to build evidence for these theories or hypotheses (Leavy, 2017). An outline of different types of quantitative design will be given below and justification for the methods chosen will be given. The majority of quantitative research designs are either experimental or survey and will be described below, along with justification for the method chosen for this study.

3.8.1 Experimental research

Experimental research compares two or more groups; an experimental group (receiving an intervention) and a control group (not exposed to the intervention). In healthcare the term experiment is generally replaced with the word 'trial' (Bowling, 2014). A true experiment, where the participants are randomised to either receiving the intervention or not are called randomised controlled trials (RCTs) (Leavy, 2017; Ratelle et al, 2019). Randomisation ensures that there is an equal chance of being allocated to either group. This ensures that any potential confounding variables (such as baseline demographic characteristics or prognostic factors) are evenly distributed between the groups. It is 'usual practice when reporting an RCT to demonstrate the integrity of the randomisation process by showing that there is no significant difference between baseline variables' (Kendall, 2003, p 166). RCTs seek to minimise variation between the groups by reducing both systematic errors (bias) and random errors (chance) (Bowling, 2014). Ideally both groups receive a pre-test and a post-test to measure the effects of the intervention (Leavy, 2017). Blinding, where both the participants and the researchers undertaking data collection are not aware of the allocation to which group, increases the strength of these types of studies (Kendall J M, 2003). Blinding may reduce biases such as the Hawthorne effect, where study responses are influenced by known participation (Leavy, 2017). There are a number of advantages and disadvantages of the RCT. When designed well, with randomisation, blinding, prospective data collection and intention to treat analysis then RCTs can be a powerful test of cause and effect (Williamson and Lloyd, 2019). Findings from studies that are close to the true effect are noted to have high internal validity (Evans, 2003; Kendall J M, 2003; Williamson and Lloyd, 2019) However this type of study may not be applicable to all populations, they are costly and time consuming, generally require large numbers, and as the study is highly controlled then the results may not be applicable to all groups or populations (Williamson and Lloyd, 2019). As a consequence, RCTs may have low external validity (Evans, 2003).

Other types of experimental research include the quasi-experiment. In these types of studies there is no randomisation as it may not be 'feasible or ethical' (Ratelle et al, 2019). Quasi-experiments may involve experimental groups only or both experimental and control groups (Leavy, 2017). Experimental design may also include single-group or single-subject designs. These studies have many more biases and threat to internal validity than the other designs described (Leavy, 2017; Ratelle et al, 2019).

3.8.2 Observational research

Observational research does not involve any manipulation of variables by the researchers and survey research is the most common design (Leavy, 2017). Surveys ask questions, primarily from standardised questionnaires used as the data collection tool, and statistically analyse the results. They can be used on large samples and are 'typically used for ascertaining individuals' attitudes, beliefs, opinions, or their reporting of their experiences and/or behaviours' (Leavy, 2017, p 101). Questionnaires contain both objective data (such as that from personal demographics) and subjective data (responses to questions on attitudes and beliefs) (Bowling, 2014). Surveys may be descriptive or analytical. Descriptive surveys are generally cross-sectional, seeking information from a group at one point in time. These surveys describe the phenomenon of interest and can be used to test as well as generate hypotheses for further testing (Bowling, 2014). Descriptive surveys tend to be retrospective and can only measure associations rather than determine cause and effect (Ratelle et al, 2019). Analytical surveys, on the other hand, may suggest the direction of cause and effect by analysing events at more than one point in time (Leavy, 2017) and are often prospective and termed longitudinal. Other types of observational survey research include cohort studies where a particular population to be sampled has a common characteristic (such as being born in the same year). They may be cross-sectional, longitudinal or sequential (Bowling, 2014)

3.8.2.1 Instrument validity and reliability

Questionnaire design and construction is a particularly involved process with the ultimate goal of creating an instrument with good validity and reliability (Leavy, 2017). There are several types of validity and they are represented in Table 8. Note that internal and external validity are important for all types of quantitative research.

Types of validity (adapted from Leavy, 2017, p 114 - 115).

Face validity	A judgement call based on common sense that, at face value, the measurement is tapping what we claim it is.
Content validity	A judgment call made by experts in that field that the measure is valid and legitimate
Construct validity	The measure is tapping into the concept and related concepts, as we propose, which requires us to create specific operational definitions
Statistical validity	The statistical analysis is appropriate and the conclusions drawn are consistent with the analysis and rules of statistical law.
Ecological validity	The findings are generalizable to a real-world setting.
Internal validity	Precautions have been taken to safeguard against the possibility that an extraneous variable (an additional factor not being tested) influenced the results
External validity	The findings have only been generalized to populations supported by the tests

Table 8 Types of validity

Reliability is concerned with whether a survey instrument, or indeed an intervention, gives consistent results (Leavy, 2017; Ratelle et al, 2019). As with validity, there are several types of reliability. Inter-item reliability refers to 'consistency of results across multiple questions or indicators intended to measure a single variable' (Leavy, 2017, p114). Tests can be used to check this consistency and are commonly Cronbach's alpha and factor analysis (Bowling, 2014). Other types of validity are test-retest validity (where testing the measure twice with the same participants gives consistent results) and interrater reliability (consistency when using two or more researchers undertaking observations) (Leavy, 2017).

3.8.3 Hierarchies of evidence

Within quantitative research, a number of hierarchies of evidence have been developed to 'rank' different types of research methods. The most common one of these is shown in Figure 16.

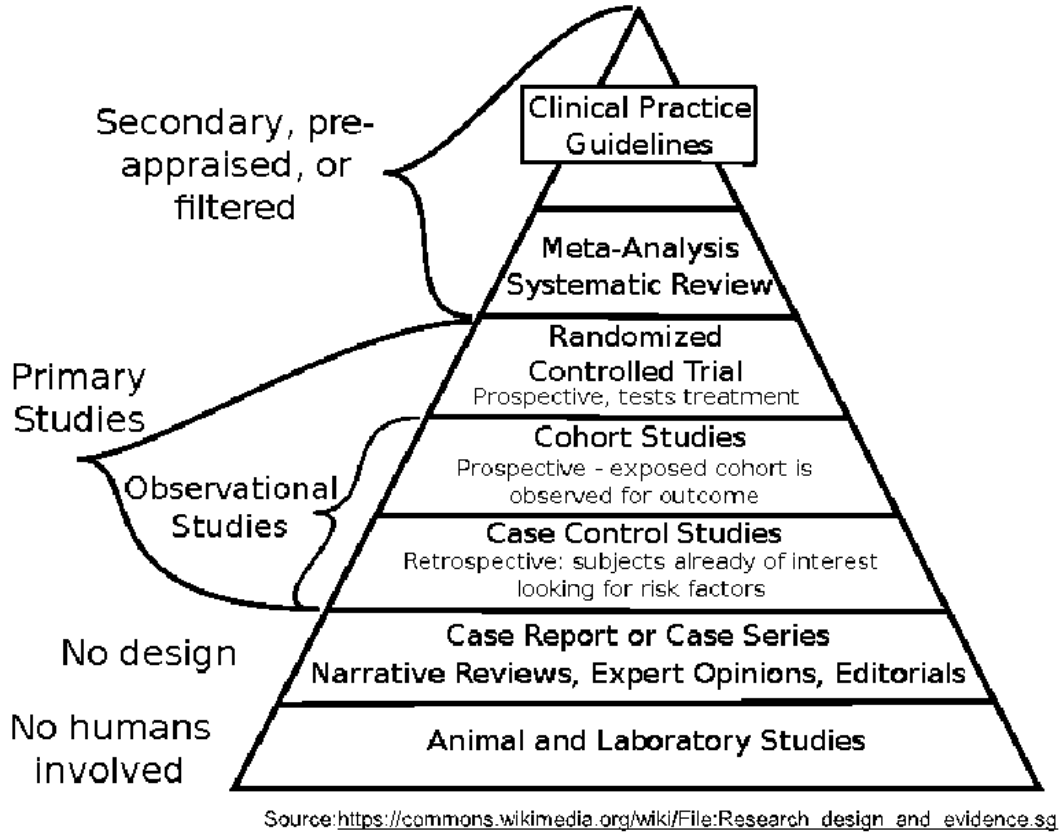


Figure 16: Hierarchies of quantitative evidence.

This hierarchy ranks those studies that are more robust and run in very controlled environments at the top. Those that are more observational or animal/lab studies are at the bottom and less able to generate robust evidence. It must be noted however, that a hierarchy such as this is not an inflexible structure and a well-designed cohort study may be of better quality and give better evidence that a poorly designed RCT (Leavy, 2017). Of note also is that most of the studies within the hierarchy are focused on effectiveness of interventions which is why the RCT, or meta-analyses of them, is at the top. Limitations of a hierarchy of evidence such as this is that the focus on effectiveness (whether an intervention works or not) discounts other issues such as appropriateness and feasibility (Evans, 2003). Appropriateness is concerned with whether the intervention is acceptable to the consumer and feasibility on whether the intervention can be implemented and the impact this has on organisations or providers (Bowling, 2014). Both of these issues should be addressed in well-designed trials but as a consequence of this limitation, other hierarchies have been developed. These hierarchies incorporate different types of research (such as qualitative) that may contribute to deeper understanding of healthcare interventions and outcomes (for an example see Evans, 2003).

Healthcare provision is increasingly complex and large funding bodies such as the Medical Research Council (MRC) have changed their approach to how these complex systems should be studied:

> *The MRC's approach to complexity has thus shifted considerably – both in terms of where the complexity is assumed to lie (from the intervention to the system to the interaction between the two) and in relation to how best to study it (from the randomised controlled trial atop an assumed hierarchy of evidence to a genuinely pluralistic approach that give appropriate weight to real-world case studies).* (Greenhalgh and Papoutsi, 2018, p2)

Proponents of mixed method research would argue that this is the best methodological approach to answer complex healthcare questions.

3.8.4 Quantitative methodology chosen for this study and justification

The quantitative design chosen for this study was observational. It was not practical, or sensible to conduct a large randomised controlled trial of the used of telemetry to monitor the fetal heart in labour and this type of design was not appropriate for the research question and aims. Exploratory work is needed to determine what tests and questions would be appropriate to use in a large RCT along with questions around feasibility and appropriateness of running such a trial.

Two non-randomised groups of women were in the observational cohort – one group using telemetry during labour and one group using conventional wired monitoring. By conducting an observational study that collected clinical outcome data from these two groups, initial exploratory data could be examined and determine areas of interest to follow up in a larger study. From review of the literature, the hypothesis that women using telemetry would feel in more control of their labour was also determined to be an appropriate area to investigate in a quantitative phase of work. A validated questionnaire (Stevens et al., 2012) was used as the data collection instrument for investigating control and satisfaction. Participants in the quantitative phase of the study completed the questionnaire in the postnatal period. Demographic and clinical outcome data were also collected from all women. Further details are given in Chapter Four: Research Methods.

Tariq and Woodman (2013) state : 'the most important, and perhaps most difficult, aspect of mixed methods research is integrating the qualitative and quantitative data' (p 6). There are several approaches that can be used in integration. Both datasets can be analysed independently using techniques that are aligned with the particular methodology. For example standardized statistical tests for the quantitative dataset and thematic, framework or grounded theory for the qualitative. Both sets of analysis are then combined to enhance the findings from each phase (Creswell and Plano Clark, 2011; Tariq and Woodman, 2013). The terms 'inference' (concerning findings from the separate quantitative and qualitative strand) and 'meta-inference' (findings found across the two strands) are sometimes used (Creswell and Plano Clark, 2011). One way of doing this is to present a side-by-side comparison of results or to construct a joint display so that both sets of data can be compared (Creswell and Plano Clark, 2011).

An alternative approach is that both datasets are analysed conventionally and then transformed; qualitative data may be 'quantitised' (more common) and the quantitative data is 'qualitised' (less common) (Tariq and Woodman, 2013). Quantitising involves coding qualitative data into numerical information, for example into dichotomous categories or counting how many participants spoke of particular themes (Creswell and Plano Clark, 2011; Tariq and Woodman, 2013). For this study, transforming the data in this way did not seem appropriate or practical and it was felt that the approach of analysing each phase separately and interpreting how both sets of results connected and enhanced the other would be more suitable for the data and the topic. Further details are given in Chapter Four: Research Methods.

This Chapter has outlined the different philosophical underpinnings of research and the importance of identifying an overarching paradigm within which to conduct research under. Pragmatism was identified as the paradigm most suited to this study and the use of mixed methods discussed and justified. Within qualitative methodologies, grounded theory was explored and identified as the framework within which to undertake and analyse the qualitative phase of the study. Quantitative methodologies and integration in mixed methods was also presented. Chapter Four will present the research methods used in this study.

Chapter Four: Research Methods

Following on from Chapter Three which provided the philosophical and methodological underpinnings for the study design, this Chapter will present the research methods used. A two-phase convergent parallel mixed methods design was chosen to explore the experiences of women and midwives using telemetry to monitor the fetal heart in labour and any impact that telemetry may have on outcomes. A 'thick' description (Ritchie and Lewis, 2014) of the two sites is given in the first part of the chapter and then the methods used for the qualitative phase of the study will be outlined. This will include details of sampling, recruitment, consent, data collection and analysis for the interviews undertaken with midwives, women and their partners. Issues of rigour and reflexivity will also be outlined for the qualitative phase. Subsequently, the methods used for the quantitative part of the study will be outlined and include details of sampling, recruitment, consent, data collection tools and data analysis.

4.2.1 Description of Beach

Site 1, to be named 'Beach' for the study analysis, was a large inner city tertiary-level NHS Trust that provides maternity care for around 9000 women per year. Antenatal care is provided in a dedicated clinic within the hospital and in the community setting by both midwives and obstetricians according to individual needs and 'risk' status. 'Beach' has a 28-bed antenatal ward, where women also attend for induction of labour, an 8-bed elective caesarean section ward, and 48 postnatal beds spread across two wards.

Women who have had an uncomplicated pregnancy and are at low risk of complications during labour and birth can choose to have their baby at home or within the hospital on the 8-bed alongside midwifery-led birthing unit (AMLU). In 2018/19 the home birth rate for 'Beach' was 0.35% compared to the national average of 2.1% (Office for National Statistics, 2017). Whilst the AMLU was not purpose built to be such, there are two rooms with birthing pools. The rooms on the AMLU are small in size (the size of a standard single hospital room) and contain a delivery bed, sink, storage and standard oxygen and suction equipment. Resuscitation equipment for neonates are available if needed. Women have access to birthing balls, and floor mats and aromatherapy for use in labour has just been

approved. Women may have Entonox (gas and air), water, and diamorphine or pethidine for pain relief. In 2018/19 10.6% of the total numbers of births at 'Beach' occurred on the AMLU, compared with a national average of 14% (Walsh et al., 2018). Women receive one-to-one care in established labour and if there are any concerns during labour or if women require further pain relief then they are transferred to the obstetric-led unit (OU), one floor below where obstetric and anaesthetic staff are available. The prescribed numbers of maternity staff per shift on the AMLU at 'Beach' are 4 registered midwives and 1 maternity support worker.

The OU at 'Beach' has a 4-bed triage department (where women may attend who are in early labour or with any other concerns in pregnancy that require them to be assessed), 14 labour and birth rooms, 3 obstetric theatres, 4 high dependency rooms (for women requiring a higher level of obstetric and medical care) and 2 rooms specifically for women experiencing stillbirths or late terminations of pregnancy. The labour and birth rooms are much larger than that on the AMLU and each have a delivery bed, sofa and chairs, storage and writing space and a resuscitaire (used for resuscitation of neonates if needed) as well as standard emergency equipment such as oxygen and suction. Each room also has a standard cardiotocograph (CTG) machine to monitor the fetal heart and contractions and this machine is connected to an electronic data capturing system called K2 which allows staff to record labour details and shows the CTG recording on a screen in the room and also on a central monitoring system within the main office space. This office space is a large room in the centre of the footprint of the labour-ward and contains computers, printers, desk space, and a large whiteboard with details of each women and the central monitoring system and screen. Whilst recruitment was being undertaken 'Beach' had three telemetry machines able to be used for women in labour. The location of the machines varied from being in rooms to being kept in a central clean utility room on a bench, charging. 'Beach' had a guideline for monitoring the fetal heart in labour which included guidelines for using telemetry in the birthing pool (Appendix 9)

The number of midwives required for each shift at 'Beach' is 15 and the midwifery staffing is split into two groups each with a senior midwife who 'co-ordinates' the shift and provides support for midwives working in that area. There are three healthcare support workers per shift and a registered nurse each shift who supports with care for women in the high-dependency rooms. Women in established labour on the OU receive one-to-one care in labour and are also seen every 4 hours, day and night, by the on-call OU obstetric team, called a 'ward round'. This team is

composed of the senior midwife co-ordinating, the obstetric consultant, up to 4 junior doctors of varying grades, and up to 4 anaesthetic doctors. The ward round will visit each room and receive an update on the care and progress of the woman and document a plan for the next four hours. If advice or action is needed in the interim period then this is also available. The OU has twenty-four hour on-site obstetric consultant cover. Women may choose Entonox, pethidine, diamorphine, remifentanil or an epidural for pain relief during labour and there is one room with a birthing pool. Birthing balls are also available for women to use.

Combined statistics for both the AMLU and OU for 2018/19 show that 54.6% of births were vaginal, 15.3% of births were by elective caesarean section, 14.3% by emergency caesarean section, 10.7% by forceps and 5.1% by ventouse. The rate for women having an induction of labour for 2018/19 was 28%. The number of whole time equivalent midwives at 'Beach' is 351 and the vacancy rate (March 2019) is 2.8%. 'Beach' was inspected by the Care Quality Commission in 2018 and was rated 'Good'.

4.2.2 Description of Forest

Site 2, to be named 'Forest' for the study analysis, was a smaller tertiary-level NHS Trust that provides maternity care for around 4200 women per year. Antenatal care is provided in a dedicated clinic within the hospital and in the community setting by both midwives and obstetricians according to individual needs and 'risk' status. 'Forest' has a 19-bed antenatal ward, where women also attend for induction of labour, and 26 postnatal beds. There is also a 5-bed triage ward for women to attend who may be in early labour or with any other concerns where they may need to be seen by a midwife or doctor.

Women who have had an uncomplicated pregnancy and are at low risk of complications during labour and birth can choose to have their baby at home or within the hospital on the 4-bed alongside midwifery-led birthing unit (AMLU). In 2018/19 the home birth rate for 'Forest' was 2.4% compared to the national average of 2.1% (Office for National Statistics, 2017). Up until February 2019 'Forest' also had a free-standing midwifery-led unit (FMLU) but this was temporarily closed due to asbestos being found during building work. The AMLU at 'Forest' was purpose built and the rooms are all large, each with their own birthing pool. The rooms on the AMLU contain a delivery bed, sink, storage and standard oxygen and suction equipment. Resuscitation equipment for neonates are available if needed. Women have access to birthing balls, and floor mats. Aromatherapy in labour is

used frequently by women in labour and administered by midwives who have undertaken extra training. The aromatherapy oils are provided by the Trust. Women may have Entonox (gas and air), water, and diamorphine or pethidine for pain relief. In 2018/19 21.7% of the total numbers of births at 'Forest' occurred on the AMLU (17.0%) and FMLU (4.7%), compared with a national average of 14% (Walsh et al., 2018). Women receive one-to-one care in established labour and if there are any concerns during labour or if women require further pain relief then they are transferred to the obstetric-led unit (OU), one floor above, where obstetric and anaesthetic staff are available. The prescribed numbers of maternity staff per shift on the AMLU at 'Forest' are 2 registered midwives and 1 maternity support worker.

The OU at 'Forest' has 12 labour and birth rooms, and 2 obstetric theatres. These 12 rooms include one antenatal and one post-natal high dependency room (for women requiring a higher level of obstetric and medical care) and 1 room specifically for women experiencing stillbirths or late terminations of pregnancy. The labour and birth rooms are large and of a similar size to that on the AMLU and each have a delivery bed, sofa and chairs, storage and writing space and a resuscitaire (used for resuscitation of neonates if needed) as well as standard emergency equipment such as oxygen and suction. Each room also has a standard cardiotocograph (CTG) machine to monitor the fetal heart and contractions and this machine is connected to an electronic data capturing system called K2 which allows staff to record labour details and shows the CTG recording on a screen in the room and also on a central monitoring system within the main office space. Each room has black-out blinds and different lighting (such as LED candles and 'fairy lights') that can be used as well as music facilities. Five of the rooms on the obstetric unit have telemetry monitors that are kept charged and ready for use. The office space is a large room in the centre of the footprint of the labour-ward and contains computers, printers, desk space, and a large whiteboard with details of each women and the central monitoring system and screen.

The number of midwives required for each shift at 'Forest' is seven and this includes a senior midwives who 'co-ordinates' the shift. Women in established labour on the OU receive one-to-one care in labour and are also seen on a 'ward round' three times per day by the obstetric medical team. In the day this team comprises the senior midwife co-ordinating, the obstetric consultant and two junior doctors. During the night the obstetric consultant is on-call and does not remain on site. The OU does therefore not have twenty-four hour on-site obstetric consultant cover. The ward round will visit each room and receive an update on the care and progress of

the woman and document a plan. If advice or action is needed in the interim period then this is also available. Women may choose Entonox, pethidine, diamorphine, remifentanil or an epidural for pain relief during labour and there is one room with a birthing pool. Birthing balls are also available for women to use.

Combined statistics for both the AMLU and OU for 2018/19 show that 64.4% of births were vaginal, 11.1% of births were by elective caesarean section, 14.3% by emergency caesarean section, and 14.3% by either forceps or ventouse. The rate for women having an induction of labour for 2018/19 was 37.2% and the percentage of women having a caesarean section following an induction of labour was 20.0%. Women in spontaneous labour had 13% caesarean section rate. 'Forest' was inspected by the Care Quality Commission in 2018 and was rated 'Good'.

4.3.1 Design

As highlighted in the literature review, very little evidence exists on the use of telemetry and in particular qualitative research that gives voice to women and midwives and explores their experiences in-depth. Therefore, the qualitative phase of the study sought to explore the experiences of women and midwives using telemetry to monitor the fetal heart in labour. Grounded theory (GT) methodology was chosen and in-depth interviews were undertaken which were facilitated and conducted by the researcher.

4.3.2 Sampling

A purposive sampling strategy was used initially to recruit women, partners, and midwives from two NHS Trusts within the Northwest of England. These two Trusts were chosen as having good links with the University and being accessible for the researcher. The researcher had previously worked clinically at one of the Trusts and both Trusts provided a full range of midwifery and obstetric care for women. Both Trusts had telemetry monitoring available for women to use but had different equipment.

The initial purposive sample included four women, one partner and four midwives. Theoretical sampling continued until categories were saturated and theory was generated and the total sample comprised of 10 women, 2 partners, 12 midwives and one student midwife. Details of theoretical sampling will be given in Section 4.2.3.

4.3.3 Recruitment

4.3.3.1 Recruitment of women

A flyer with details of the study was placed in antenatal clinics, triage, antenatal day units, antenatal wards and induction of labour bays on both maternity units. The flyer contained details of the study, a link to an online Facebook page with further information, and contact details of the research team. There were no contacts with the researcher through the Facebook page.

Women admitted for an induction of labour were assessed for eligibility by the midwives caring for them and if eligible were asked by the midwife if they were agreeable to being approached by the researcher to be given more information about the study. The researcher discussed the study with women who may potentially have been able to use telemetry in labour and gave them a participant information sheet (see Appendix 10) about the study and being interviewed. Women were often on the induction of labour bay for several days while the induction of labour process was ongoing and so this gave women the opportunity to think about the study and taking part. Women interested in being interviewed were asked to fill in a consent to contact form (see Appendix 11) so that the researcher could contact them in the postnatal period (either in person on the postnatal ward or by telephone or e-mail) to see whether they used telemetry in labour and if they would be happy to be interviewed.

If women were on the delivery unit and did not wish to be approached by the researcher or the midwife caring for the woman did not think it was appropriate (for example she was in advanced labour or distressed) then a flyer and consent to contact form was left with the midwife to give to the woman at an appropriate time.

Any woman who had completed the consent to contact form was contacted by the researcher in the postnatal period. For some women this was on the postnatal ward and for others this was by telephone as they had been discharged. The woman was asked if she had used telemetry in labour and if so whether she had any questions about the study and whether she would be happy to be interviewed. The majority of women were interviewed when the baby was around four weeks old and all of the interviews were conducted within eight weeks of the woman giving birth. Written consent was taken at the time of the interview and all interviews took place in the woman's home. Demographics of the sample are given in Chapter 5.

4.3.3.2 Recruitment of birth partners

Only partners of women who had completed a consent to contact from and met the inclusion criteria were considered eligible to be approached to be in the study. Partners were given a separate participant information sheet (with details very similar to the women's participant information sheet) that was given to them at the same time as women were given one. Partners were given an opportunity to ask questions about the study and decide if they were happy to be interviewed as well. If the partner did not wish to be interviewed this did not affect the woman being interviewed if she wished. The partner was also eligible to be interviewed if the woman did not want to but this was not the case for any of the interviews. Written consent was obtained at the time of interview. The two partners that were interviewed for the study were present at the interview of the women and so were not interviewed separately.

4.3.3.3 Recruitment of midwives and student midwives

A flyer with details of the study was placed in relevant places within maternity units including antenatal wards, induction of labour bays, delivery units and staff rooms. The flyer contained brief details of the study and contact details of the researcher if midwives wished to obtain more information. Information about the study was also given out verbally at the beginning of some shifts by the researcher. Midwives and student midwives who had previously cared for women using telemetry, who met the eligibility criteria, were approached directly by the researcher and given an information sheet (Appendix 12) about the study and being interviewed and answered any questions. Midwives and student midwives were given at least twenty-four hours to decide if they were happy to be interviewed about their experiences of caring for women using telemetry. Prior to the interview the researcher checked that the midwife or student midwife had understood the information sheet and answered any further questions. Written consent (Appendix 13) was obtained prior to the interviews and all of the interviews took place in a quiet place within the maternity units.

Recruitment was undertaken between March 2018 and August 2018 and interviews were conducted between March 2018 and September 2018.

4.3.4 Inclusion Criteria

4.3.4.1 Inclusion and exclusions criteria: women and partners

English-speaking women who were 18 years of age or older and 37 weeks or more gestation at the time of admission were eligible to be in the study. Women were also required to have had continuous monitoring of the fetal heart during labour and had telemetry for at least one hour of their labour. Women were excluded from being in the study if they had a multiple pregnancy, a breech presentation, a complicated pregnancy (such as diagnosis of severe pre-eclampsia, severe fetal growth restriction, suspected abruption or antepartum haemorrhage) or a fetus with a known anomaly or planned admission to neonatal intensive care (NICU). Women who were admitted to the High Dependency Unit (HDU) or Intensive Care Unit (ICU) following birth were also excluded. Breech, multiple pregnancy and premature birth all involve monitoring challenges and would not have been appropriate to include. Women with highly complicated pregnancies often need other types of monitoring that reduce the ability to mobilise and take advantage of telemetry. It would also not have been appropriate to interview women whose baby had been unwell or had been unwell herself following the birth, therefore exclusion criteria for HDU, ICU and NICU were included. Women who lacked the capacity to consent were also excluded from the study.

It is acknowledged that the voices of all groups of women, including those without fluent English, should be included in research. However, the decision was made to recruit only women with a sufficient command of English due to time and translation complexity as well as methodological considerations of constructionism, such as social interaction and the relationship between researcher and interviewee.

The inclusion criteria for the women's partner to be interviewed were being present during labour for 90 minutes or more, capacity to consent to being interviewed and to speak English.

4.3.4.2 Inclusion criteria midwives and student midwives

Midwives and student midwives (of any year group) invited to participate in interviews for this phase of the study were required to have provided care for women in labour using telemetry. They were also required to be employed (or for students, on a placement) at one of the two sites, and have consented to taking part in the study.

4.3.5 Data collection: In-depth interviews

In-depth one-to-one interviews were chosen as the primary method of data collection for the qualitative phase and are the most common method in GT methodology (Birks and Mills, 2011; Charmaz, 2014). Other interviews such as focus groups and telephone interviews were considered but as individual experiences were crucial to understanding how telemetry worked in practice, it was felt that one-to-one semi-structured interviews would be the best type to use. The semi-structured interview 'is neither an open everyday conversation nor a closed questionnaire' (Kvale, 2008, p11) and has the aim of eliciting and exploring the participants own personal accounts of the subject of interest. The interviews were recorded using an Olympus DS-3500 recorder, and downloaded onto a secure file on a password protected computer. Two of the interviews with women and two of the interviews with midwives were transcribed by the researcher. This was so that the researcher could understand the nuances of the interviews and become deeply immersed in the data. Due to time constraints the remainder of the interviews were sent securely to a professional transcription company approved by the University of Manchester. The interviews that were not transcribed by the researcher were listened to several times during data analysis in order for the researcher to be grounded in the data and become as familiar with the interviews as for those transcribed by the researcher.

There is some debate between the various schools of grounded theory on recording and transcription of interviews with classical grounded theorists arguing that only notes should be taken of interviews as this ensures separation between the researcher and the data (Birks and Mills, 2011). However, a more constructivist approach attends that recording and transcription of interviews, particularly if some are done by the researcher, ensures that the nuances of language are noted, rich details are retained, and construction of the interview is recorded (Kvale, 2008; Rubin and Rubin, 2012; Charmaz, 2014). Body language and non-verbal communication can also be important and can be observed in one-to-one interviews without the interruption of note-taking. Audio recording also ensures verbatim quotes can be used in any thesis or publication and introduces a degree of trustworthiness to the research process in that other members of the research team can also listen to the recordings (or read subsequent transcripts) and agree on any coding terms or interpretation (Kelly, 2013). Following the interviews, short notes (collected as memos, see 4.4.4.2) were taken by the researcher, in a reflexive diary,

and contained initial thoughts and feelings about the interview and any major themes that had arisen.

4.3.5.1 Topic guide

Crafting a GT interview aims to 'achieve a balance between designing a useful interview guide that simultaneously focuses your topic and fosters pursuing new areas that had not occurred to you' (Charmaz, 2014, p63). An interview that is too structured will prevent the pursuit of unanticipated themes and one that is too loose may result in an interview without focus. The interview guide within GT research may be one that evolves as the study progresses, with interviews conducted following theoretical sampling more focussed in their topic and questioning (Wimpenny and Gass, 2000).

An initial topic guide was developed for both women and midwife purposive samples (see Appendix 14 and 15). An introduction to the study was outlined for participants and confidentiality, recording and transcription discussed. Initial broad general and straightforward opening questions were then asked. This allowed participants to relax into the discussion and feel at ease. For midwives this first question was 'Can you tell me about where you trained and how long you have been a midwife?' For women the opening question was 'Could you describe to me your understanding of how your baby could be monitored during labour?' Non-verbal communication and prompts were used to elicit more information when required such as 'Can you tell me more about that?' and 'How did that make you feel?' Themes were derived from the literature review and included questions around fetal surveillance during labour, mobility in labour, relationships with health professionals and birth partners in relation to fetal monitoring, and general thoughts around telemetry. As the interview progressed more detailed responses were elicited. The topic guide was amended once theoretical sampling and interviews were undertaken. This guide asked more focused and specific questions in response to constant comparison and analysis of previous interviews (Charmaz, 2014). Some of the questions used in the theoretical sampling group included:

How did being more mobile in your labour affect the support you received from your birth partner(s)?

Can you tell me about any parts of your labour that you feel were influenced by using the telemetry?

Could you expand on why you felt that going to the bathroom independently was so important in your labour?

Thus the analysis influenced the questions that were asked, with the 'direction of the interview becoming driven by the emerging theory' (Wimpenny and Gass, 2000, p 1485). At the end of the interviews, the researcher presented a summary of what had been discussed during the interview with the interviewee, and the main topics that had arisen. This confirmatory approach allowed the researcher to bring the interview to a close and to also ask if the interviewee wished to add anything else. Formal 'member-checking', when the main ideas or emerging categories are taken back to the interviewees at a later date (Charmaz, 2014), was not able to be undertaken due to time constraints. However, as the interviews continued and more theoretical sampling was undertaken then the emerging categories were able to be explored with interviewees.

Data for analysis included transcribed interviews, and memos. All field notes were hand written whilst some memos were hand written and others were documented in Word. The study sampling and analysis followed key grounded theory principles of following an iterative process; sampling aimed at theory generation; creating analytical codes and categories from the data itself; advancing theoretical development throughout; makings systematic comparisons; and theoretical density (Birks and Mills, 2011; Charmaz, 2014; Higginbottom and Lauridsen, 2014; Polacsek et al., 2018a). Coding was done according to that set out by Charmaz (2014) and involved initial, focused and theoretical coding. Data collection and analysis were performed simultaneously, moving from one to the other to allow categories to emerge and analysis to move to a more theoretical level and conceptual level (Draucker et al., 2007; Birks and Mills, 2011).

All transcriptions were uploaded and managed with the use of NVivo 12, a computerised qualitative data analysis software programme (QSR International Pty Ltd, Version 12 Pro). There has been some debate as to the use of Computer-Assisted Qualitative Data Analysis Software (CAQDAS) within the qualitative research field with the suggestion that the use of it turns analysis into a rigid process and 'neglects the role of human interpretation and reflection' (Hutchison et al, 2010, p285). However it is accepted that the use of CAQDAS can enhance the process if used sensitively (Bringer et al., 2004) and if researchers understand that a project will not be analysed by software nor 'fit into it' (Richards, 2002). The

researcher undertaking this study found the use of Nvivo incredibly useful and it was primarily used to manage and sort the large amount of data. The ability to create 'nodes' and file parts of transcripts into nodes gave the capacity to view all similar codes from different interviewees in one document that could be exported into a word file. More complex facilities of the software were not utilised and the researcher used hand drawn diagrams and written memos to advance the analysis.

4.4.1 Initial coding

Initial coding involves studying 'fragments of data – words, lines, segments, and incidents- closely for their analytic import' (Charmaz, 2014, p 109). All of the audio recordings were listened back to and the transcript read at the same time. The transcript was then analysed line-by-line or paragraph-by-paragraph and nodes developed *'in vivo'* (that is assigning a code or label to that particular part of the transcript). Separate folders were used for the midwife and women interviews to begin with and codes were kept simple and concise. Examples of initial coding for purposive interviews with a women and a midwife are given below; both in table form for ease of viewing (Table 9 and 10) and illustrating how the coding was carried out in Nvivo (Figures 17 and 18). The initial women and midwife nodes are also shown in Figures 19 and 20. Several transcripts were read by the supervisory team and discussion of the emerging codes ensured agreement between the researcher and supervisors.

Interview number 001 Amanda	Initial Codes
And can you remember how it felt compared to the conventional type?	
Oh much better, because it just meant that I could move around…ummm… and although with the wires on it was like actually you can sit on a ball, you can move around it's like well I can't really because I can't go and walk over there, or I can't kind of get right down. And with the wires you still feel quite restricted whereas this time it was actually if I want to spin around I can, if I want to kind of readjust it myself to try and get kind of like the heartbeat back…..ummm…. just felt like there was much more control over the situation and over what was going on. So I wasn't kind of anxious around any of it or annoyed by any of it, it was just like actually they'd assured me that once I sat down and it lost the connection that was ok because once I stood up it was alright again and baby's heart rate was there. It was just that bit where I sat back down and then it would lose the baby's heartbeat. But it was just much better.	Better than conventional Being mobile – ball Different positons Re-adjust herself More control Less anxious, less annoyed Reassurance from staff Loss of contact
Can I just pick up on that little bit about you saying you felt like you could adjust it yourself and you….can you expand on that a bit in terms of what you think made you feel like you were able to do that?	
I think just the fact that, because I could move around, I was less aware of it in terms of… because there were no wires hanging from me, it was just I'd sit down and go 'oooo' it's lost it and I'd just kind of adjust, whereas I think with the one with wires it wasn't the same, I didn't kind of feel the same because it felt like it was a bit of equipment, whereas it didn't really feel like that with the wireless one, it just kind of was a bit more part of me, and yes it's there and I know what it's doing and I know it's job but there was a bit more kind of ownership over it I think, which was good.	Being mobile No wires Felt different Technology and equipment Felt a part of her Know what it's doing Feelings of ownership

Interview 010 Anna

And you were fully dilated and pushing at that stage? Yeah. Yeah but I think at that point, because I was kind of mobile, and I was calm and I wasn't as anxious, I think that's why he came. I genuinely honestly do. I think if I had been laid on a bed with them monitors, I think I would have had another C-section, definitely.	Mobile – sense of calm Feeling that being on a bed with monitors led to caesarean
Because you would have been more anxious?	
Yeah. I was definitely more anxious, because I think it felt more medical, I think when I was hooked up to these machines, I can hear all this noise around me, I can't move, I felt very done too, and I felt less in control of my labour, and I felt I was very much part of a medical model, very consultant led. Whereas this time, the consultant was in and out but they weren't present, I didn't have...and although I did have a midwife with me the whole time, it felt different. It felt very much part of the team, we're doing it together, you're going to get me through it, I didn't feel like I was being done too, if that makes sense.	Feeling medical led to increased anxiousness 'hooked up', noisy Less control, medical and doctor-led Partnership with midwife, doing it together Not 'done to'
Yeah, absolutely.	
And the recovery for me was automatic, like I was back on my feet the next day. I was out with the kids doing the food shop, it was just, I felt so different to my experience with Niamh. I'd say, I didn't move out the house for three months with Niamh because I really struggled. But with him I didn't have any of that. I didn't have any of the guilt, I didn't have any of the bad feelings towards the birth. I felt really empowered with him, that I'd done it on my own, and I do feel the monitors contributed towards that, the fact that I was able to move and feel in control of the birth. Feel like I could have a choice to get up and move when I wanted and not to be told, no you can't do that, don't move, we're monitoring baby.	Better recovery from normal birth Felt more positive about birth, no guilt Empowered, sense of achievement Mobility and leading to control Independence of actions, not being told off for moving

Table 9: Examples of initial coding of interviews with two women

Initial codes

And what do the midwives say about using them. I heard someone say that they fight over them. Is that a true reflection of how they feel about them?

Yeah. And even say they've got a lady start off with the telemetry but then she decides she wants an epidural they'll leave the telemetry on cos it's nicer for the woman not to have two extra leads. It's just nice!! It is about not forgetting your skills and having had monitoring in labour there's nothing worse than being strapped to the bed when every other urge is telling you to get up cos you don't want to be on your back. So if you've got good technology that we've paid a lot of money for it needs to be used. And it's a better experience for women. And they work perfectly well with an FSE. We had a lady with a BMI of 56 the other week. Put on a FSE, so instead of having that faffing of holding and messing around the FSE just clipped in and then she was walking around with the telemetry on and a perfect quality recording. And that's the woman that needs to be up and be mobile and she isn't feeling like she's losing out on an experience. I have a lot of sympathy for the raised BMI ladies so it's important to……just because they need monitoring doesn't mean they can't have upright active births. And it's about instilling that and I think we're getting there now.

Using telemetry with epidural

Less leads the better, emotions – 'nice'

?midwifery skills – getting off bed

Justification for money spent – need to use telemetry

Impact on women's experience – better

Working with FSE for higher BMI

Implication - harder to monitor high BMI with conventional monitor.

Better physically for high BMI women to be mobile. Not losing out ??equality

Monitoring doesn't mean inactivity

So would you say that the women who have telemetry are more mobile?

Yeah. I think unfortunately a lot of the ladies that we see on the delivery suite aren't spontaneous labourers as they go to the birth centre and we've got quite a high induction rate, our induction rate is about 37%. So quite a lot of our ladies will be prostin induction, ARM, oxytocin. So we always start them off upright and mobile cos we've got 4 hours to see if we can get things going and that's, cos generally there is a reason why we're inducing, a fetal reason. So getting them up to a good start, getting them mobile and it might be that she won't be mobile for all of her labour because she'll decide she wants an epidural. But it's about making sure that they have

Intervention rates

Try to keep mobile ?normality

Benefits of mobility in early stages even if not mobile all of the time

Being given a choice, better

that experience and they know that they were supported to be mobile and you're not taking away that choice away from them just because they're being induced. Do you know what I mean?

experience – equity again

Interview 107 Midwife Helen

Initial codes

Or if you're a bit suspicious about something. So I think this is more like… I think with telemetry there's more dignity, isn't there? Because it's like they can go to the toilet. They don't have to just sit on a bedpan and we all stand behind a curtain or something. So I like that.

Dignity and bathroom

Not use bedpan, can just go

That is awful, isn't it?

Yeah. And just the like…the movement really. Because, I don't know, they seem like… I think even if a lady's got quite a pendulous abdomen, with the telemetry, as long as you've got it, it's not…you're not just moving it around all the time, are you? I think because it…I don't know. They seem to stay on better as well. I don't know if I've just made that up, but they seem, you know, without all the wires and stuff.

Moving

Telemetry works better? Not fiddling with it

So you feel like you're fiddling with it a bit less?

Yeah. I think fiddling with it a bit less so you're not in their faces so much when you don't need to be. You're not faffing about with loads of wires. They can walk… I think just movement really, encouraging that like mobility. Or not. If they don't want to be mobile, fine, but it's easier for them to shift their position about without us having to be moving X, Y and Z, untangling loads of stuff. And going in the water, which I haven't had any experience of here, but at Nottingham I think I definitely had someone in a pool on telemetry at one point, so…and that was really, really good. You know, so…yeah.

Not as physically close to woman

Option to be mobile if want

Less wires – easier to move

Pool and telemetry benefits

Just I'm interested in what you said about not being in their face all the time. What implications do you think that has when you're caring for the woman?

You know, obviously we're all in a room, and we get to know each other, and we're like a little team, and we're having this experience together. But I think on a CTG, especially when it's a traditional CTG, if you're chasing the baby or… It just feels like you're always touching them. And I know that there's an aspect of that but you don't necessarily just want... And it's like, oh can I just move this, can I just move that? And especially with wires because if you've got a drip running, you're doing the blood pressure, you've got CTG on, they're very...like there's a lot of stuff connected to them, isn't there?	Working together, joint experience Not touching as much – less invasive? Less things connected to woman
Yes, yeah.	
And I just feel like without those wires it's like one less thing, isn't it, that I'm, you know… And some women you're going to have to move the CTG around and like position changes and things. But I feel like when someone's on a CTG you are…you've got that proximity, haven't you? You're sort of like leaning over them a lot or into them or, you know, you've got a hand holding something on, and it just feels a bit invasive.	Midwife closer to woman in a negative way with a conventional CTG – invasive, invading space?

Table 10: Examples of initial coding of interviews with two midwives

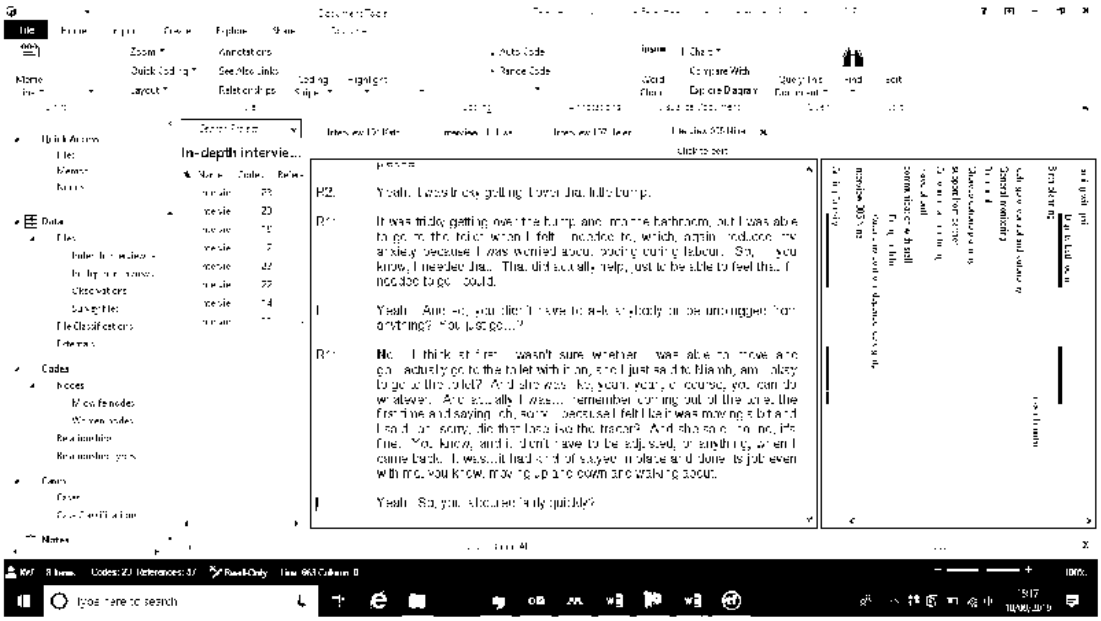


Figure 17 Nvivo example of initial coding for interview with a woman

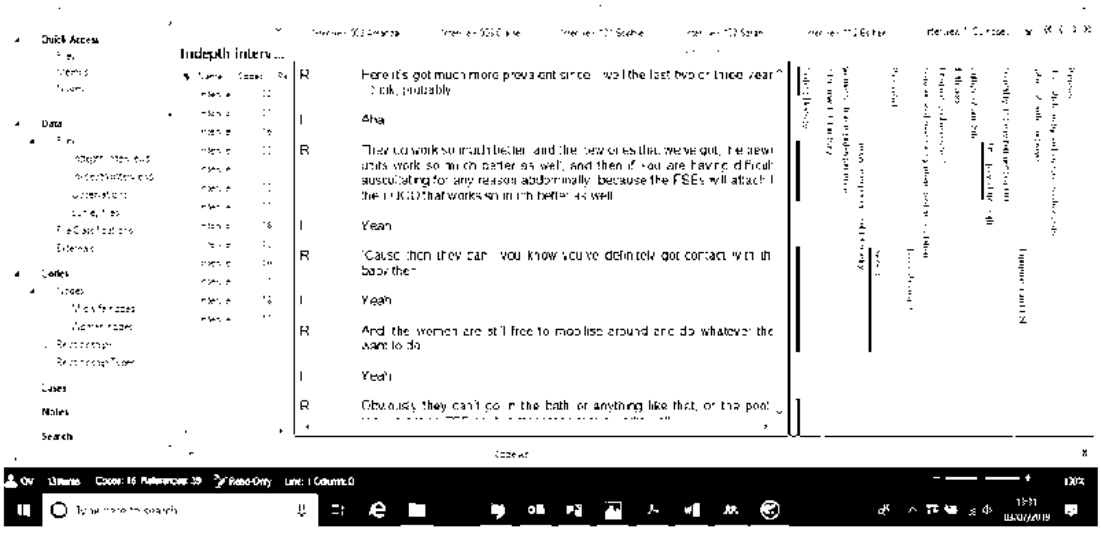


Figure 18 Nvivo example of initial coding for interview with a midwife

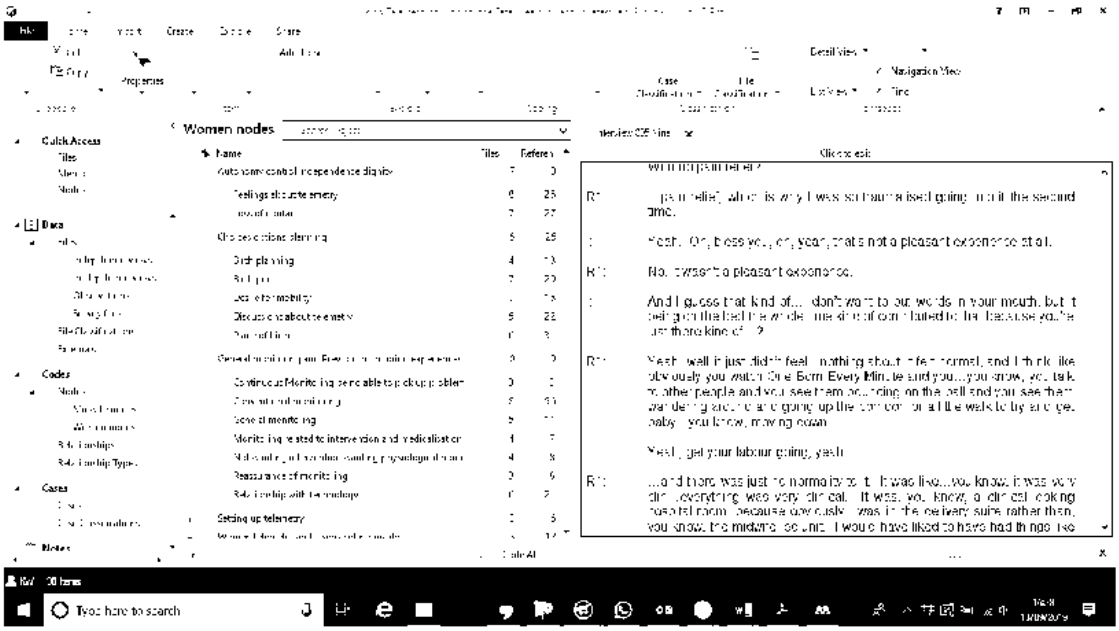


Figure 19 Initial node tree - women

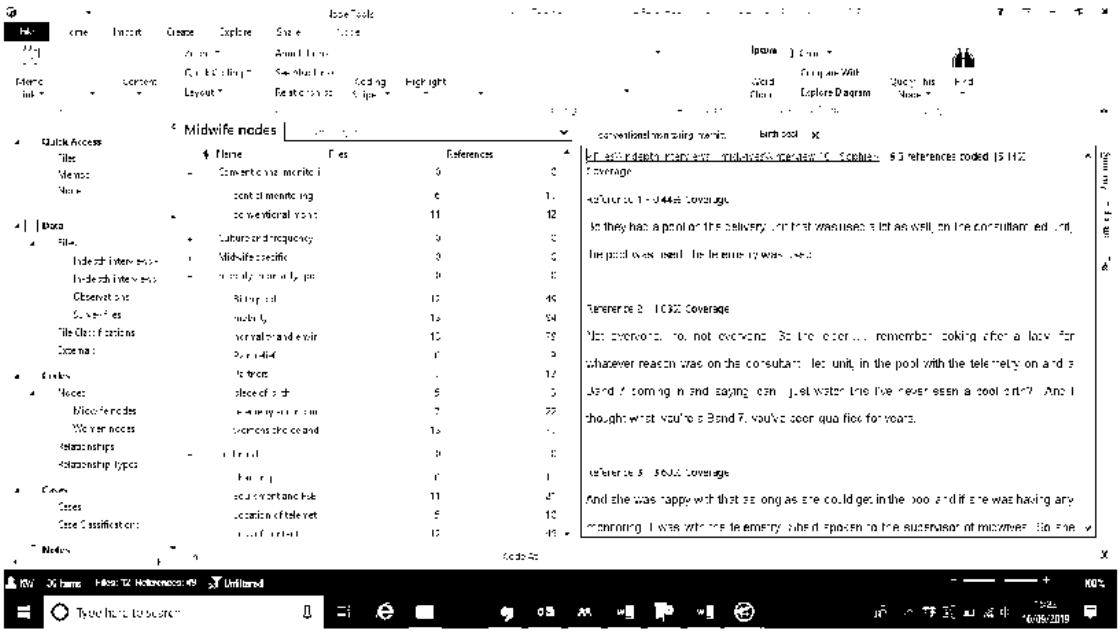


Figure 20 Initial node tree - midwives

The initial coding stage resulted in 27 separate codes for women and partners and 31 separate codes for midwives. There were over one thousand combined references for women and midwives (although many of these references were coded into more than one node).

4.4.2 Focused coding

Initial coding gives rise to first thoughts and possible paths to analysis. Focused coding takes analysis a step further and focused codes can subsume many initial codes (Charmaz, 2014). This process happened relatively quickly for the researcher as codes that became important, useful and of significance were tested against new data. Similarities and differences within and between codes were examined and relationships between codes were explored. Data and relationships between midwives and women also started to be compared. Larger parts of the text were coded and at this stage theoretical sampling was occurring which directed interview questions and participant requirements. Memos were also formulated and documented. Ongoing supervisory meetings and discussions were used to explore and discuss the developing focused codes.

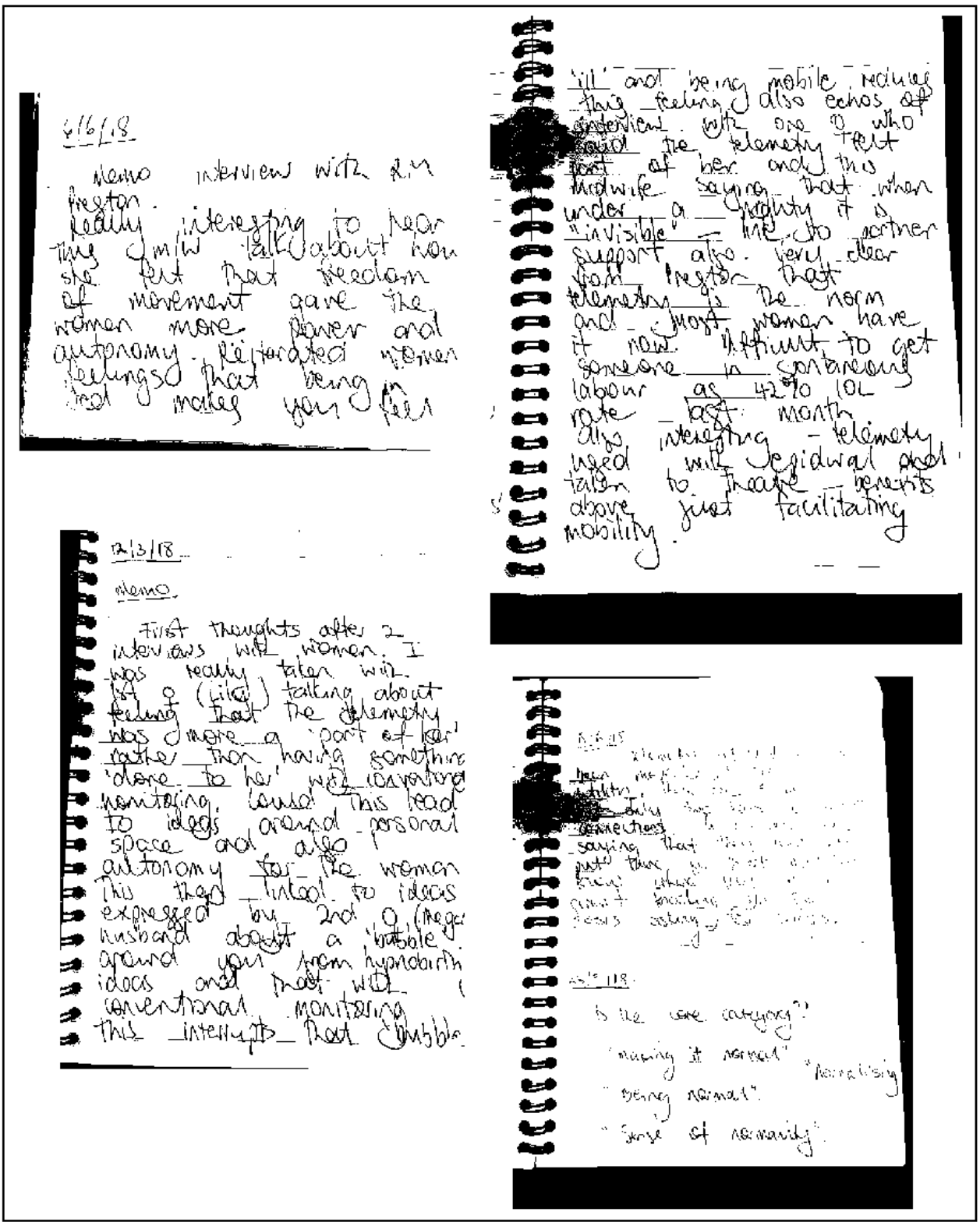
4.4.2.1 Theoretical sampling

Theoretical sampling is directed by focused coding and developing theory (Draucker et al., 2007) and the main purpose of theoretical sampling is to 'elaborate and refine the categories constituting your theory' (Charmaz, 2014, p193). Theoretical sampling is to be distinguished from other sampling which may seek to broaden the population, demographics of participants or increase generalisability (Draucker et al., 2007). Theoretical sampling for this study involved collecting more data from both women and midwives where new questions could be asked within the interview. As well as broad questions around telemetry and experience, more focused questions were used to test emergent theory such as (but not exclusively related to) normality, control, dignity and support. Theoretical sampling also directed recruitment of particular participants such as an interview with another partner, with a student midwife and with more senior management midwives who could provide different perspectives and experiences. A women for whom telemetry did not work so well was also interviewed.

4.4.2.2 Memo-writing

Memo-ing is seen as a crucial part of grounded theory data collection and analysis and continues from the very first analysis to the final theory development (Birks & Mills, 2011; Charmaz, 2014; Draucker et al., 2007; Polacsek et al, 2018b). Charmaz (2014) defines memos as 'the pivotal intermediate step between data collection and writing drafts…and is a crucial method in grounded theory because it prompts you to analyse your data and codes early in the research process' (p162). Memos can vary in style and length and increase in complexity and raise data to a conceptual

level (Birks and Mills, 2011; Charmaz, 2014). Memos were recorded by the researcher and as above, did range in complexity and density. Examples of memos (both hand written and typed) are given below (Figures 21, 22, 23, 24). Memo writing was useful to get thoughts in order, to document processes and observations of what was happening at each site in relation to telemetry. Memos were also sent on to the supervisory team for discussion and transparency about the research process and developing theory.



6/6/18

Memo interview with R.M Preston.
Really interesting to hear this mw talk about how she felt that freedom of movement gave the women more power and autonomy. Reiterated women feelings that being in bed makes you feel 'ill' and being mobile reduces this feeling. Also echos of interview with one Q who said the telemetry felt 'not' at her and the midwife saying that when under a lamp it is "invisible" — ME to partner support also. Very clear from Preston that telemetry is the norm and most women have it now. Difficult to get someone in spontaneous labour as 42% IOL rate last month. Also interesting - telemetry used with Jetidwal and taken to theatre - benefits above just facilitating mobility.

7/3/18

Memo.

First thoughts after 2 interviews with women. I was really taken with M & O (like) talking about feeling that the telemetry was more a 'part of her' rather than having something 'done to her' with (covering monitoring, could this lead to ideas around personal space and also autonomy for the woman This then linked to ideas expressed by 2nd O (mega husband about a 'bubble' around you from hypnobirth ideas and that with conventional monitoring this intervention that bubble

Is the core category?
"making it normal"
"being normal"
"sense of normality"

Figure 21 Examples of hand-written memos

Memo – conventional monitoring

I don't think there is much in the literature about midwives experiences of and thoughts on conventional wired monitoring. Interesting much of what the midwives spoke to me about completely resonates with what the women are saying – lots of talk of being 'strapped to the bed', 'pinned to the bed', 'confined to the bed' even though there is a recognition that being mobile would be beneficial to women there is a resignation/acceptance that women aren't with wired monitoring. Restrictions even if trying to be mobile include having to be near the bed, cumbersome equipment, unplugging and plugging in attachments when women move or go to toilet. Do midwives 'go along' with women being on the bed on a CTG because it is easier than trying to facilitate mobility with wired monitoring? Also resonance with themes around personal space, always fiddling with the machine and the wires, 'there's a lot of stuff connected to them', wires become a barrier between midwife and the woman, the more paraphernalia the more like a patient the woman becomes. One midwife mentioned 'self-care' which again resonates with the theme around dignity that the women mentioned. Are findings more rigorous when the women and midwives reflect what each other are saying?? I think yes.

Figure 22 Example of computerised memo – conventional monitoring

Memo – culture on the maternity units

The cultures on each labour ward are very different and I suppose the question to ask is do the different cultures affect the different amount of telemetry used or is it purely down to Site 2 having better machines that work better??? My feeling is that it is a combination of the two. Is there a way of describing in a theoretical scenario what the different drivers and influences are that would enable a woman to use telemetry successfully (eg strong midwifery clinical leadership, best telemetry machines, midwife recognising benefits of mobility and facilitating this, women desire to be mobile, women's previous experiences, physical space/environment that supports and encourages mobility including access to a pool, culture of a unit that prioritises the woman's experience and ability to have choices even when having more complex needs).....is this the beginning of a theory in which telemetry works for women and for midwives?? Facilitators/barriers.....

Figure 23 Example of computerised memo – culture

Memo - women

For me the most striking thing is that I don't think it is just about being physically mobile; it is as if being mobile leads to psychological benefits such as feeling more in control, more autonomous and less anxious. Could I explore themes of embodiment and agency in childbirth and how telemetry might contribute to this?? Women described that not having any wires meant that they were left alone and able to do their own thing and go with their bodies. One woman described the telemetry as feeling like a part of her rather than a piece of equipment – does this have any deeper meaning or impact on labour?

Figure 24 Example of computerised memo - women

4.4.3 Theoretical coding and identification of a core category

The final stage constructing grounded theory using the Charmaz model, was advanced coding and theoretical integration. This can be one of the most challenging parts for grounded theorists and moves analysis beyond pure description. In doing so a theory is produced that is 'grounded in the data and demonstrates explanatory capacity' (Birks and Mills, 2011). Birks and Mills (2011) propose three factors necessary for the integration of a grounded theory (p110):

1. An identified core category
2. Theoretical saturation of major categories
3. An accumulated bank of analytical memos

A core category is centrally related to all concepts and explains phenomena under investigation and is the 'hub of the developing theory' (Birks & Mills, 2011, p 111). The researcher for this study used memos along with diagramming to develop the core category. Diagramming 'may be used to map analysis conceptually throughout the research and visually represent the conceptual categories that develop between categories' (Polacsek et al., 2018a).

Some of the diagramming is represented in Figures 25, 26 and 27 and represents advanced analysis and identification of the core category. I found that it was easier to represent categories and sub-categories in a diagrammatic way and see how they related to each other and to other categories and sub-categories. These diagrams were discussed within supervisory meetings and there were several different versions of the diagrams produced as the analysis became more theoretical.

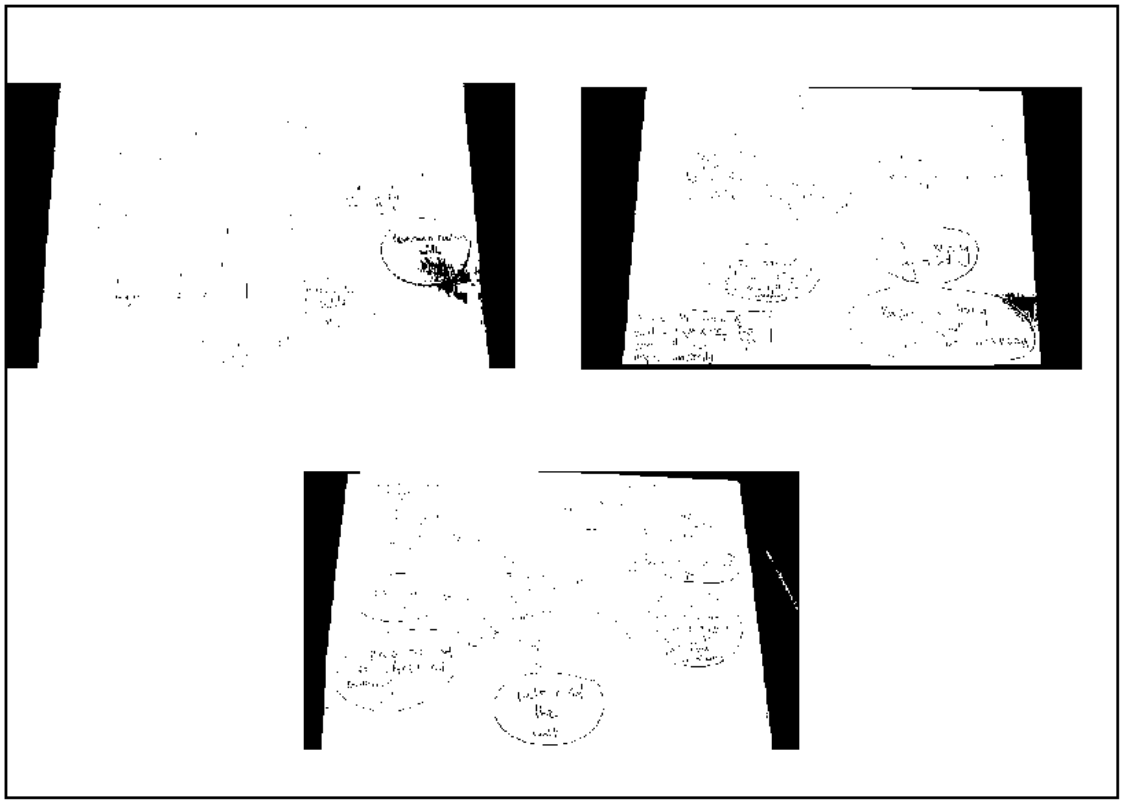


Figure 25 Example of initial diagramming to assist advanced coding

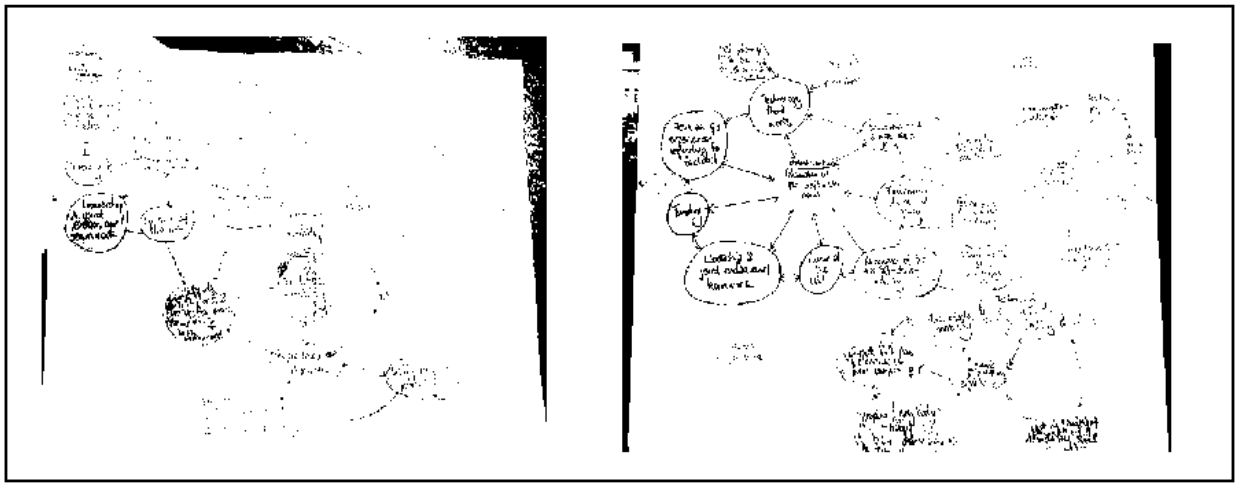


Figure 26 Advanced diagramming

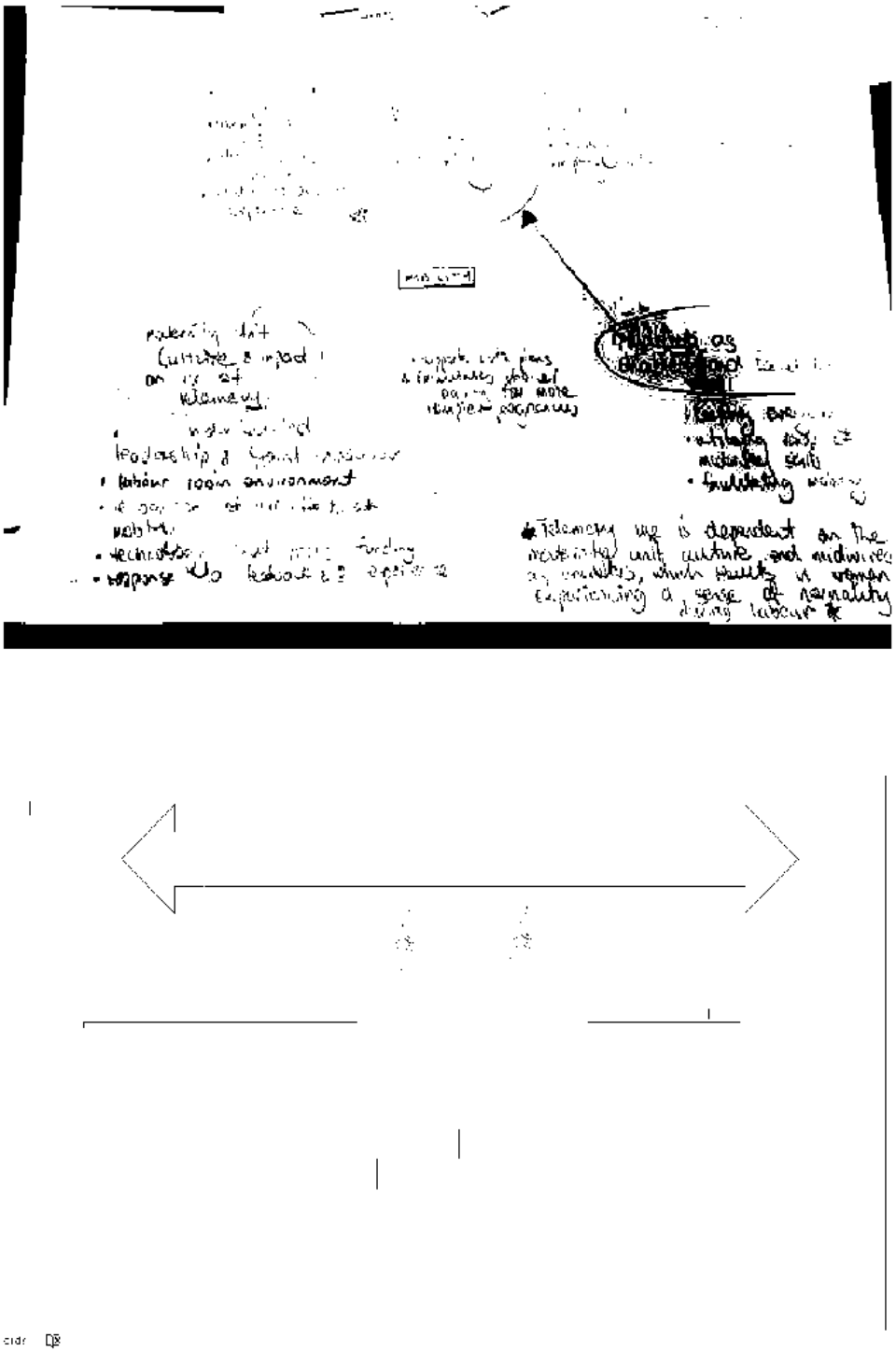


Figure 27 Final grounded theory diagrams

The quantitative phase of the study was designed to collect clinical outcome data from a cohort of women using telemetry during labour and a cohort using conventional wired monitoring. Before the study began, and after a review of the literature, it was hypothesised that type of pain relief, length of labour, and issues around control and satisfaction during labour may be influenced by the use of telemetry. Following initial analysis of the qualitative interviews it was confirmed that these would be justified in investigating during the quantitative phase. Clinical outcome and mobility in labour data were collected from each group. Women from both groups completed a questionnaire on control and satisfaction in labour in the postnatal period.

4.5.1 Study design

Design: Non randomised cohort of women using telemetry and using conventional wired monitoring to continuously monitor the fetal heart during labour.

4.5.2 Sample

As this study was not testing specific hypotheses, the sample size was be based on estimating percentages and means to an acceptable level of precision within each of the two study groups, women having telemetry and women not having telemetry. Previous studies by Stevens (2012) report a score for Perceived Control in Childbirth with a mean (SD) of 4.84 (1.02) and a score for Satisfaction with Childbirth with a mean (SD) of 5.33 (1.54). Based on these figures, a sample of **64** participants per group was sufficient to estimate a generic percentage with a margin-of-error for a 95% confidence interval of +/-25%, a mean for Perceived Control in Childbirth with a margin-of-error of +/-25%, and Satisfaction with Childbirth with a margin-of-error of +/-0.40 in each group. An overall total of 170 women were required across both sites. This allowed for an approximate thirty five percent non-return rate of questionnaires and gave the required number of 128 completed questionnaires (64 in the telemetry group and 64 in the wired group). Recruitment ceased at 161 women, once the required number of questionnaires was received. For women that consented and did not return the questionnaire, labour and birth outcome details only were collated and analysed.

4.5.3 Recruitment

A flyer with details of the study was placed in relevant areas within both maternity units including antenatal clinics, triage, antenatal day units, antenatal wards, staff

rooms and induction of labour bays. The flyer contained details of the study and also a link to an online page with more information (https://www.facebook.com/groups/500214130358889/) Contact details of the researcher were also on the flyer, if participants wished to obtain more information. The main recruitment and consent of women for the study took place on the antenatal ward of both units which is where women undergoing an induction of labour were cared for. Some recruitment was also undertaken on delivery units at both sites. Eligible women were asked by their midwife if they would be happy for the researcher to discuss the study with them and receive an information sheet (Appendix 10). The information sheet included information about monitoring the fetal heart in labour and the data collection was needed for the cohort study.

During discussion of the research women were asked if they would consent to have details about their mobility in labour recorded, as well as demographics and data about their birth collected from notes and electronic records. They were also asked to complete a survey about control and satisfaction in labour and birth, following the birth. Women were given at least an hour once being approached by the researcher to decide whether or not to take part. This process is in line with that given by the Royal College of Obstetricians and Gynaecologists (2016) where consent to participate in perinatal research is time critical. After at least one hour, women were asked if they had read and understood the information sheet and if they had any questions. Written consent was then obtained and the questionnaire to complete in the postnatal period was given to the women. Women were asked not to look at the questionnaire until after they had birthed their baby. Most women did not know whether they would be using telemetry or not during their labour and were advised that the decision about using telemetry would be made between them and the midwife providing care during the labour. A small number of women were recruited on the delivery unit where the type of monitoring had been decided prior to consent. Recruitment was undertaken between September 2018 and March 2019.

4.5.4 Inclusion/exclusion criteria

Inclusion criteria for telemetry cohort

- ≥ 18 years of age
- ≥ 37 weeks gestation
- Singleton pregnancy
- Cephalic presentation

- Continuous monitoring of the fetal heart used on admission in labour, or during labour, according to indications given by NICE (2014).
- Telemetry for ninety minutes or more of labour at any point (including if there is a change from conventional monitoring to telemetry or vice versa).
- Speaks English

Inclusion criteria for conventional CEFM cohort

- ≥ 18 years of age
- ≥ 37 weeks gestation
- Singleton pregnancy
- Cephalic presentation
- Continuous monitoring of the fetal heart used on admission in labour, or during labour, according to indications given by NICE (2014).
- Conventional CEFM for the whole of the labour
- Capacity to consent to be in study
- Speaks English

Exclusion criteria for telemetry and conventional CEFM cohort

- Complicated pregnancy such as diagnosis of severe pre-eclampsia, severe growth restriction, suspected abruption or antepartum haemorrhage.
- Fetus with a known anomaly or planned admission to neonatal intensive care
- Lacks capacity to consent to being in the study

4.5.5 Data collection

Data collection was in three parts

4.5.5.1 Collection of perceived control and satisfaction in labour data

Women were asked to complete a questionnaire (Appendix 16) with 19 validated questions about perceived control and satisfaction (Stevens et al., 2012). Questions were modified slightly for a UK population (for example 'medical care provider' was changed to 'midwife or doctor'). Questionnaires were given to the women prior to discharge and the researcher collected them from the postnatal ward. Women were also given a stamped addressed envelope to use if they preferred to send the questionnaire back after discharge. The questionnaire used in the study was that reported by Stevens et al. (2012) who developed and validated two instruments to assess perceptions of control of the childbirth environment and satisfaction with the

childbirth experience. A number of tools were used in scale development including item construction, exploratory factor analysis, confirmatory factor analysis and construct validity analysis. The results supported the validity and reliability of the two scales.

The researcher was unable to find any other publications where this method of assessing control and satisfaction in labour was used. A systematic review of validated instruments measuring women's childbirth experience (Nilvér et al, 2017) included the Stevens (2012) paper and was critiqued. The systematic review used a quality assessment tool and rated the Stevens tool as suitable. There were some tools that scored more highly but the authors concluded that when choosing an instrument that measures experience, researchers need to consider 'measurement properties that are most important for a specific application, setting and population' (Nilvér et al., 2017, p6). The researcher felt that this instrument was best placed to examine experiences around control and satisfaction in labour for women using telemetry.

The perceived control in childbirth (PCCh) scale was comprised of 12 Likert questions with ranging from 1 (strongly disagree) to 6 (strongly agree). Four of the questions were expressed in the negative and reverse scored. The satisfaction with childbirth scale (SWCh) comprised of 7 Likert questions ranging from 1 (strongly disagree) to 7 (strongly agree). Two of these questions were reverse scored. Items within both scales were intended to be aggregated to give and index of control and satisfaction but the authors (Stevens et al, 2012) also noted that items may be analysed individually. The decision was made to therefore analyse both aggregate and individual questionnaire data.

4.5.5.2 Collection of demographic and labour data.

Demographic details collected include age, ethnicity, parity and BMI (Appendix 17). Maternal outcomes included type of labour, type of pain relief, length of labour, use of syntocinon, mode of birth, blood loss and perineum status. Neonatal outcomes included weight, APGAR at 5 minutes, skin-to-skin, breastfeeding and admission to NICU. The data were collected from the maternal hand-written notes, and electronic record keeping data that was routinely collected from labour and birth for all women.

4.5.5.3 Collection of mobility in labour data.

Initially, midwives and birth partners were asked to collect contemporaneous data about the woman's mobility in labour. A collection sheet was devised and time periods were in 15 minute blocks indicating which position the woman was in for the

majority of the preceding 15 minutes (Appendix 18). After ten women had been recruited it was clear that collection of this data was difficult for midwives and birth partners to complete. Data on women's mobility was therefore collected from the electronic record as this was documented regularly. Data were also collected on whether telemetry was converted to conventional monitoring and why.

The return rate of the questionnaires was poor in the first month of recruitment and therefore a substantial amendment (Health Research Authority, 2019) was submitted and approved by the Research Ethics Committee that enabled the researcher to call the women at home to remind them to return the questionnaire. This improved the response rate.

4.5.6 Data analysis plan

Data from all data collection sheets was entered into the software package, IBM SPSS Statistics (Version 23) in preparation for analysis. A ten percent random sample of entries was compared against the original data to check for quality and control. Variables to be analysed were pre-defined and agreed beforehand aside from a sub-group post-hoc analysis preformed on women having telemetry for more than 50% of their labour and women having telemetry for less than 50% of their labour. These sub-groups were compared with wired monitoring and with each other for the control and satisfaction analysis as well as the clinical outcome data analysis.

4.5.6.1 Control and satisfaction data analysis

There is some debate in the literature as to how to analyse Likert data and whether to consider aggregation of scores or each individual score (De Winter and Dodou, 2010; Boone and Boone, 2012). A Likert scale can be defined as 'a series of four or more Likert-type items that are combined into a single composite score/variable during the data analysis process' (Boone & Boone, 2012, p5). Generally only the composite score is of interest and used. The aggregate scores for the Likert scale for each woman was calculated and mean aggregate score calculated. Difference between the groups was calculated using the independent samples t-test (Whitley and Ball, 2002b). When individual Likert questions were analysed, data were treated as ordinal rather than interval, medians rather than means were used, and the Chi-square test for trend (Bewick et al., 2004) was applied.

4.5.6.2 Labour outcome data

Characteristics of women in the two groups were compared descriptively using frequencies and percentages for categorical variables, and means and standard deviations for numerical continuous variables. Continuous variable data were assessed for conformity to normal distribution using appropriate measures (histogram, skewness, kurtosis, normality plots and Shapiro-Wilk). Parametric tests (independent samples t-test) were used for continuous variables when normality was confirmed (Whitley and Ball, 2002b; Ghasemi and Zahediasl, 2012). Non-parametric testing (Mann-Whitney U test) was employed for variables that deviated from normality to a large extent, and with ordinal data (Whitley and Ball, 2002c; Vowler, 2007). Categorical analysis was employed using Pearson's chi-square when less than 20 percent of expected cell counts were less than five, Fisher's exact test when the cell count did not meet this criteria and Chi-square test for trend when categories were ordinal (Vowler, 2007). For all statistical tests the probability value ('p' value) was observed to be significant at $p < 0.05$.

4.5.6.3 Mobility data

Mobility data were collected, using the data collection form, from the electronic records for women. The data collection form specified that the woman's position was to be recorded for each fifteen minutes of the labour but it was found that much of the documentation within the electronic records did not record the position the women was in frequently enough. Data were therefore only collected where the position that the woman was in was documented at least every 30 minutes (and was sometimes more frequently documented than this). Data were collected from 58 records and entered into SPSS. The data collection sheet (Appendix 18) contained 17 different positons that the women could have been in during labour and birth. It was identified that entering all of these different positions into the data-set would not have given any meaningful data and so the positions were collapsed into six main positions as outline below:

1. Upright – this included on knees over the back of the bed, on a birthing stool, on all fours, squatting, sitting, walking and standing
2. On a birthing ball
3. In the pool
4. Semi-reclined or lateral on a bed
5. Sitting upright (sometimes called the 'chair' or 'throne positon') in a bed
6. Lithotomy position

For further analysis the positons were collapsed again and the first three classifications were combined into one 'upright' position to give four main positions for analysis

1. Upright (positons 1,2,and 3 from initial list)
2. Semi-reclined or lateral on bed
3. Upright in the bed
4. Lithotomy

It was decided to keep upright in the bed ('chair' or 'throne' position) separate from other positions that were upright as this position is used frequently when women have wired monitoring and it was not felt that telemetry would have any impact on women adopting this position. Both Beach and Forest had labour and birth beds that could be adjusted into many positions and facilitated this 'upright in the bed' position. This position involves the back of the bed being adjusted so that it is almost upright and the bottom third of the bed being lowered so that the woman's legs are at a right angle. The other 'upright' positions require the woman to be off the bed or to manoeuvre significantly (for example on knees over the back of the bed).

Percentages were then calculated giving a proportion of time the woman was in each position for each labour. Difference between percentages for each of the groups was then compared using independent samples t-test (Whitley and Ball, 2002b).

A data analysis plan with variables and potential statistical tests to be used in shown in Table 11.

Variables	**Test planned**
Age, BMI, Mean gestation; all telemetry v wired	Independent t-test
Parity, ethnicity, pre-existing medical condition, Induction of labour, Indication for induction; all telemetry v wired	Chi-square
Mean aggregate score for PCCh (telemetry v wired), Mean aggregate score for SWCh (telemetry v wired)	Independent t-test
Individual question scores (telemetry v wired)	Chi-square test for trend
Length of first stage of labour (mean), length of second stage of labour (mean), mean time spent on any CEFM; all telemetry v wired	Mann-Whitney
Mode of birth, perineum; all telemetry v wired	Chi square test for

	trend
Artificial rupture of membranes, oxytocin use, pain relief, episiotomy, breastfeeding within first hour, delayed cord clamping, admission to NICU; all telemetry v wired	Chi square
Estimated blood loss; telemetry v wired	Independent t-test
Positions in labour; telemetry v wired	Independent t-test

Table 11 Data analysis plan

The cornerstone ethical principles outlined in the Belmont report of respect for persons, beneficence and justice (Sims, 2010) were adhered to during the study. Study participants were treated with respect and courtesy and the tenets of 'do no harm' and fairness were followed. A clear rationale was given for undertaking the study and the need to contribute to the evidence-base on the use of this technology for women in labour was justified. The researcher is a registered midwife and bound by the Nursing and Midwifery Council Code (Nursing and Midwifery Council, 2018b) which stipulates that midwives must act in the best interests of people at all times and respects people's right to privacy and confidentiality. The researcher holds a certificate in 'Good Clinical Practice' (GCP) which is the ethical, scientific and practical standard to which all clinical research is conducted. Compliance with GCP 'provides public assurance that the rights, safety and wellbeing of research participants are protected and that research data are reliable' (National Institute for Health and Clinical Excellence, 2019).

Support and advice regarding ethical consent for the study was received from the research governance team within the Faculty of Biology, Medicine and Health at the University of Manchester, who was also the sponsor for the study. Supervision and advice on ethical issues was also given by the researcher's supervisory team who have previously conducted many large pieces of research. A detailed research protocol was developed which outlined the steps taken to guide the research process and adhere to ethical principles. Research consent was gained from the Northwest-Haydock Research Ethics Committee (17-NW-0699) and the major ethical considerations given for the approval are outlined below. Due to the nature of the study and recruitment issues two substantial amendments were made to the ethics committee throughout the study. One amendment involved making changes to the quantitative data collection sheet and the second was to gain consent to

telephone the women in the postnatal period to remind them to send the questionnaire back.

4.6.1 Informed consent

All eligible women, birth partners and midwives in both phases of the study were given detailed participant information sheets specific to the phase of the study they were potentially being recruited for. The information sheets contained details of the background to the study, requirements of the participants (including time), risks and benefits of taking part, researcher funding and affiliations, confidentiality details and data collection and protection procedures. The researcher discussed this information with the participants and time was given for answering questions. Prior to taking part, each participant completed a signed consent form, again specific for each part of the study. Participants were aware that participation was voluntary and they could withdraw from the study at any time.

4.6.2 Risks and burdens for participants and researcher

It was recognised that interviewing women about their labour experiences may have brought up possible traumatic or distressing memories, particularly if the labour did not go as expected. Women were excluded if they or their baby needed a higher level of care such as ICU or NICU. However, it is recognised that for some women who have healthy outcomes, labour may have been a stressful event. The researcher was an experienced midwife who was used to talking to women about their labour and birth experiences. She has experience in de-briefing women who request time with a senior midwife after their baby is born to discuss events. A distress policy (Appendix 19) was formulated for the study and referral procedures outlined within the policy. None of the women interviewed required referral on to other health professionals. There was a burden of time for the women who were recruited into the study which was around one hour for interviewees and 15 minutes for women to complete the postnatal questionnaire. The location and time of the interviews were at the participants' convenience which ensured flexibility and minimised disruption.

Interviews with the women and birth partners took place in the women's homes which posed a potential risk to the researcher. The Safety Guidance for Research Fieldwork policy for the University of Manchester was followed and a safety device was used at each interview. This device ensured that a named person knew the address that the researcher was at and this person was called before and after the interview.

4.6.3 Confidentiality

Appropriate access controls were put in place to ensure that access to confidential research information was restricted to the researcher only. Electronically held data such as transcriptions of interviews and SPSS files were held on a password protected encrypted computer and stored on secure servers rather than the hard drive. Personal contact details were also kept separate from other files. All participant data were anonymised by assigning each participant a unique identification number. All interviews were recorded on an encrypted digital voice recorder and uploaded securely to a University approved supplier for transcription. All participants were given a pseudonym and this was used when any direct quotes were used in the findings and analysis. The two NHS Trusts used for recruitment have also not been identified in this thesis and will remain anonymised for any subsequent publications. Manual data files such as consent forms, labour outcome data collections forms and mobility forms were stored in locked filing cabinets within locked offices at each site.

4.6.4 Patient and public and involvement

It is vital that women using maternity services within the United Kingdom are actively involved in research about all aspects of care provision, quality and safety and this is acknowledged by the researcher. In preparation for the NIHR application the researcher submitted to undertake this study and complete a PhD, six women undergoing induction of labour at one of the sites used for recruitment were interviewed to determine their views surrounding conducting researcher about different types of fetal monitoring, including telemetry (REC reference 13/NW/0808). The views of the women were taken into account when considering the study design and themes identified from the analysis confirmed women's interest in telemetry monitoring and the importance of undertaking the research. None of the women were aware that telemetry monitoring was available at the site and most were unclear about the fetal heart rate monitoring options available or recommended. The women interviewed confirmed that if they had been approached to be recruited to a study of this nature they would be happy to be interviewed and did not identify any major concerns with the design. A critical review of the design was provided by a doula working with women at the site and a lay member from the NICE Intrapartum Guideline update committee. Both women provided useful comments about the proposal which were taken into account during the design of the study.

Participant Information sheets and the mobility data collection sheet were seen by two women who volunteered to provide comments. Minor changes were made following these comments. It is planned that findings from this study will be communicated to lay and other interested groups within the community.

Rigour, defined as 'the quality of being extremely thorough and careful' (Oxford English Dictionary, 2015) is crucial for any high quality study. Rigour should be considered throughout the whole of the research project, not purely at the end post hoc (Morse et al., 2002). Within the mixed method literature there are developments in how this type of research is validated and frameworks proposed that seek to unify some of the terms and concepts used within quantitative and qualitative perspectives (see Onwuegbuzie and Johnson, 2006; Dellinger and Leech, 2007). The consideration of rigour within mixed methods may be complex as each phase of a mixed method study will often have different methodologies and paradigms (Giddings and Grant, 2009). However, Creswell notes, 'assuming that the study is persuasive and rigorous in both the qualitative and quantitative strands, we can use the standards of both approaches that are available in the literature' (Creswell and Plano Clark, 2011). Creswell then proposes that some broad mixed method criteria are used following assessment of the rigour of each individual phase. It is this approach to rigour the researcher has adopted for this study and takes into consideration the note by Tobin and Begley (2004) that 'rigour is the means by which we show integrity and competence: it is about ethics and politics, regardless of the paradigm' (p 390).

4.7.1 Rigour within quantitative research

The concepts validity, reliability and generalization are all terms associated with positivistic/quantitative paradigms and contribute to rigor of a study. These were briefly discussed in relation to questionnaire development in section 3.8.2.1. Within the quantitative phase of this study the study design, sampling and data collection analysis have been clearly outlined which contribute to the overall rigor of the study. Development of the questionnaire used to measure control and satisfaction demonstrated high internal consistency (Cronbach's alpha = 0.91 and 0.92 for both scales), construct validity and reliability (Stevens et al., 2012). It is widely accepted that a Cronbach's alpha of greater than 0.7 means that there is good internal consistency of the instrument; in this case the questionnaire that was used (Heale and Twycross, 2015). This meant that the questionnaire scale was reliable, that

inferences could be drawn from the scores in relation to control and satisfaction and that the scores are consistent. Threats to generalisability include sampling, selection and response bias and will be acknowledged when discussing limitations of the study in the final Chapter.

4.7.2 Rigor within qualitative research

There is debate about whether the concepts of validity, reliability and generalization should be applied to the naturalistic/qualitative paradigms at all (Seale and Silverman, 1997; Tobin and Begley, 2004). The terms have been mostly rejected by the qualitative research community and viewed as a 'poor instrument' with which to evaluate qualitative research (Davies and Dodd, 2002). It is important however to have criteria with which to judge qualitative research in order that it remains a 'scientific process that has a valued contribution to make to the advancement of knowledge' (Tobin and Begley, 2004, p 390). In their seminal work Lincoln and Guba (1985) substituted reliability and validity with the term 'trustworthiness' which contained four aspects; credibility, transferability, dependability and confirmability. The criteria and how they may be achieved within a qualitative research study are outlined in Table 11.

Criteria (and quantitative term replaced by)	Description
Credibility (replacement for quantitative concept of internal validity)	Concerned with 'fit' of participant views and researcher's representation of them – a credible description
Transferability (replacement for quantitative concept of external validity)	Ability to asses fit with other settings
Dependability (replacement for quantitative concept of reliability)	Audit trail of the research process that is logical, traceable and clearly documented
Confirmability (replacement for quantitative concept of objectivity)	Data and interpretations are derived from the data

Adapted from Tobin and Begley, 2004; Onwuegbuzie and Johnson, 2006; Schwandt et al., 2007.

Table 12 Criteria for judging trustworthiness of qualitative research

The steps taken in the qualitative phase of this study to ensure trustworthiness will be outlined below along with consideration of theoretical sensitivity and reflexivity which are both paramount in constructivist grounded theory research (Hall and Callery, 2001). In addition to the criteria described in Table 11, Charmaz (2014) describes criteria for evaluating a final constructivist grounded theory that has been developed. These criteria are; credibility, originality, resonance and usefulness and will be discussed in the strengths and limitations section (8.2.1) towards the end of the thesis.

4.7.2.1 Credibility

Credibility, confidence that the findings are a true representation of the study, is vitally important. It is achieved by ensuring that the study was conducted using typical procedures of the type of qualitative method used (Connelly, 2016) and may include; prolonged engagement with the topic and participants so that salient topics may be pursued, member-checking and reflective journaling (Schwandt et al., 2007; Connelly, 2016). The initial thoughts for this study germinated almost two years before the NIHR award was achieved. The researcher was working clinically and was also part of a NICE committee publishing guidelines on intrapartum care. As part of this committee, the evidence on telemetry was examined and the researcher observed that there was a gap in the literature on the evidence for use of telemetry. The development of the NIHR application, discussions with supervisors and selection process for the fellowship award all contributed to engagement with the topic and consideration of the researcher's underlying assumptions about the topic. Grounded theory was chosen, after several discussions with supervisors, as the methodology that would best answer the qualitative researcher question as there was very little know about the experiences of women and midwives using telemetry. Selection of a methodology that suits the research questions and aims is a crucial step towards credibility (Green and Thorogood, 2004).

The steps used in constructivist grounded theory methodology were followed methodically and systematically including moving flexibly between data collection and analysis, constant comparison, use of theoretical sampling and the use of memos (Birks and Mills, 2011). Reflective thoughts of the process were kept by the researcher and some of these used as memos in the analysis. Discussion of the findings that occurred during each step of the grounded theory process, with the supervision team, challenged the researcher and ensured that the resulting theory was grounded in the data and accurately represented the topics. Several interview transcripts were also seen by the supervisory team so that categories and sub-

categories were agreed upon and this enhanced credibility. Due to time restraints, formal member-checking, (that is taking findings back to participants to verify the results), was not undertaken by the researcher. At the end of each interview the researcher did give a precis of the discussions to confirm major themes discussed. There is some disagreement in the literature on member-checking with one argument stating that member-checking affects analysis and may result in more descriptive and less theoretical analysis and 'may actually invalidate the work of the researcher' (Morse et al., 2002). Theoretical sampling ensured that issues expressed by participants were verified or dismissed by new participants and saturation was achieved.

4.7.2.2 Transferability

Transferability refers to how applicable the findings are to other settings. Connelly (2016) states that researchers 'support the study's transferability with a rich, detailed description of the context, location, and people studied, and by being transparent about analysis and trustworthiness' (p 436). By its nature, and provision of rich descriptions of participant's individual experiences, qualitative research does not attempt to be generalizable to other settings, but readers may determine how relevant findings are to their own locations and positions (Connelly, 2016). Within grounded theory, theoretical sampling attends to transferability and increases the ability to transfer findings to other settings (Hall and Callery, 2001). 'Thick descriptive data' (Schwandt et al., 2007, p 19) was provided for each site in the study, which provided contextual information about the settings including size, staffing and other nuances. Verbatim quotes were also used within the results and analysis of the qualitative phase so that the participants own words shaped the narrative and increased understanding of the findings. This also contributed to the authenticity (Schwandt et al., 2007) of the research which demonstrates the extent that the research presents participants views and experiences (Connelly, 2016) and is a particular quality of qualitative research.

4.7.2.3 Dependability and confirmability

Dependability refers to how the data and study conditions remain stable over time (Connelly, 2016) and may be confirmed with an audit of the study processes (Schwandt et al., 2007). Auditing of the study data, analysis and findings may establish confirmability (Schwandt et al., 2007; Connelly, 2016) and establish that findings are not 'figments of the inquirers imagination' (Tobin and Begley, 2004, p 392). Presentation of methods used for the qualitative phase of the study in this Chapter provide evidence of how the study was undertaken. Documentation of all

phases of recruitment and consent was kept including numbers of participants that were approached and those that declined to take part. The use of computer assisted software (Nvivo) also provided an audit trail of the various stages in data analysis including initial and focused coding so that the supervisory team could view and discuss with the researcher. Memos and diagramming also provided evidence of developing analysis.

4.7.2.4 Theoretical sensitivity and reflexivity

Theoretical sensitivity and reflexivity both have the potential to increase the rigor of a grounded theory study. Theoretical sensitivity 'reflects the investigator's ability to use personal and professional experiences and the literature to see the research situation and data in new ways and exploit the potential of the data for developing theory' (Hall and Callery, 2001). The researcher is able to use experience to construct and analyse categories that best reflect the situation that is being explored. Reflexivity goes hand in hand with theoretical sensitivity and is more concerned with the interview process and consideration of the researchers underlying assumptions and how they may influence the inquiry. Reflexivity is concerned with honesty and authenticity and Charmaz (2014) defines it as:

> *"The researcher's scrutiny of the research experience, decisions, and interpretations in ways that bring him or her into the process. Reflexivity includes examining how the researcher's interests, positions, and assumptions influenced his or her inquiry. A reflexive stance informs how the researcher conducts his or her research, relates to the research participants, and represents them in written reports" (p 344).*

In a constructivist grounded theory framework it is acknowledged that data is socially constructed and does not stand alone as a translation of reality (Hall and Callery, 2001). For constructivists, interviews are conversations between two or more people, both with particular knowledge, interests and backgrounds. They are a social event, with interactions between interviewer and interviewee ebbing and flowing. This links too with symbolic interactionism.

As an experienced clinical midwife with a strong belief in normal birth and minimising intervention this position needed to be acknowledged before undertaking the research. The researcher's own experience of having two very active normal births also needed to be reflected upon. But this experience, along with broad clinical knowledge ensured that the researcher had a good understanding of the research area and topic and was able to construct codes and categories that were

close to the data and that were meaningful. The researcher's initial perspective before starting the NIHR application was that telemetry must be a great thing for all women and why didn't every hospital use them for every women? Through being very open about these views, this allowed these assumptions to be challenged, and for the researcher to be receptive to all viewpoints and perspectives in order that they were heard and incorporated.

Developing rapport and mutual trust with interviewees is crucial (Kvale, 2008) and being reflective of and acknowledging potential power imbalances may be important. The researcher had worked in a senior role in one of the sites used for recruitment and so some of the interviewees were known to the researcher. It was important to convey to these interviewees that the interview was completely confidential, that there were no right or wrong answers and that the interviewer was there as a researcher, not as a clinical midwife. Interviews with women were done at a convenient time for them and in their own home which contributed to building rapport and ensuring participants were able to respond with ease in an environment they were used to. Questions were asked in a neutral way but the researcher was mindful of the 'miner and traveller' metaphor described by Kvale (2008), viewing the traveller interview as 'intertwined phases of knowledge construction, with an emphasis on narrative' (p 20). The first few interview transcripts were viewed by the research's supervisors and constructive criticism given. As the interviews grew in number the researcher became more adept at them and gained in confidence.

This Chapter has presented a transparent description of how both phases of the study were undertaken. Following a description of both recruitment sites the methods for design, sampling, recruitment, inclusion/exclusion criteria, data collection and data analysis were given. Ethical considerations were also discussed along with aspects of rigor for each phase. The following Chapter will present the grounded theory of using telemetry to monitor the fetal heart in labour.

Chapter Five: A grounded theory of telemetry use

This Chapter outlines the grounded theory of telemetry use. Details are given about the participants and then a description is given of the core category *Telemetry: A Sense of Normality.* The grounded theory is represented diagrammatically in Figure 28. The three sub-categories that define the theory are *'Being free'*, *'Enabling and Facilitating'* and *'Culture and Change'*. These are outlined in detail using excerpts from both the midwife and women interviews.

A total of 24 women signed a consent to contact form but not all were interviewed. This was for a variety of reasons including women not using telemetry during labour and the researcher being unable to contact the women on the numbers provided. In-depth interviews were conducted with 10 women in the postnatal period across both sites. All interviews took place within the first eight weeks of birth. Two partners were also present for two of the interviews; they were not interviewed separately but did contribute to the conversation and formal consent was taken. A total of 12 interviews were conducted with registered midwives and one interview with a student midwife. At the time of recruitment there was only a small number of student midwives on placement at each site which affected student recruitment. Participant characteristics are presented in tables 11 and 12. Six of the twelve qualified midwives had previous employment at other Trusts where telemetry was also in use and were able to draw on experience from those positions as well as their current one. One midwife had been working at Beach for two months and had previously worked at Forest. The interviews ranged between 21 and 64 minutes.

Participant pseudonym	Site	Parity	Ethnicity	Age	Profession	Labour / birth	Sampling
Lily	Beach	3	White Irish	31-35	Teacher	Spontaneous labour, normal birth, previous LSCS	Purposive
Amanda (plus partner Mark)	Beach	1	White British	31-35	Human resources manager	Induction of labour for post maturity, emergency LSCS	Purposive
Claire	Forest	1	White British	26-30	Teacher	Induction of labour for Small for Gestational Age fetus, Invitro Fertilisation, SVB	Purposive
Helen	Beach	3	White British	31 - 35	Medical writer	Induction of labour for decreased fetal movements, SVB	Purposive
Nina (plus partner Clive)	Forest	2	White British	31 - 35	Teacher	Induction of labour for SROM, SVB	Purposive
Miranda	Forest	4	White British	31-35	Full-time mother	Induction of labour for decreased fetal movements	Theoretical
Kalpana	Beach	3	African	31-35	Civil servant	Induction of labour for previous Neonatal Death and GBS	Theoretical
Aditi	Forest	1	Indian	26-30	Doctor	Induction Of Labour for Obstetric Cholestasis, emergency LSCS	Theoretical
Holly	Beach	2	White British	31-35	Physiotherapist	Spontaneous labour, emergency LSCS	Theoretical
Anna	Beach	2	White British	26-30	Psychologist	Induction of Labour for decreased liquor, previous LSCS, SVB	Theoretical

Table 13 Characteristics of interviews with women.

Midwife Name(Alias)	Site	Band and role	Years since qualification	Sampling
Sophie	Beach	6 – rotational midwife	6	Purposive
Lindsey	Forest	6 – delivery unit midwife/research midwife	6	Purposive
Esther	Beach	6 – rotational midwife	5	Purposive
Faye	Forest	6 – Du midwife	9	Purposive
Alice	Beach	5 – rotational midwife	3	Theoretical
Jacqui	Beach	6 – rotational midwife	4	Theoretical
Abigail	Beach	Student midwife	N/A	Theoretical
Sarah	Beach	7 – delivery unit ward manager	15	Theoretical
Eve	Beach	7 – CTG midwife	16	Theoretical
Lucy	Forest	7 – delivery unit ward manager	12	Theoretical
Harriet	Beach	5 – rotational midwife	2	Theoretical
Melissa	Forest	7 – co-ordinating midwife	7	Theoretical
Lisa	Beach and Forest	7 – Du midwife co-ordinator	5	Theoretical

Table 14: Characteristics of interviews with midwives

The use of telemetry to continuously monitor the fetal heart during labour led directly to women experiencing 'a sense of normality'. This sense of normality was felt in two ways: in terms of the labour feeling more physiologically normal and less medicalised, and also in the actions of the woman whilst being more mobile. Midwives also perceived that telemetry contributed to this sense of normality both in terms of the woman's labour and what was happening in the room. Many women had experienced conventional wired monitoring in previous births and had negative views of it. Women felt tied to the bed and restricted in how they could move with wired monitoring and this impacted on choices made for the subsequent birth. Women perceived that telemetry was better than conventional wired fetal heart rate monitoring and the option of greater mobility conferred additional benefits.The use of telemetry did facilitate mobility and was overall a positive experience for women, partners and midwives caring for them. Women were able to change and adopt different positions easily and felt less restricted in what they could do and positions they could adopt. A feeling of ownership and jurisdiction over the birthing space was felt by the women and resulted in greater control over the environment, including lighting and access to personal items. Women's birth partners were able to offer more physical and emotional support when the women were using telemetry as they were spending more of their labour off the bed and in closer proximity to partners. The ability to use the bathroom whenever they needed led to strong feelings of increased dignity and autonomy for women. All of these actions (moving aorund the room, support from partner, access to belongings and the bathroom) contributed to the sense of normality felt by women. Women also felt more in control over what was happening during their labour and felt more involved in decision-making.

Midwives felt that telemetry contributed to 'normalising' labour for women with more complex pregnancies and offered increased choice. This choice, and the option to be more mobile if desired, led to a perception of increased equity between women who were experiencing low-risk labour on a midwifery-led unit and women who had more complex needs and were advised, or chose, to birth in an obstetric-led setting. Midwives caring for women using telemetry were able to draw on a wider range of midwifery skills when caring for women which also included using birthing pools. The recording of the fetal heart was sometimes of a lower quality with telemetry and midwives described various methods to increase the quality of the recording.

Occassionally monitoring reverted back to the use of conventional wired or a fetal scalp electrode.

The culture of the maternity unit impacted on the priorty given to women having access to telemetry. When good quality telemetry was combined with an environment that incoporated elements of low risk care that encouraged calm and quiet labour spaces and normality, then telemetry was used enthusiastically for women whose fetuses needed to be monitored continuously in labour.

The grounded theory of telemetry is represented diagramatically in Figure 28. This diagram shows the core category 'A Sense of Normality' spanning across the three main categories and sub-categories. The three main categories are 'Being Free', 'Enabling and Facilitating' and 'Culture and Change' and are supported and described by eight sub-categories. All of the categories include both women's and midwives experiences and narrative segments from the interviews present widely shared ideas from the interviews.

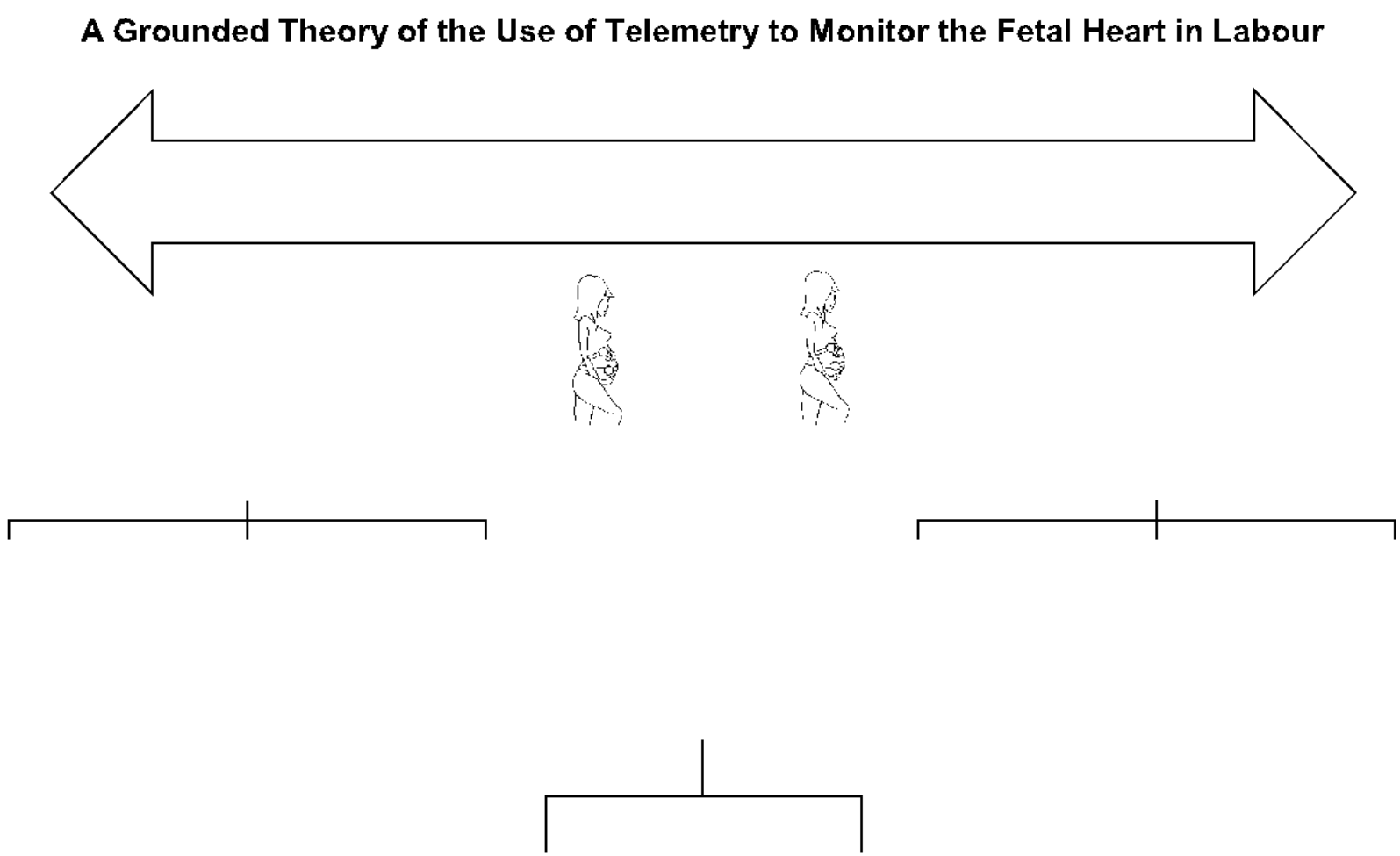


Figure 28: Telemetry: A Sense of Normality

The category 'Being free' contains three sub-categories (Figure 29): 'Strapped to the bed'; 'I just felt more normal'; and 'Together as a team'. This category primarily reflects the women's experiences of telemetry. However, the three subcategories are mutual between both women and midwives with many of the midwife interviews providing confirmatory data of the women's experiences.

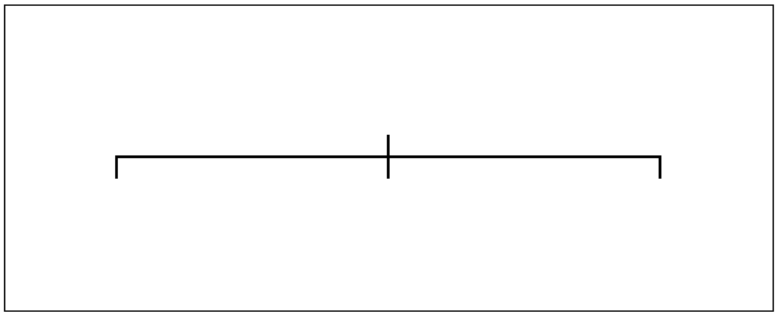


Figure 29 Category – Being Free

5.4.1 Strapped to the bed

Many of the women interviewed spoke of previous experiences of wired continuous monitoring, either in a previous labour or during the induction process prior to the most recent birth. Many of these experiences were negative and women spoke of being 'tied', 'strapped', 'pinned' and 'confined' to the bed which led to a sense of immobility. One woman described feeling like an 'upside-down turtle'. Women also spoke of being 'attached' and 'hooked up' to a machine which to them felt unnatural – one that did not resonate with ideals behind normal and natural birth. The previous experiences of women impacted on preferences and expectations of monitoring for subsequent births. Lily remembered her first birth and recalled the negative feelings of being made to stay on the bed:

> *"I was on the monitor and I was having to kind of stick to the bed and lie down when all I wanted to do was move around but I couldn't 'cos every time I tried the straps slipped off and it was like 'Oh you need to lie down, you need to stay still, we need to monitor baby'. Um, which was the main reason for not wanting it the second time 'cos I didn't want to be strapped to the bed." (Lily, 2nd baby, Beach)*

Many of the midwives reiterated this sentiment, echoed terms that women used, and corroborated that wired monitoring tended to result in immobility. This restriction of movement went against what they had learnt about the importance of encouraging

women to being active and mobile in labour. Midwife Beth spoke of trying to encourage mobility with wired monitoring:

> *"I think that once they're on the CTG that's it, they're not allowed to move, they're strapped to the bed, and I always say to them 'Look, although we do have to continue to monitor you, you can be in every positon you want to be, if you want to stand up you can stand up, if you want to kneel on the bed you can'. I think because they just automatically think they have to be in that sitting-in-the-bed-and-not-being-able-to-move position." (Beth, midwife, Beach)*

Even when encouraging movement, both the women and midwives acknowledged that the physical attachment to the monitor still resulted in some restriction, entanglement with the wires, and staying close to the bed. The lack of movement for women also contributed to feelings of being out of control during the labour. Nina described her first birth in these terms, and how it didn't align with how she had imagined birth would be:

> *"I was sort of out of control and I wasn't……to be honest it was quite a traumatic experience, the first time, and it wasn't how I'd wanted it to be. Obviously you always know that there's a chance that you're going to be induced, but I never envisaged that I'd be stuck on a bed and feeling so out of control of what my body was doing." (Nina, 2nd baby, Beach).*

Likewise, Miranda, spoke of vulnerabilities when being on a bed and having things done to her which led to feelings of not being in control, of disembodiment, and of surrendering control to the medical team:

> *"I just feel sort of like you lie on the bed, you're half dressed, aren't you, and you're being checked, and I just sort of feel like everyone's asking you questions, are you okay, are you not, and I just feel like I'm not me,……. I just felt like everyone's poking you and prodding you and doing your blood pressure and, we'll just stick this needle in here and now we're going to put you on that and you're not sort of like labouring as you'd want to, you're not in control, everyone else is in control, the doctors have majority of control I feel because you're on the bed." (Miranda, 4rd baby, Beach)*

When women were asked about what they had known about fetal monitoring during labour many primiparous women had not thought about it in depth or been given detailed information either by their midwives or from attending antenatal classes. Several women mentioned watching women in labour on television programmes such

as One Born Every Minute. This sometimes resulted in their own reality of birth not meeting expectations of the birth they had formed from information received from the media. Nina also spoke about this and how being continuously monitored and on a bed didn't feel normal:

> *"Nothing about it felt normal, and I think obviously you watch One Born Every Minute and you, you know, you talk to other people and you see them bouncing on the ball and you see them wandering around and going up the corridor for a little walk to try and get baby moving down…and there was just no normality to it. It was like…you know, it was very clinical, everything was very clinical" (Nina, 2nd baby, Forest).*

The theme of not feeling normal, being out of control, and feelings around illness, and infantilism resonated with many of the women. Being in a very clinical environment and being seen as, or made to feel like, a 'patient' when on a bed in a hospital was also echoed by many of the women, and with midwives like Melissa:

> *I was definitely more anxious, because I think it felt more medical, I think when I was hooked up to these machines, I can hear all this noise around me, I can't move, I felt very done too, and I felt less in control of my labour, and I felt I was very much part of a medical model, very consultant led……I kind of felt like, just do as you're told, just stay on the bed, don't move, be a good patient. (Anna, 2nd baby, Forest)*

> *"Because when you go into hospital and you become attached to things, it's like a barrier between you and that person isn't it, almost, so the more paraphernalia you have attached to you, the more a patient you become" (Melissa, midwife, Forest).*

Some women such as Lily, had met with a senior midwife to prior to labour discuss previous experiences and options for the current birth, which included desires for greater mobility and questions around the availability of wireless monitoring. Lily, who had a previous caesarean section, wanted to labour and birth on the midwifery-led unit but was advised not to and was recommended to have CEFM on the obstetric-led unit:

> *"She [the senior midwife] could give me the kind of options in terms of what options there were for me on the consultant–led ward and suggested things…we don't need to go for the intermittent monitoring, we do have the wireless monitoring, would you have that? And it was like, oh yeah, it's not the*

being monitored that was the issue, it was sticking to the bed and lying down" (Lily, 3rd baby, Beach)

Other women, predominantly from maternity unit 'Forest', were only aware of telemetry when it was used automatically for them in labour. Telemetry was used frequently at 'Forest' and not presented as a choice for many women – it is what was used. For the women at 'Beach' the use of telemetry was less routine and used more often for women who were aware of it and requested it or the use of it was part of a pre-written birth plan. For all of the women interviewed, the availability of telemetry and the ability to be more mobile in labour was a welcome experience.

5.4.2 I just felt more normal

This subcategory focusses on women being more mobile in labour which led to feelings of increased control and dignity, and feelings of normality.

5.4.2.1 Being mobile

The majority of the women interviewed expressed that **telemetry enabled them to be more mobile** and move around within the labour room; they were freer. Some women recognised why it was important in a physiological sense to be more upright and mobile:

"Well, for me, just because I value a natural labour, I know that positioning is sometimes what it all rests on, so if you have to change position then you have to be mobile; and just remaining on the bed, well, it just doesn't help with even releasing your own energy or being in the ideal position for your baby." (Kalpana, 2nd baby, Beach)

Women were able to get off the bed, use birthing balls, walk around and get into different positons. The different ways that women moved during labour are detailed in Figure 30. Women described moving during labour as physically rewarding and used birthing balls, beanbags and the bed for support as well as squatting, walking, swaying and standing. All but one of the women interviewed used telemetry for the majority of their labour and women described being mostly off the bed and mobile during the labour.

"And I was quite happy with that, I could move around"

"If I want to spin around I can"

"I think I was standing, I wasn't lay on the bed, I was active and moving" (Lily)

"It was really nice to be able to get up, it really was, just to be able to stand up and go on the birthing ball"

"Just to be able to get off the bed was fantastic, it was good"

"Just being mobile, just stretching, just having something else to do apart from lying on the bed"

"I was able to do different positions, you know like squats and leaning over the bed and stuff like that" (Amanda)

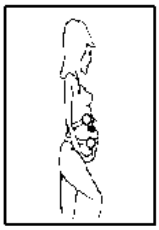
"So I was able to get up and go on the birthing ball: I sat on that"

"It was good because I could be off the bed, on the ball, leaning on the bed" (Claire)

"The whole time I was moving around because I was trying to walk around as much as possible"

"So it was a mixture of walking and bouncing on the ball" (Helen)

"I could get up and use the beanbag or go and use the toilet, go and get a glass of water, sit with my partner and then go and sit with my Mum" (Anna)



"I was on my feet, I had my earphones in and I was swaying"

"I was on all fours for the whole time right up until the last few pushes"

"Swaying about, moving my hips from side to side, which I couldn't have done if I'd been on the bed" (Nina)

"I mean, I didn't go far, I was still like near the bed leaning on the bed, but I could walk around" (Miranda)

"But it was really good though, because if I wanted to get up off the bed and just have a walk around, I could have a walk around"

"I was able to be mobile, I leaned up against the back of the bed (Kalpana)

Figure 30 Women's descriptions of mobility

"I could sit in whatever position I wanted to when I was on the bed, on the chair"

"I was on the yoga ball for a while"

"I can actually walk around, do what I want, it didn't stop me from doing anything I wanted to do" (Aditi)

For one woman, Helen, the telemetry machine did not work perfectly as the transducer used to monitor the contractions was not recording them properly. The midwife needed to keep readjusting the transducers and the straps around her abdomen. However, even with this difficulty, Helen reported mobility was more important:

> *"It wasn't brilliant if I'm honest because the contraction one never worked, it never picked up any contractions…and obviously they were keen to keep it on me so I could keep moving around so we did persevere with it. …….Even with it not working properly I would rather have it not working perfectly and being able to walk around rather than me being stuck on the bed" (Helen, 3rd baby, Beach).*

One of the woman interviewed did not have a good experience with telemetry which left her feeling disappointed and as if her body had failed in not being able to give a good recording of the fetal heart. When telemetry was suggested she had felt elated at the possibility that she could be more mobile during labour, as this was something she had planned on. When the telemetry did not work and conventional wired monitoring was used, this contributed to her sense of failure:

> *"So back on to CTG, kind of was like a bit disappointed about that because I did want to be active in my labour. And I think at the beginning, I accept that things don't always go to plan, I think where then that had an implication is that now, like afterwards looking back, it was part of another failure, you feel like you failed the induction, even that term 'failed to progress', 'failed at induction', I then failed with telemetry and then I failed to manage my own pain because I needed an epidural" (Anna, 1st baby, Beach).*

For the vast majority of women interviewed, telemetry resulted in other advantages in addition to mobility.

5.4.2.2 Being in control

Being mobile lead directly to increased feelings of **control over the birth environment**. Women spoke of being able to access facilities within the room such as turning lights off and on and getting personal effects from bags which gave them ownership of the birthing space/labour room, a sense of control over surroundings, and a sense of homeliness. This also reduced dependence on birth partners to do tasks for them and led to a feeling of being at ease:

> *"Well I felt like I owned the room, I owned the space, and I think that the hospital very much allowed me to do that. You know, when I spoke to them*

about dimming the lights and they had their little candles round, I felt like I'm at home giving birth. And that was again, a very different experience to [previous child] when all the lights were turned on, I was very much in a hospital with [previous child], and that is the feeling that I got when I arrived. Whereas this time round I felt that because I could get up and use the beanbag or go and use the toilet, go and get a glass of water, sit with my partner and then go and sit with my Mum. I felt like this space is mine, and I think that maybe made me feel at ease in the labour." (Anna, 2nd baby, Forest)

In contrast to feelings of being attached to a machine with conventional monitoring, telemetry also conveyed to the women that they had control over their own personal space, as well as the birth space. One woman described the monitoring as feeling like a part of her and she would often forget that it was there. Amanda also described this as a feeling of independence:

"It's just the fact that you're not hooked up to a machine, or you don't feel like you're hooked up to a machine. And yeah, it does give you that kind of bit of independence and you're in your own kind of space, essentially." (Amanda, 1st baby, Beach).

For many women the ability to be off the bed and have autonomy over their actions also led to feelings of being more in **control of what was happening in the labour**. This contrasted directly with the feelings of not being in control when on wired continuous monitoring. Nina spoke in detail about this:

"I think, again, because you're not confined to a bed and you can kind of look out the window, or you can move around a bit, or you can go and get something out of your bag if you need to, you are…you're more in control of your movements and almost you can distract yourself a little bit. Whereas if you're stuck on the bed you're kind of just in that place and whatever you're looking at you can't…you know, you can't sort of look at other things."(Nina, 2nd baby, Beach).

Many of the midwives reflected on how telemetry could lead to increased feelings of control for the women also:

"By coming here and being able to say, oh yeah, I want the lights down, oh I want wireless monitoring – she still feels like she has control over it, which I

think is so important in her maintaining control of herself and not, you know, losing it or becoming overly distressed." (Lisa, Band 7 midwife, Forest).

Some women also expressed that when looking back on their labour they felt that being off the bed, more upright, and more in **control resulted in less pain relief requirements and less intervention**, as expressed by Miranda and Anna:

"I think if I hadn't had the telemetry and I had gone on [conventional] continuous monitoring straight away I think we'd have ended up in theatre a lot earlier. Because I think if I'd been lay on the bed I don't think things would have progressed as quickly as they did .....I think it was the staying active and staying on the ball as much as I could and not lying down for as long as I could that helped with all that definitely. And it just, I think it made me realise that I was a lot more in control and that my body could do it, rather than just being right, you're lying down,...I think there would have been a lot more intervention, definitely." (Miranda 4th baby, Beach).

"Because I was kind of mobile, and I was calm and I wasn't as anxious, I think that's why he [the baby] came. I genuinely honestly do. I think if I had been laid on a bed with them monitors, I think I would have had another C-section, definitely" (Anna, 2nd baby, Forest)

Control over what was happening during the birth led to a sense of empowerment for some women, a belief in their body's ability to give birth, and for some, a healing of past negative experiences. Anna had a previous caesarean section and spoke of being traumatised by the birth. She subsequently had a normal labour and birth using telemetry:

"But for me potentially, the kind of experience around that guilt that I had was about control. It was about not feeling in control of the labour, not feeling in control of the birth, not feeling in control of the C-section. And I think if I had of had, which I did have this time around, I felt in control, I've had a different outcome. And I do think there is a lot in that you know, if patients feel in control of their labour or their environment I think potentially it would reduce some of the trauma, it would reduce some of the depression that people feel after their birth because they feel more empowered and in control of their experience. I think if you can walk away from a birth feeling empowered as a women, feeling

strong and confident and feeling like you can do it again. Versus disempowered, done to, out of control, medicalised, of course that's going to have a huge impact on whether you want to engage in that experience or not" (Anna, 2nd baby, Forest).

Anna also felt that even if she had a caesarean with the second baby, as she had been mobile during the labour and had they type of labour she wanted, then a caesarean would not have left her as disappointed and traumatised as with the first birth.

5.4.2.3 Autonomy and Dignity

One of the most important aspects for *all of the women* using telemetry and being more mobile was the ability to go to the bathroom without asking staff, or activating a call-bell to ask if they could be disconnected from the CTG machine. This benefit was also recognised by the midwives. Melissa spoke of this when women were in early labour and the midwife was perhaps not in the room as frequently as when the women is in established labour.

"And I think with the telemetry it offers that freedom as well, that she's not having to buzz me to ask me to come off to go to the toilet and I can be in and out of that room." (Melissa, midwife, Forest).

Women who had previously used wired monitoring reported most often the transducers and straps being kept attached to the woman's abdomen, the wires disconnected from the main machine and being carried (or sometimes placed around the neck) to the bathroom. Partners or midwives often supported women getting off the bed and then accompanied them to the bathroom in these situations. Women described these experiences as cumbersome and difficult. Conversely, telemetry enabled women to be independent in their movements and not rely on anyone else, including help from a birthing partner, to get to the bathroom. Even when women had an intravenous infusion this was not viewed as negatively as wired monitoring, as it could be moved with the woman fairly easily. **Mobilising to the bathroom led to increased feelings of dignity** for women. Anna spoke of her previous experience of being asked to use a bed-pan and how this contrasted dramatically with her recent experience when she was able to use telemetry and mobilise to the bathroom:

Anna: "I wasn't given a choice to get off the bed and go to the toilet with [previous child], I had to go to the toilet where I was on a bed-pan.

Interviewer: And how did that feel?

Anna: In front of my husband, in front of my mum. Just really embarrassing, just degrading, very disempowering. Shameful. It's not something I've ever experienced before and there's no dignity, you can't have any dignity in that. And I think there is a limited amount of dignity that you have in birth but I felt very respected and dignified in this labour because I could go to the toilet.

Interviewer: And shut the door?

Anna: Shut the door, yeah, have privacy, and even at parts of the labour where there was a lot of blood and all of that, the fact that I could get up and move and they could change the sheets and it just felt so much more respected and so much more dignified than the first time around." (Anna, 2nd baby, Forest).

Midwives also echoed this sense of increased dignity:

"I think with telemetry there's more dignity, isn't there? Because it's like they can go to the toilet. They don't have to just sit on a bedpan and we all stand behind a curtain or something…..Because sometimes if they're on a CTG, and even if they're on a bed and they're lying down or something, it's like them physically getting them up to do stuff underneath them rather than them being able to kind of being a bit more self-caring in a way…..So I like that." (Harriet, midwife, Beach)

Being in a private space behind a closed door seemed to provide sanctuary from what was happening in the labour room where others were present. Mobilising to the bathroom also reduced anxiety for some women both in terms of being able to get to the bathroom independently but also once they were in there and reassured that the baby was still being continuously monitored.

"I was able to go to the toilet when I felt I needed to, which, again, reduced my anxiety because I was worried about pooing during labour. So I, you know, I needed that. That did actually help, just to be able to feel that if I needed to go I could" (Nina, 2nd baby, Beach).

"So it was nice to know that while I was in the loo, baby was still being monitored, and so they knew that if anything went wrong, they could have shouted me quickly, and that was nice, I rushed when I was on the wires to get it plugged back in to make sure he was okay" (Amanda, 1st baby, Beach).

The ability to go to the bathroom independently shone out from all of the interviews with the women and highlighted how important this aspect for women in labour is. Midwives also acknowledged it but not with the same conviction, or understanding of the importance of the issues, that the women did.

5.4.2.4 Normality

The reduced anxiety and sense of dignity that mobility allowed was expressed by many of the women interviewed and using the bathroom privately was also linked to doing something 'normal', something that is done every day and not treated as different when in labour. Doing normal activities was also linked to concepts of 'normal' and 'natural' labour and birth where there was less intervention and more freedom. **Being mobile led to a sense of normality** for the women. For Miranda this was a particularly strong sentiment which was then confirmed by other women who were subsequently interviewed, as well as midwives.

> *"Something has got to be private and being able just to say, thank you, shut the door, go to the loo in private and come back out. Everything else, you know, you don't have your dignity when you're in that [labour] room, that's it, but being able to go to the toilet like a normal person would and shut the door and not have your partner stood there looking at you and the midwife walking past, you know, it's nice." (Miranda, 4th baby, Beach).*

Doing something 'normal' like using the bathroom whilst not attached to a monitor also led to a sense of women expressing that they felt more like themselves and were doing something natural rather than lying in bed like a patient and having things done to them. Women as a consequence felt that they were experiencing a more natural labour with less intervention and medialisation. None of the women however, mentioned a 'normal birth'; for them it was doing normal things in labour that was important.

> *"But being up and walking about, I felt like a normal person, although I was having a baby I felt like a normal person rather than being ill on a bed, so it was nice, I enjoyed it" (Claire, 1st baby, Forest)*

This was also expressed by Aditi and Nina in terms of normalising their labours:

> *"In terms of monitoring during labour, if you need to be monitored you're probably a bit more high risk and if you're able to be mobile then that, kind of, makes you able to do more normal things. I think it's a really nice way of non-medicalising pregnancy and labour as well, because it's just more natural to*

walk around and do things, and get yourself your own drink or what not…" (Aditi, 1st baby, Forest).

"Yeah and there was a ball in the room. So, I thought, you know, all things like that, like, okay, yeah, it's quite normal, you can, you know, be a bit…have a bit of normality. Yeah, that's it. (Nina, 2nd baby, Beach).

Being more mobile in labour also had an impact on the relationships women had with birthing partners and other health professionals.

5.4.3 Together as a team

5.4.3.1 Relationships with and support from birthing partners

Mobility in labour when using telemetry had a positive impact on the support that women received from their birth partners. This support came both physically and emotionally for some women. Women reported that birth partners were able to suggest different positions to women whilst they were in labour:

"He was able to say 'well why don't you try sitting over here' or 'why don't you lean on this chair', 'lean on the bed'. I think you were lifting up the bed a few times weren't you [to partner] so I could lean on it which was helpful" (Lily, 1st baby, Beach).

Lack of the physical presence of wires and more freedom when off the bed seemed to promote closer physical contact between birth partners and some women. Women reported that their partners were able to rub their back, massage shoulders, stand next to them and provide a physical supportive presence. For Anna, the amount of physical support provided by her partner was influential and led to increased feelings of his involvement in the labour and birth and a 'team' approach. A feeling of normality was again described:

"And this experience he was massaging my back, he was you know, holding my hair back, he was getting me the gas and air, he was getting me a drink, he was there with a wet flannel. So I felt very much with him because I could go and lie with him on the floor, he was kind of massaging my back on the bed, so he was very much present at the birth…….I think if you were to speak to him he would say probably he felt more confident and empowered of the fact that I could move. And I think with that we probably did get a sense of normality, that this is us together as a team, giving birth to our baby and feeling quite okay with that.

It was almost an experience of not being in a hospital, I kind of felt like I was giving birth at home" (Anna, 2nd baby, Forest)

For one woman the close physical presence involved her partner feeling her abdomen when a contraction occurred and for her this also created a sense of them being 'in it together'. Many women that had experienced labour with conventional monitoring, and most of the time spent on the bed, their partners had not been able to provide much physical support. One woman described her partner as a 'spare part' and only able to hold her hand. Amanda's partner said he felt more involved when his partner was moving around and mobile; he was able to get equipment and feel less helpless:

"But when she was just on the bed, you know, most of that was just me sat there, a few conversations with midwives. At least when it came to the fact that she could move around, I could go and get the ball for her…..so although it's just simple things…they just made me as the partner fell a lot more included and more useful to the whole thing. So that was a big positive…because when you're just sat there, you know, your partner's in discomfort or pain, you just feel helpless. Whereas at least if you can go and get a chair or move them you just feel as if you're doing something" (Mark, Amanda's partner, Beach).

Both Nina and Anna felt that as they were more mobile and in control this helped to reduce their partner's anxiety which in turn reduced their own anxiety and increased confidence. This resulted in a positive feedback loop which benefitted both the woman and her partner:

"I think he was a lost less stressed because he could see that I was able to be on my feet. So he kind of knew that, oh, she must be okay because, you know, she's moving about and she…you know it was probably more normal for him. So I think he was calmer" (Nina, 2nd baby, Beach).

"I think potentially the relationship that me and my partner had, the fact that I could be mobile and feel more in control and I think he could see that confidence in me. I think he could see, do you know what, you can do this, and I think that is because I felt more in control and more confident around him and using the space and things." (Anna, 2nd baby, Forest).

Many of the midwives interviewed echoed what the women expressed about birth partners involvement in the labour when the woman was using telemetry.

"But I suppose it's probably good for them seeing their partner taking control, doing what they need to do, sort of thing rather than have them sat on the bed" (Abigail, student midwife).

Both women and midwives expressed that the bed acted as a barrier to partners providing physical support. One midwife expressed that when women were in labour off the bed then this could promote closer contact and possible increase in oxytocin release which would benefit the progress of labour:

"Quite often women on telemetry, they'll be standing and stuff won't they? And then you can get, you know, we've got a bit of contact going on there potentially, so a bit of cuddling or…..like sitting on the sofa…..if the woman is sat on a ball at the side of the bed trying to get their partner to come and sit on a chair near them and do the whole oxytocin drug spiel, you know, like get a bit of happy love vibes going!" (Harriet, Band 6 midwife, Beach).

One midwife, Ester, described how a woman she was caring for used the shower for pain relief, whilst using telemetry, and her partner's involvement with this. This echoed the 'team' approach raised by other interviewees:

"He was helping to dry her afterwards and helping to get her changed. Just it was like a real partnership thing, as opposed to just him being sat on a chair and her on the bed" (Lisa, Band 7 midwife, Forest).

5.4.3.2 Communication with staff

Being free, being more mobile also had an impact on communication and relationships with midwifery staff as well as birth partners:

"I felt like I was interacting with the midwives as well, we were talking and having a laugh. So that was nice to be able to do that."

Interviewer: "And do you think standing up and being mobile enabled that a bit more? "

Yes, yes I do". (Kalpana, 4th baby, Beach)

Some women were shown equipment, such as a resuscitaire, that was in the room by their midwife. This was easier when the women was using telemetry as she could walk with the midwife to be shown. This also led to the women feeling more ownership of the birth space and they were in a partnership with midwives. This also had an impact on interactions with obstetric staff with a number of women voicing that when they were

seen by medical staff to be upright and moving around this seemed to create a sense of reassurance. Some women also expressed that being mobile had an impact on how decisions were made around the labour and birth and that standing and being upright placed them on a more 'even-footing' with staff. For these women, when they felt more in control of their labour they felt more in control of decisions and more empowered to speak up.

> *"I think even if they [the medical staff] had of spoke to me about a C-section, I think because of the experience of being in control, being able to move, being able to have a choice of what I can do, I would have felt more in control of my decisions. So I would have felt if you were talking to me about a C-section, because I felt in control this whole time I would have felt more empowered to make the right decision" (Anna, 2nd baby, Forest).*

5.4.4 Summary

The category 'Being free' encompassed women's previous experiences of wired CEFM and how these were in the main negative. Women expressed that the physical connection required by traditional monitors enforced immobility and led to feelings of being tied down, out of control of the labour and birth process, of feeling like a passive 'patient' and having 'things done to them'. For some women, these experiences impacted on their desires for the subsequent birth to involve more mobility and freedom. Telemetry did enable mobility for the majority of women who used it and this mobility led to women feeling more in control of their physical environment, more in control of what was happening in the labour and a confidence in their abilities to give birth. This also led to women feeling like they required less pain relief and had less intervention. A surprising frequent and important finding was how significant it was for women to be able to mobilise to the bathroom independently and how this then led to a sense of autonomy and increased dignity. Midwives recognised the importance of women being able to mobilise to the bathroom as well. Being mobile and in control of the environment led to a greater sense of normality for the women, both in the actions they took and feelings of less intervention and medicalisation. Being mobile with telemetry also had a positive impact on relationships women had with their birthing partners, in that they were more able to provide physical support which also led to decreased levels of anxiety for both parties. Communication with midwives and other health professionals was also enhanced for some women when using telemetry.

The second category 'Enabling and facilitating' (see Figure 31) is predominantly centred on the midwives experiences of telemetry and their fundamental role in facilitating telemetry use for women. As with the category 'Being free' many of the women's interviews corroborated what the midwives reported and this helped to saturate the category and give strength to the concepts. Women's voices are interspersed with midwives, where relevant to the sub-categories. The three sub-categories that define the category are 'Encouraging Mobility', 'Using midwifery skills', and 'Technicalities and training'.

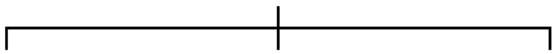


Figure 31 Category – Enabling and facilitating

5.5.1 Encouraging Mobility

5.5.1.1 Being mobile

Many of the midwives recognised the benefits of encouraging women to be mobile and the potential effect that this could have on the woman's labour. Even with wired monitoring, midwives described trying to facilitate mobility and this was sometimes, although not always, more problematic:

> *"I try and encourage women the same as if they had wires anyway. I don't let the wires prevent me from helping a woman get into whichever position she wants to because although she is restricted to where she can move you can usually get them on their knees and over the back of the bed or standing next to the bed" (Faye, Band 6 midwife, Forest)*

Midwives described how they encouraged women to be mobile who may not have realised the advantages of it and women also described these conversations with midwives:

> *"I think some women come in with really specific birth plans of wanting to be mobile, which is great. Other women don't really know the benefits of it until*

they come into the room, and then when you talk to them about it, they are very open to the idea, especially if you've got telemetry available. So I think a lot of the time they just need that reassurance and they might have heard or read something about keeping mobile. They don't really know why or what the benefits are, so when you go through it with them, then they're interested in it" (Ester, Band 6 midwife, Beach).

"And she was like, right, you can get up now, I was like, what, off the bed? She was like, yeah, you can have a wander round if you want, I was like, oh, right, yeah, I will do. I mean, I didn't go far, I still was sort of like near the bed leaning on the bed, but I could walk around and go to the toilet on my own." (Miranda, 4th baby, Forest)

Midwives recognised that mobility could encourage descent of the presenting part of the fetus and encourage established labour and progression. Midwives reported that this might be less likely if a woman was lying on bed. Midwives also recognised that the ability to be mobile with telemetry could lead to many of the same positives that women expressed in their interviews such as being able to get personal possessions more easily, control lighting and temperature in the room, help with pain relief, receive more support from partner, and go to the toilet independently. Midwives described many examples of this as well as positons that women were able to get in when using telemetry that made caring for the women easier:

"It's less cumbersome in terms of…do you know, if your woman's quite mobile and she might be kneeling up on the bed or she's changing position, on the ball, it's less cumbersome in terms of her being able to move, you know, don't have to worry about the leads. So that's one definite added bonus." (Sarah, Band 7 midwife, Beach).

"Well the woman can just go for a walk anywhere, she can do what she wants, she's not tied to the bed, and she can go to the bathroom. Even if she had synto going and if the telemetry is working fine you're not restricted to 'oh do I put her on a bed pan? Oh the CTGs not great, oh well let's just get her to the bathroom. Well it just doesn't really matter does it, she can just go. She can sit next to her husband or her partner on a chair or whatever, she doesn't need to be on the bed." (Eve, Band 7 midwife, Forest).

Conversely, one midwife from Beach felt that it was easier to monitor a woman on the bed with wired monitoring particularly if they have an epidural. Midwife Sophie was

asked if she thought monitoring a women on the bed with conventional monitoring was easier than if she was in different positions:

> *"Yes, yes. If you've got a monitor yes. Just because [if a woman is] sitting on a ball and it's [the fetal heart] right down low and you have to hold it on and they go on all fours, it is harder, whereas if you've got an epidural and they sat there and 'bing' there it is and so it does take a little bit more work and I think that's some of the problem. Ummmm and I think part of the problem is they all have epidurals so they're not getting off the bed so why do they need the telemetry?" (Sophie, Band 6 midwife, Beach).*

Throughout the interviews midwives gave many general and specific clinical examples of when they had used telemetry and how it facilitated mobility as shown in Figure 32.

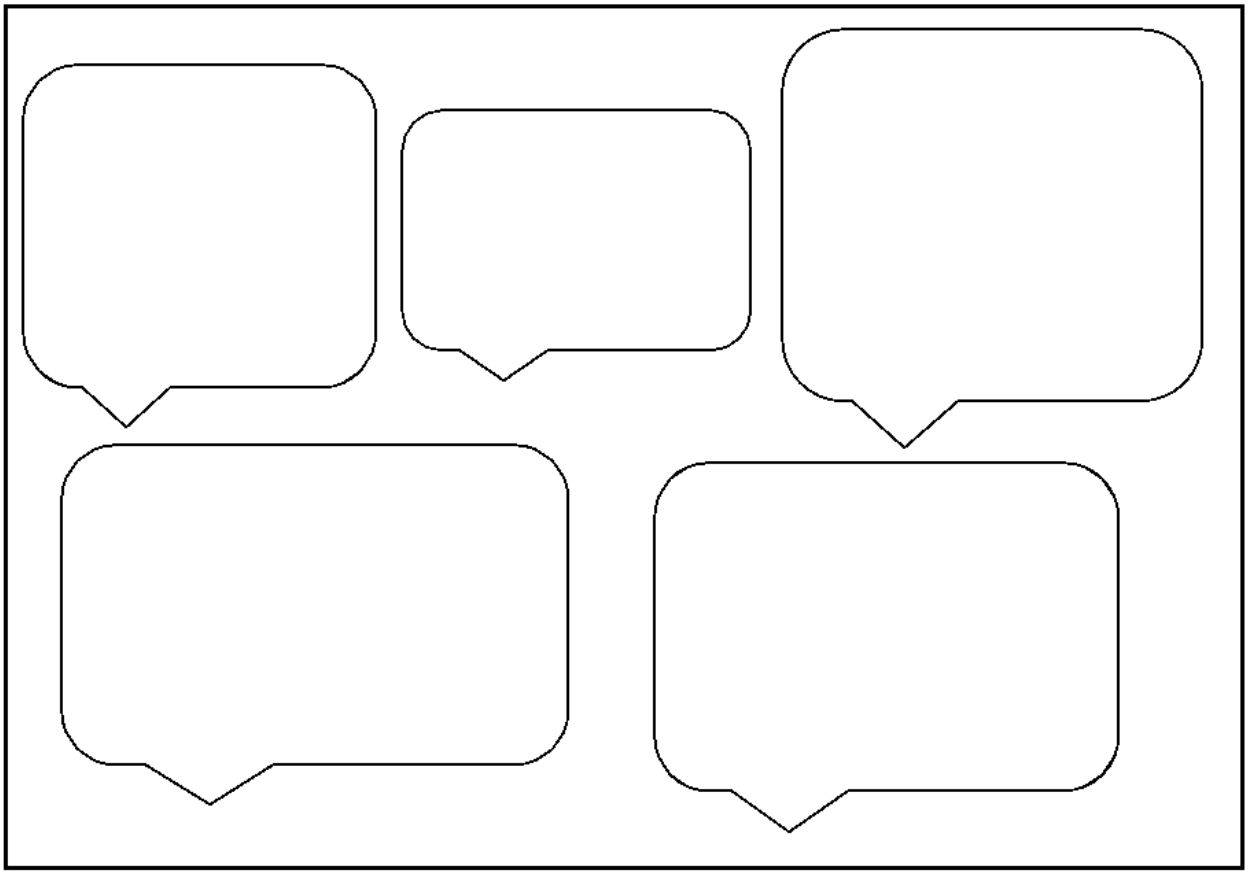


Figure 32 Descriptions of women using telemetry as given by midwives

Midwives also expressed that not all women chose to be mobile with the telemetry and this often depended on what had happened in the time leading up to being continuously monitored in labour. Women having an induction of labour were identified as being less likely to mobilise:

> *"I think it depends on the woman. I think it depends on what they want and their expectations and what's gone on before, so I've found that if the woman's been in and, say, she's an induction of labour and she's had it for a long period on the antenatal ward and she's tired, then a lot of these women tend to not always be as mobile because they're tired and they've done a lot of bouncing and walking around and pacing on the antenatal ward ....and sometimes they're exhausted. But I'd still always use the telemetry with them, because then they have that freedom" (Melissa, Band 7 midwife, Forest).*

Even when women chose not to be mobile, for many midwives ensuring that the option was there was important. Many midwives, particularly those from 'Forest' chose to use telemetry even when women chose not to be mobile or had an epidural as it removed one more set of wires for the women (and also the midwife).

5.5.1.2 Choice and Normality

Many of the midwives reported that when women used telemetry and were more mobile this resulted in the labour feeling more 'low-risk' and women having an experience that centred on normality. The midwives used the term 'normality' differently from the women; women used it in terms of their actions and 'doing normal things' where midwives used the term in relation to 'normal labour'. Midwives views were often couched in terms of giving women choice around their monitoring options and mobility.

> *"So I think it moves away from the medicalised birth, doesn't it, in terms of women, the medicalised picture of a lady in labour is being attached to a monitor, being attached to a drip on the bed. And whilst we look after a lot of ladies on here that are being induced, that are perhaps going down a bit more of a medical path telemetry gives women a bit more of a choice. It allows them to be more mobile. And perhaps maybe normalises more complex women." (Sarah, Band 7 midwife, Beach)*

> *"And it's kind of like, well telemetry isn't just for low risk labour is it? It's like making women who need to be monitored more mobile and so therefore more low risk, I think, because you're trying to encourage normality and movement really, aren't we?" (Harriet, Band 6 midwife, Beach).*

Having choice and options for mobility also led to some midwives and women expressing that telemetry kept everybody happy and was sometimes a compromise; women could mobilise if desired and the fetal heart was being continuously monitored as recommended by obstetric staff and guidelines. Midwives also felt that when women were more mobile they were able to leave the women more and let the labour unfold. Midwives were more watchful than perceiving a need to 'do things' when women were in a bed. This watchfulness resonated with the midwives education on normal labour and caring for women in a midwifery-led setting. This resulted in a great sense of satisfaction for some midwives.

> *"It was much more midwifery led, and it kind of took the high risk element out of it for her and it was a bit more normality for her……I could just sit back and watch and see her behaviour more than just focusing on the medical side of it all. It was better because you feel like you're being a midwife. Really we're just there to be at a birth, you're not there to assist with it, you're not there to intervene, you're there just as a support mechanism really and you can make suggestions and you're not really doing anything to her, she's doing everything" (Jacqui, Band 6 midwife, Beach).*

> *"And I think I felt like I fulfilled her birth plan by her being able to do that. And it was really satisfying to see it, because it just worked so brill….and you get job satisfaction then, because you think, oh, you know, I've been able to help facilitate a normal delivery, make what could have been a high risk situation, low risk. Like it was just lovely." (Harriet, Band 6 midwife, Beach).*

Encouraging and seeing mobility also led to midwives feeling like they were able to use more of their midwifery skills when providing care.

5.5.2 Using midwifery skills

5.5.2.1 Midwifery skills

Many of the midwives felt they used a wider repertoire of their midwifery skills when women were using telemetry and more mobile. This included skills needed when women adopted other positions to give birth in:

> *"And I think, yeah, it really helps to…it helps as a midwife, with your normal skills as well, you know like, just delivering babies in different positions for example, you know, like kneeling or whatever, squatting, that kind of thing will become more common, I think, with telemetry, and therefore improve*

your skills as a midwife, rather than just continuously delivering in lithotomy or semi-recumbent." (Ester, Band 6 midwife, Beach).

Some midwives also raised the issue of 'loss of contact' of the fetal heart trace (where the fetal heart is not recorded perfectly and the print-out is of poor quality). Loss of contact will also be discussed further in the following section. Skill was needed to determine if there was 'loss of contact' with the fetal heart or if the fetal heart was truly decelerating and confidence needed when communicating findings with other members of the obstetric team. Midwives use these skills with wired monitoring also (and are probably more adept at obtaining a good quality fetal heart recording than other colleagues). However, particularly at Beach, the telemetry machines resulted in more loss of contact of the fetal heart and these skills were called upon more frequently.

"You're relying on your midwifery a lot more, you know, is that loss of contact or is that a deceleration? The trace that comes out isn't the beautiful trace you get with the conventional one, it is a little bit more, bits of loss of contact. But I think if you have confidence in what you're seeing and hearing then it's not a problem. Because you're in the room with that woman, so you're listening, when a doctor comes and looks at the trace and goes "oooo, could it be a decel', then you say well actually no I've been in here I've heard that it hasn't dipped it is just a bit of loss of contact. It's having that confidence to say to that doctor 'no I know what I'm listening to'." (Sophie, Band 6 midwife, Beach).

Harriet described caring for a woman who had changed position frequently and there had been some loss of contact of the fetal heart and the medical team had come into the room. This required Harriet to articulate that she was certain of what the fetal heart was doing as she was providing one-to-one care for the woman and was in the room listening to the fetal heart which may have not been recording perfectly on the CTG print out. A sense of frustration with the medical team coming into the room and assuming what was happening was expressed by Harriet:

"And the doctors were like, 'no that looks like a bradycardia'. And I was like, it's clearly not a bradycardia…But that was just like another one of those stupid things that you get where you're like, but I was here and I'm responsible for this woman and this baby and I will put my job on it not being a bradycardia." (Harriet, Band 6 midwife, Beach).

5.5.2.1 Caring for women in a birth pool

The use of a pool to labour and give birth in has historically been the domain of midwifery-led settings. Conventional wired CEFM is not able to be used in a birthing pool as the transducers are not waterproof and the presence of electrical wires would make it unsafe. The majority of women who labour and birth in a pool have intermittent monitoring of the fetal heart. The transducers for telemetry are waterproof however and this gives women the option to go into a birthing pool if appropriate.

Most of the women interviewed for the study mentioned the use of water during labour and a desire to use this in either a previous or the most recent pregnancy. Women described discussing the use of a pool with their midwives in the antenatal period and were often not given a definite answer as to whether they could use it or not in labour:

> *"So then at 16 weeks they told me that I had the strep B, she told me on the phone. I said 'oh, does that mean that I can't go in the birthing pool?' And she said yes, but, she said, the rules might change by the time you have your baby." (Claire, 1st baby, Forest)*

> *"I think they said that if I was induced there could be a chance that I could still use a birthing pool but it just depended on the situation at the time and the…you know, the…because the situation in the hospital I suppose. I didn't really get a clear answer, I don't think, on whether that would be something I could…you know, I could do." (Nina, 2nd baby, Beach).*

Both of the maternity units in the study had birth pools on their obstetric-led units. The telemetry used at both units was waterproof and women could use it in the pool. Forest had one pool that was formally built in and plumbed into the water supply and they had recently also purchased 3 temporary inflatable pools that could be used in other rooms. These pools were used occasionally for women to labour and sometimes birth in with telemetry and the majority of midwives working on Forest were comfortable looking after women in the pools.

> *"Yes, so I used it in the pool with a lady who was a prolonged ruptured membranes who wanted to go to the birth centre, who wanted low risk care but obviously she was a prolonged ruptured membrane so she needed accelerating. She came up and she had telemetry in the pool with synto[cinon]. So the consultant was happy for her to be on synto in the pool and then used the telemetry and she had the birth that she wanted in the pool." (Melissa, Band 7 midwife, Forest).*

Beach had one room with an integrated birthing pool. This pool had not been used for over two years as there had been an infection control issue. Whilst recruiting for this study the pool was signed off as being safe to use again. This raised some issues in terms of updating staff in midwifery skills and knowledge on caring for women in the pool:

> *"They are hoping the pool will be back in use shortly and they will be offering some training sessions because they're aware that a lot of people on here will not have done a pool birth or not done one for a very long time." (Alice, Band 5 midwife, Beach).*

> *"A lot of my staff rotate up to the midwifery-led unit. So they should be up to date with how to care for a woman in labour in water. There are core staff who might not be, who might need updating. The Band 7 midwives will definitely need updating." (Sarah, delivery unit manager, Beach).*

Most midwives interviewed recognised that if more women who require CEFM could use a birthing pool for pain relief then this would be positive and midwives would become more confident as more women used the pools. For both units however, the number of women who could use the pool, and who did eventually use the pool was small. Beach did have a guideline on the use of telemetry in the pool and excluded many women from this including those with a high BMI, women with hypertension and women with syntocinon or other drugs being delivered through an intravenous line.

The use of syntocinon and the birthing pools was a different issue for staff at 'Forest' as senior midwives there had been campaigning for women to be able to use the pool with syntocinon. This was contentious however. Some midwives at Forest had cared for women in a birthing pool using syntocinon but the official guidelines did not advocate its use in the pool due to syntocinon being run through a pump that could be connected to the mains supply. This was an issue that was ongoing throughout the study:

> *"So now the next step is oxytocin in the pool. As I've said with the high induction rate most of our ladies are inductions and we can't torture them by having a pool in the room and then saying 'no, you can't'. With our guidelines they go out to the whole service, every midwife, during the consultation phase for their input. And so [our consultant midwife] who is amazing has put this in the revised birthing pool guidelines and we're just getting a lot of resistance now so this is the next step." (Kath, delivery unit manager, Forest).*

One of the midwives from Forest expressed that she felt uncomfortable with the number of pools in the rooms on the obstetric unit. She felt that the number of women that used the pools was actually quite small and that some women who were in labour in rooms with a pool who were unable to use the pool may feel like they were missing out.

> *"Yeah, so I haven't verbalised this to anybody else. 'Cause you don't want to seem negative about anything that's a positive. You know they're trying. But when I heard about it and I saw them, the first thing I thought was that's brilliant for women who can use the pool but what about those women who are unable to go in and really want to and then they start thinking, I really wanted that, I'm not allowed to go in it. It's the only thing that I...I've not told anything to anybody else." (Faye, Band 6 midwife, Forest)*

5.5.3.1 Recording quality and different brands of telemetry

Some midwives at Beach expressed concerns with the amount of loss of contact that resulted from using telemetry. This was more than the amount of loss of contact that occurred with wired monitoring although none of the midwives could account for why this might be. Midwives found that more loss of contact was linked with the Body Mass Index (BMI) of the woman using telemetry:

> *"I think subjectively it often depends on the woman's BMI in terms of contact and monitoring, so varying success in terms of the quality of contact with the telemetry. I find if you have quite a slim lady you can get reasonable contact." (Sarah, delivery unit manager, Beach).*

Midwives described ways of managing with this such as documenting on the CTG recording when there was loss of contact so that other staff would know that this was related to the woman moving rather than real concern with the fetal heart. Both maternity units had centralised fetal monitoring which meant that other staff not in the room could see the CTG recording on a central monitor. Midwife Lisa described working in partnership with the woman to ensure that the fetal heart was recording well:

> *"I speak to the woman and say – I'm really struggling to monitor your baby when you crouch right down, or whatever, I want to support you but if you stand I can monitor it. And it's just kind of working together. There are positions that*

they get into where you can't monitor that baby and you have to monitor that baby. It's not the end of the world, it is just going – yeah, I know I've got a bit of loss of contact. Sometimes you can hear the FH it's just not picking up, so I would then just document that it's audible at whatever it is. But yeah; use your common sense. If she's just got off the bed and you've got loss of contact, it's not that you're not monitoring that baby as such, it's because she's moving around, and it's been fine." (Lisa, Band 7 midwife, Beach).

Poor quality recording for midwives at Beach often resulted in them returning to wired monitoring to ensure the recording was better. As well as loss of contact of the recording, midwives at Beach also described the transducer for contractions not working properly. Midwives from both units also raised other issues such as the machines not being left to charge fully and some of the equipment going missing. One of the women interviewed also described the telemetry machine running out of battery and having no back-up machine that could be used.

Forest maternity unit had a different brand of telemetry than Beach and had two older models and three newer models of this brand. Midwives reported that the newer models were far superior to the older models:

"So with the new units you can't tell any difference between a telemetry unit and a mounted fixed wall one [conventional wired monitoring] in that you get a nice good quality strong signal and perfect trace. The new ones are amazing, they're a dream. Whereas with the [old] one it's a bit patchy. You've got contact but its not good quality contact if that makes sense?" (Lucy, delivery unit manager, Forest).

The majority of midwives at Forest would go out of their way to use the new telemetry machines and only use a wired machine if the telemetry wasn't available. Midwives at Forest described setting up a room prior to a woman being admitted and going to find a telemetry machine if there wasn't one already in the room. All of the midwives at Forest expressed that they would only use a wired monitor if they couldn't find a telemetry unit (generally because they were all in use).

The telemetry machines at Forest (but not those at Beach) also had fetal scalp electrode (FSE) capability so that if monitoring on the abdomen was problematic then a

small clip could be attached to the fetus' head and the fetal heart directly monitored. This could be done wirelessly and so the women could remain mobile if desired:

> *"And they work perfectly well with an FSE. We had a lady with a BMI of 56 the other week. Put on a FSE, so instead of having that faffing of holding and messing around the FSE just clipped in and then she was walking around with the telemetry on and a perfect quality recording." (Lucy, delivery unit manager, Forest)*

Midwives from Beach also described how they would use two straps for the fetal heart transducer as this gave a better recording especially when the woman was in the pool.

5.5.3.2 Frequency of use and training

The use of telemetry at Beach was much less frequent than at Forest and there were a number of reasons given for this including the more frequent amount of loss of contact with the particular brand of telemetry used at Beach.

> *"The other night I had a comment; somebody said – oh yeah but the telemetry didn't work properly. They're just very blasé about it – oh it never works so there is no point trying" (Lisa, Band 7 midwife, Beach).*

There were three telemetry machines at Beach and during the course of recruitment the machines alternated from being in the rooms or being kept in one central place so that midwives could find them if needed. This was also cited as one of the reasons that the telemetry was not used so frequently.

> *"I mean if we had more then we could work on getting it ingrained in the culture more, whereas at the minute, if you say to somebody – oh why don't you put her on telemetry? Well – I can't find one." (Lisa, Band 7 midwife, Beach)*

Midwives from Beach also felt that there could be more training on the use of telemetry and this was a reason that it was not used so frequently. There was no formal training on the telemetry equipment at Beach and most midwives worked it out or learnt from other midwives who had used it:

> *"To be honest, I've never had any formal training on how to use it but I just worked it out because it was common sense really. But I think that's the only thing really that people maybe just haven't been shown how to use it and to make sure that if you've got one in your room make sure that you turn it on so*

that at least even if your lady's not using it make sure it's charged for other people." (Jacqui, Band 6 midwife, Beach).

"Being completely honest, I think people aren't sure how to use it. I think people have difficulty finding it because we're a big footprint, although we've been saying to return it to the clean utility. Sometimes I think it's a bit of apathy towards it and a bit of…you know, well it's easier just to put them on a normal monitor. So I do think…do you know, I think those are probably the three big reasons." (Sarah, delivery unit manager, Band 7, Beach).

A senior midwife co-ordinator from Beach also felt that the overall acuity and business of the unit contributed to more junior midwives, or midwives who were unsure how to use the telemetry, not asking for help to get the telemetry working:

"They're reluctant to come out and ask for help for something like this because the people that can help them are busy and they're worried about the response they're going to get from that person and they think well she's doing something more important so you know what I'll just take that off and I'll put the [wired] CTG on and I do think that is a lot of the problem." (Eve, Band 7 midwife, Beach).

Some of the women interviewed from Beach also noted that the use of telemetry was not 'the norm' and that if they wished to use it then it had to be found and set-up:

"She did say, we'd have to sort of request it from the hospital rather than they would say it's an option, and that we'd have to request it as early as possible because they might have to then charge them up, because they dust them off in the cupboard and they're not used as much, that's what…so it was kind of we have to be the instigator." (Amanda, first baby Beach)

Amanda's partner also felt that if there was a telemetry machine in every room then midwives would not need to spend time to go and find one. The telemetry at Forest was more accessible for the midwives as there were more machines and a smaller number of rooms for them to be distributed in. The telemetry worked well, staff knew how to use it, and the use of it was actively promoted by senior midwives at Forest. Over the preceding two years there had been a cultural shift in how care was provided at Forest and this will be discussed in the final category 'We're all invested in it'.

5.5.4 Summary

The category 'Enabling and facilitating' in the main described midwives experiences of telemetry. Midwives from both sites confirmed that telemetry enabled them to encourage and facilitate mobility for women during labour. Some women were not aware of the advantages of mobility and telemetry facilitated these discussions. Midwives noted that some women were not interested in being mobile, particularly if they had been induced and were perceived as being exhausted by the time they got to the labour ward. Several general and specific examples were given from midwives describing mobility in labour with telemetry. For many midwives, telemetry normalised the labour and tempered some of the more medical and clinical procedures that happened during labour. Midwives found great satisfaction in caring for women that were mobile and left to follow the messages their bodies were giving. This also resulted in midwives recognising that more of their true midwifery skills were being called upon and used. Midwives from Forest were used to caring for women in the pool with telemetry, sometimes with syntocinon but this was an ongoing issue for resolution at the Trust. The pool at Beach had only just been recommissioned and so the use of the pool and telemetry was an infrequent event. Telemetry was used more frequently at Forest as there were more machines and less rooms for them to be distributed in. The different, newer brand of telemetry also resulted in better recording and less loss of contact than at Beach. Midwives from Beach also reported that more training would be welcome on using the telemetry.

The third and final category 'Culture and change' (Figure 33) primarily concerns different cultures observed on the two maternity units women and midwives were recruited from. The two cultures and way care was provided impacted on the use of telemetry and women's experiences. The sub-categories described are 'We are all invested in it' and 'It has not even entered people's minds' and they describe the two maternity units individually and their journey with telemetry and care provision.

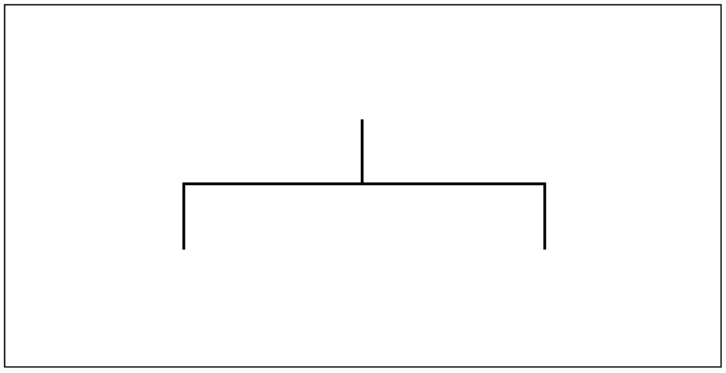


Figure 33 Category – Culture and Change

5.6.1 We are all invested in it

The midwives at Forest all spoke positively about telemetry but also about how the use of telemetry was part of a package of care that they wished to provide for women with more complex pregnancies being cared for on the obstetric-led unit. The midwives spoke of this philosophy of care (described below) and recognised how telemetry was an integral part of care provision.

> *"So that's why they want to use the telemetry because they know that this is important for the women. Do you see what I mean? They have a vested interest in it." (Lucy, delivery unit manager, Forest)*

The delivery unit manager of Forest described to me the history behind changes that had been made at the unit. Two years before recruitment began at Forest maternity unit it had been selected as one of two Trusts within the UK to work with the Royal College of Midwives Better Births Initiative on a project called *Better Births by Design*. This project was supported by a University and the work was focused on implementing participatory design approaches in maternity care for service improvement. Lucy, the ward manager of Forest described the experience:

"What they taught us to do was engage with service users and staff and look at your environment, not what we want as health professionals but seeing it through the eyes of women using the service and what they want. It's like a two year long project and we're just starting to see the changes happening now. But it was all about discovery and insight and that brought about cultural change really." (Lucy, delivery unit manager, Forest).

The premise of the project had been how to make the obstetric-led delivery unit more appealing to women. Forest had a midwifery-led birth centre one floor below and there had been a lot of work done on the environment there with midwives commenting that it was 'like a spa'. The driver for change had come from the different perceptions of the two units:

"What sort of sparked off the application for the Better Births was women with complex pregnancy needs see how beautiful the birth centre is and what is going on in there and they are like 'well I want a bit of that' " (Lucy, delivery unit manager, Forest).

"I think some of it came from the women's perceptions, also the attitude between the midwifery led service and the high risk service when it was like, you don't want to go to the delivery suite because they make you sit on a bed, they hook you up with wires, they have all the lights on, you don't get any of this nice care – and it was making the women panic when they were transferred." (Lisa, Band 7 midwife Beach and Forest).

Interviews revealed that engagement work was done with women who had birthed at Forest. Women were interviewed and asked to tell midwives involved in the project about their birth experience. Questionnaires were also sent out to women who had birthed a baby in one particular month. Women identified that they wanted a more homely environment on the obstetric-led unit, for it to look less medical and to have access to mobility and water.

5.6.1.1 Telemetry and the labour room environment

A lot of work was done on the environment of the rooms on the obstetric-led unit at Forest. The blinds in the rooms needed changing so these were all replaced with black-out blinds. The rooms were all re-painted and communication with the painters meant that different colours could be used instead of the usual off-white. Staff became engaged with the work that was being done and did fund-raising to buy other equipment for the rooms:

"So we've bought the aromatherapy diffusers, we've bought some wall art, we've bought lighting globes, we've bought battery candles, trying to get the soft touches that the women want. But we've done it as a team, so they've invested in it and it's important to them and they're proud of it" (Lucy, maternity unit manager, Forest).

Purchase of more telemetry equipment was central to the labour room changes. There was an acknowledgment that whilst environmental changes were being made then more women should have the opportunity for mobility in labour; to experience some of the normality that they would have if in labour on the midwifery-led unit. The senior team of midwives did not want women to feel that coming to the delivery unit was a compromise or that they were missing out on anything despite their pregnancy being more complex or having to transfer from the birth centre during labour. There was also an emphasis on choice and experience for women and making sure they felt comfortable with being on an obstetric-led environment:

"Quite often the ladies that come from the birth centre, say an intrapartum transfer, they come from this spa like environment and you know we're doing our very best but it is a medical environment despite everything that we are doing so you feel if you can offer them telemetry it's like you're not shattering their birth experience, they're still getting the monitoring that they require but they know you are respecting their wishes and you're supporting them to be mobile and to have what they want whilst addressing the need for the transfer if that makes sense to you?" (Lucy, midwifery unit manager, Forest).

"I think what we don't want women to feel when they come to the obstetric unit is that they're missing out. Oh, I really wanted that and I'm not going to get it now. We want them to see, okay, things might have changed, however we can still try and give them the experience as best we can and they can still have things that they wanted before. And I think they do appreciate that, I think it does go a long way to making them feel, okay, things haven't gone the way I wanted but actually, do you know, this is not bad, this is actually not what I thought it was going to be." (Faye, Band 6 midwife, Forest).

Midwives also commented that the changed labour room environment impacted on how they felt about caring for women who were more complex. Some midwives felt that when the room was quiet, darker and more home-like then this affected that way that care was provided for the women. Midwives acknowledged that it was the woman's experience that was central to everything.

"I think it chills us out as midwives as well. I think if you've got a birthing room, no matter if she's PET, she's on magnesium sulphate, she's thirty-two weeks – whatever is going on there, if you make that environment just a bit darker, a bit quieter – fairly lights, you know, stuff like that – it helps the woman relax a little bit but also helps the midwife kind of relax because you're made to be a bit quieter, a bit more considerate, and realise that this isn't the midwife's room, this isn't her experience, it is the woman's." (Lisa, Band 7 midwife Beach and Forest).

Women interviewed from Forest also noticed the environmental changes that had been made, particularly if they had birthed there previously and noted that the ward and rooms felt much more homely and welcoming. For some women this contrast was particularly stark:

"My experience even of the room was totally different, it was all dim lighting, there was candles round, essential oils, the mobile monitors, it was just so vastly different. Like I can't tell you, like the first time round it was really strong lights, there was just beeping all the time, every time her heart dropped, the beeping sound, and then I was getting anxious and worried, it was just totally different this time." (Anna, 2nd baby, Forest).

5.6.1.2 Embedding change, strong leadership

The engagement work done with women prior to the environmental changes that had been made was continuing whilst recruitment for the study was being undertaken. Each room had a whiteboard on it for the women to look at which contained tips for labour and information about mobility, telemetry, and use of the pools. Women were asked to leave five pieces of feedback about their experience and these were shared with staff on a central information board. A video had also been made showing a woman in a pool with telemetry which was being shown in antenatal clinics in the hospital.

Midwives interviewed from Forest articulated that strong midwifery leadership had contributed to staff being engaged with the project, and viewing it as a joint endeavour to improve the experience for women. Obstetric staff were also reported as being very supportive of changes that had been made, including more use of telemetry, and had contributed to purchasing of equipment to improve the environment, such as lighting. Band seven midwives on the delivery unit were identified as being crucial and supportive for more junior staff who may have been less confident with telemetry and a more midwifery-led type environment. Strong and visible midwifery leadership ensured

that intervention for women on the delivery unit only occurred when absolutely necessary. An example of this was that all of the women being induced were given four hours following an artificial rupture of membranes to get labour established before syntocinon was started. There had also been a recent emphasis on achieving skin-to-skin for all babies on the unit independent of type of birth and a new project around the birth experience for women having an elective caesarean section. Both the consultant midwife and the delivery unit manager were identified for their leadership roles:

> *"So it's a thing now really, if you know someone is coming in, you get the room ready for them, get the telemetry, get some lights, put the bed in a seating position so they don't think, 'oh I've got to lie on the bed'. We've really embraced that and I think it's all down to [midwife manager of unit] really, she's really pushed for it" (Faye, Band 6 midwife).*

All of the midwives interviewed from Forest were incredibly positive about the changes that had been made to improve women's experiences including telemetry and the labour room environment. Future plans included purchasing more telemetry so that there was a new model in every room and to increase the number of women using water for pain relief.

5.6.2 It has not entered people's minds

The obstetric-led maternity unit at Beach was much larger than Forest and the use of telemetry was less embedded. Some of this was due to poor experiences with the technology, training and availability of the machines as detailed in the category "Enabling and Facilitating". However, many of the midwives interviewed from Beach also mentioned the maternity unit culture of Beach and that this was not conducive to providing labour care that facilitated mobility and incorporated low-risk elements of care. Midwife Lisa had worked at Forest before coming to work at Beach and so had insight into the two different cultures on the units:

> *"I just don't think it's ingrained as a culture here [at Beach]. I think the whole concept of providing that low risk care in an obstetric unit has not even entered people's minds and I don't know if that's the confidence of the midwives and feeling that, you know, they're confident to dim all the lights and make that fetal heart quiet and use the telemetry and have that confidence in themselves to go – oh it's only loss of contact because she's moving, rather than – oh my God, I'm not monitoring the baby, someone's going to tell me off" (Lisa, Band 7 midwife, Beach).*

There was a sense from the midwives that as the unit was large and cared for women with complex pregnancies then it was accepted that this would mean labour and birth was highly medicalised and it was difficult to challenge this philosophy:

> *"I think fundamentally it is [a very medicalised unit]. I think it's quite hard to change that. I think we are a delivery unit of well over 9,000 births a year, aren't we. And we have four high dependency rooms. We have a critical care nurse on every shift. We're looking after women with very complex medical histories. Our ward rounds are massive in terms of obstetric input, in terms of anaesthetic input. And midwives can sometimes be a bit of a lone voice in terms of championing normal birth and normalising complex...women with complex medical histories. So it can be quite challenging. And sometimes I think the culture is just to, kind of, get on with the medicalised side of it." (Sarah, maternity unit manager, Beach).*

Some midwives described occasions when they had changed the room around, dimmed the lights and used telemetry but as this was not the 'norm' then other staff would often comment on this when coming into the room. All of the midwives interviewed at Beach mentioned the regularity and size of the ward rounds that came into the rooms. These were done every four hours and could sometimes be comprised of 8 or more staff including obstetricians, junior doctors, students and anaesthetists. There was an acknowledgment from midwives that this often disrupted what was happening in the room and impacted on the women's experience:

> *"The culture of the unit, the ward rounds, the business, the noisiness of it goes through the [labour room] doors I think. And I think that is what really impacts on that experience. So for example the ward round comes in and all the lights go up, five, six, seven people come in stand at the end of the bed and look at the woman. They don't talk to her, or they'll talk to her at the end, they'll be looking at the notes, talking to each other, you stand there as the coordinator with a clipboard, you go over and speak to the woman but it still feels a little bit awkward and you're completely disrupting whatever might have been going on physiologically." (Eve, Band 7 midwife, Beach).*

Beach was viewed as being a 'busy' unit and this was often mentioned in the interviews with midwives from Beach. There was often capacity issues within the unit with movement of women (from the antenatal ward and triage to the delivery unit then onto the postnatal ward once the baby had been born) given priority from more senior midwives in management roles. The business and bed pressure of the unit meant that

once women arrived on the delivery unit, particularly those being induced, then the clock was ticking and there was little time for women to get into established labour themselves; for the majority of women being induced syntocinon was commenced immediately after their waters were broken. One midwife referred to this type of care as a 'production line'. The pressure on the maternity unit was also picked up by one woman's partner in relation to using telemetry. Mark, Amanda's partner felt that if a midwife had to go and find a telemetry machine then this was taking up time which didn't fit into the ethos of getting women onto the delivery unit and off again as quickly as possible:

> *"Everything's on a timescale, they're targeted, you know to get this out and that out….so everything's on a pressure basis. So from my point of view, for them to just go, there's a machine in every room with wires in it, I think just it fits in with their current, you know, regime of how they need to do it. And although the telemetry's a welcome thing, it's not the norm for them to use it, you have to ask for it" (Mark, Amanda's partner, Beach).*

One woman, Anna described her experience with midwives at Beach after trying to use the telemetry had been unsuccessful. Anna wished to be mobile in her labour and once monitoring had been converted back to wired then she felt she had to insist on trying to be mobile:

> *"Nobody suggested I could be in a different position, and I just knew from my own experiences of working in maternity care that it is possible to change positions, and it is possible to still get information through CTG in different positions, and I was prepared to accept that if they couldn't, I was prepared to accept that I had to return. But I think nobody put that to me until I asked." (Holly, 1st baby, Beach).*

5.6.2.1 Opportunity for change

Despite the highly medicalised and challenging environment on Beach, many of the midwives interviewed wished to change this culture and saw this time as an opportunity. It emerged from the interviews that there had been a group of new Band 7 co-ordinating midwives who it was felt were more enthusiastic about change and had lots of ideas on how to make a difference. Leadership was also acknowledged as being crucial to making change happen:

"So gradually things are changing and I think they are definitely changing for the better because we've got consistent leadership…it allows us to try and change things and come up with ideas and think about what we want to do to make it better because I don't want to work somewhere where everyone has a crap experience. I think we're getting momentum now to have this sort of culture change and it's that that will do it. There are so many ways we can make things better but it just feels like now we've got a really big opportunity and it's our responsibility to go with that and make it better." (Eve, Band 7 midwife, Beach).

5.6.3 Summary

The two maternity units used in this study had different cultures and philosophies of care which impacted on telemetry use. Forest had done a large amount of improvement work that was focused on ensuring that women who came to the obstetric-led unit did not feel like they were missing out on some of the normal experiences that low-risk women had. This incorporated changes to the environment, purchase and use of telemetry, and gaining feedback from the women. Strong leadership contributed to this change in care and culture. Forest was also a less busy and smaller unit than Beach and this had an impact on the time that midwives spent with women and the overall philosophy of care that was becoming embedded. Beach was viewed as a very busy and medicalised obstetric-led labour ward which prioritised through-put of women, and routinized practice such as large ward rounds. Championing quieter, darker environments, mobility in labour with telemetry and normalising complex pregnancies was seen as a challenge and not the 'norm'. Senior midwives on Beach acknowledged this and were ready for change.

This Chapter has presented the grounded theory of using telemetry to monitor the fetal heart in labour. The overall core category, A Sense of Normality was described along with the three sub-categories; Being Free, Enabling and Facilitating, and Culture and Change. The following Chapter will present findings from the quantitative cohort.

Chapter Six: Observational Cohort Analysis and Findings

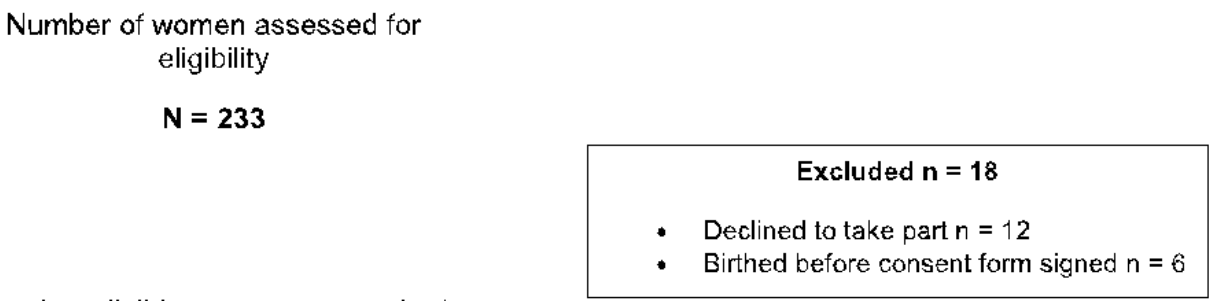
Chapter Six will present findings from the quantitative phase of the study. Details of participant flow and recruitment will be outlined and then baseline characteristics for both groups, telemetry and conventional wired monitoring, given and compared. The questionnaire given to women on control and satisfaction in labour is analysed along with a post-hoc sub-analysis. Clinical outcome data and mobility data was also analysed for both groups and is presented.

Women were recruited on the antenatal wards, in maternity triage and on the delivery units at two maternity units in the Northwest of England, identified by the pseudonyms 'Beach' and 'Forest', for the quantitative phase. Women were identified by the clinical team as being eligible to be approached by the researcher to discuss taking part in the quantitative part of the study. Participant flow and recruitment is summarised in Figure 34. Across both sites, 233 women were assessed for eligibility and of these, 184 were approached by the researcher; 10 women were excluded due to not meeting the inclusion criteria and six women declined to be approached. A total of 23 women were unavailable to be approached and for another 10 women it was deemed inappropriate (in pain or in advanced labour).

Of the 184 women approached by the researcher and given information, 166 women consented to participate in the quantitative phase of the study. A total of 12 women declined to take part and 6 women had birthed their baby before the consent could be obtained. Of the 166 women consented, five were excluded from the final cohort as three women underwent an elective caesarean section due to an unsuccessful induction of labour and two women were cared for on a midwifery-led unit and had intermittent auscultation of the fetal heart. The total number of women recruited to this phase of the study was therefore 161. Recruitment stopped when the pre-determined number of questionnaires were returned from each group (64 from the telemetry group and 64 from the conventional monitoring group). Clinical outcome data were extracted from hospital records for women who did not return a questionnaire as consent was gained for this in the consent form. Recruitment started on the 20th June 2018 and the last participant was recruited on the 9th March 2019.

Data were entered into one IBM SPSS Statistics file from data collection sheets (clinical outcome data, questionnaire data and mobility data). Data entry was checked for completeness and obvious errors by selecting a ten percent random sample of entries and checking against initial entry. All data analysis was completed by the researcher using the IBM SPSS (Version 23) statistics package.

Figure 34 Participant Flow and Recruitment



Excluded n = 49

- Did not meet inclusion criteria n = 10
- Declined to be approached n = 6
- Asleep or not on the ward n = 23
- In advanced labour/in discomfort n = 10

Excluded n = 5

- Had a failed induction and elective LSCS n = 3
- Had intermittent monitoring and went to a midwifery-led unit n = 2

Final number of participants

N = 161

Total number of women using telemetry

N = 74

Total number of women using conventional monitoring

N = 87

Completed questionnaires

N = 64

Completed questionnaires

N = 64

Mobility data collected

N = 41

Mobility data collected

N = 17

The total numbers of women recruited at each site are presented in Table 13. The majority of women who were continuously monitored at Forest used telemetry

(telemetry n = 35, 81.4% vs. wired n = 8, 18.6%). At Beach, less women were monitored using telemetry (telemetry n = 39, 33.1% vs. wired n = 79, 66.9%).

	Telemetry	Wired	Totals
Forest	35	8	43
% within site	81.4	18.6	100.0
Beach	39	79	118
% within site	33.1	66.9	100.0
Totals	74	87	161
	46.0	54.0	100.0

Table 15 Recruitment at each site

Baseline characteristics for the telemetry and conventional monitoring groups are presented in Table 14. There were 74 women (46%) who used telemetry in labour and 87 women (54%) who had conventional wired monitoring. The baseline characteristics for the telemetry group and the conventional wired monitoring group were broadly similar with mean age, parity, ethnicity and gestational age showing no difference. Reasons for induction of labour within in each group were the same with fetal reasons being most common.

Women in the wired monitoring group had a higher Body Mass Index (BMI) compared to the telemetry group (mean ± SD; 27.6 kg/m^2 ± 6.14 wired vs. 25.7 kg/m^2± 4.53 telemetry; p = 0.035). More women in the wired group had an pre-existing medical condition (such as cardiac disease, Type 1 diabetes mellitus or systemic lupus erythematosus) than the telemetry group (n = 23, 26.4% wired vs. n = 8, 11.1% telemetry, p = 0.015). This difference could be related to women with pre-existing underlying medical conditions being less likely to be offered wireless monitoring due to other clinical interventions during labour.

Significantly more women in the wired group than in the telemetry group were being induced (n = 86, 98.9% wired vs n = 63, 85.1% telemetry, p = 0.002). The large number in both groups was due to the ability to recruit women who were being induced and induction of labour rates at both sites ranging from 30-35% (personal communication, maternity unit lead midwives, April 2019). Most women who go into

spontaneous labour from each Trust will birth on a midwifery-led unit with intermittent auscultation of the fetal heart and there are therefore very small numbers of women going into spontaneous labour who require CEFM, which is reflected in the data. The impact of the differences in the baseline data will be considered in further analysis in the chapter.

	Overall	Telemetry	Wired	p
Participants N (%)	161 (100.0)	74 (46.0)	87 (54.0)	
Age, years, mean (SD)	31. (5.5)	31.7 (5.3)	30.5 (5.6)	0.155[a]
BMI, kg/m^2, mean (SD)	26.8 (5.52)	25.7 (4.53)	27.6 (6.14)	**0.035**[a]
Parity, N (%)				
• **0**	76 (47.2)	38 (51.4)	38 (43.7)	0.532[b]
• **1-4**	78 (48.4)	32 (43.2)	46 (52.9)	
• **5-10**	7 (4.3)	4 (5.4)	3 (3.4)	
Ethnicity, N (%)				
• **White British, other white background**	126 (78.3)	60 (81.1)	66 (75.9)	
• **Non-white background**	35 (21.7)	14 (18.9)	21 (24.1)	
Mean gestation, weeks (SD)	39.6 (1.47)	39.7 (1.46)	39.5 (1.47)	0.322[a]
Pre-existing medical condition, N (%)	31 (19.5)	8 (11.1)	23 (26.4)	**0.015**[b]
Induction of labour, N (%)	149 (92.5)	63 (85.1)	86 (98.9)	**0.012**[b]
Fetal indication for induction	140 (94.0)	59 (92.2)	81 (95.3)	0.652[b]
Maternal indication for induction	6 (4.0)	3 (4.7)	3 (3.5)	
Other induction for induction	3 (2.0)	2 (3.1)	1 (1.2)	

a) Independent samples t-test b) Chi-square

Table 16 Baseline Characteristics overall and within telemetry and wired groups

The primary outcome of the quantitative phase of the study was to determine if there was a difference in perceived control and satisfaction with childbirth, assessed via a questionnaire (Stevens et al, 2012), between the telemetry group and the wired group Appendix 16). Of the 161 women consented to the study, 128 (79.5%) returned questionnaires (64 in each group) and this was when recruitment stopped. The distribution within sites and within groups is given in Table 15. As telemetry was used for the majority of women at Forest and very few using wired monitoring, then the

majority of questionnaires returned for the wired group (n = 58, 90.6%,) were from Beach.

	Telemetry	Wired	Totals
	n=64	n=64	n=128
Forest (% within each group)	29 (45.3)	6 (9.4)	35 (27.3)
Beach (% within each group)	35 (54.7)	58 (90.6)	93 (72.7)
Totals (% within each group)	64 (100)	64 (100)	128 (100.0)

Table 17 Questionnaire return distribution

Women completed the questionnaire, either before discharge from the postnatal ward or posted the form back to the researcher. All questionnaires were completed within six weeks of birth. A total of 45% of the questionnaires were completed in the first few days of the postnatal period before the woman was discharged home. The remainder were taken home and sent back by the woman, all within six weeks of the birth.

Aggregate score data for both Perceived Control in Childbirth (PCCh) and Satisfaction With Childbirth (SWCh) are presented in Table 16. There was no significant difference between the telemetry and wired groups for PCCh aggregate score (mean ± SD; 5.2 ± 0.8 telemetry vs 4.9 ± 0.9, wired p = 0.138). There was also no statistical difference between the telemetry and wired groups for SWCh aggregate score (mean ± SD; 4.4 ±1.5 telemetry vs 4.7 ± 1.7 wired, p = 0.256).

	Telemetry n=64	Wired n=64	p[a]
Mean aggregate score for PCCh (SD)	5.2 (0.8)	4.9 (0.9)	0.138[a]
Median	5.4	5.1	
Range	2.7 to 6.0	2.5 to 6.1	
95% CI for mean	5.0 to 5.3	4.7 to 5.2	
Mean aggregate score for SWCh (SD)	4.4 (1.5)	4.7 (1.7)	0.256[a]
Median	4.2	4.9	
Range	1.6 to 7.0	1.0 to 7.0	
95% CI for mean	4.0 to 4.8	4.3 to 5.2	

a) Independent samples t-test

Table 18 Aggregate scores for PCCh and SWCh

Analyses for each individual question in the PCCh and SWCh are given in Tables 17 and 18. Scores were reversed for the reverse score questions and therefore the questions have been reversed. There was no statistical difference between groups for any of the questions in the PCCh scale. For the SWCh scale questions there was a statistically significant difference between the two groups for question 2. The wired group expressed more agreement with the statement *'My baby's birth did go the way I wanted it to'* than the telemetry group (χ^2 test for trend = 3.90, df = 1, p = 0.048).

	Telemetry n = 64 Mean, median score*	Wired n = 64 Mean, median score*	Chi-square test for trend (χ^2 trend)	Degrees of freedom (df)	Probability , p
Question 1: *I was able to participate in making decisions about how to manage my labour and birth.*	5.42, 6.00	5.36, 6.00	0.12	1	0.727
Question 2: *I was given choices before procedures were decided upon.*	5.59, 6.00	5.41, 6.00	1.40	1	0.237
Question 3: *I felt that I was in control of my birth environment.*	4.80, 5.50	4.58, 5.00	0.62	1	0.429
Question 4: *That I could question my health professional's (midwife or doctor) decisions.*	5.23, 6.00	5.14, 6.00	0.18	1	0.692
Question 5: *That I had some influence over what procedures were done.*	5.14, 6.00	4.86, 6.00	1.17	1	0.280
Question 6: *That I was in control of the situation.*	4.73, 5.00	4.38, 5.00	1.86	1	0.172
Question 7: *That I could get all my questions answered.*	5.69, 6.00	5.61, 6.00	0.32	1	0.571
Question 8: *That what I said made a difference to what occurred.*	5.33, 6.00	4.86, 6.00	3.03	1	0.082
Question 9: *I was not at a loss to know what I would be experiencing.*	4.84, 5.50	4.59, 5.00	0.90	1	0.342
Question 10: *If I wanted to, I could change the procedures I was receiving.*	4.45, 5.00	3.98, 4.00	2.33	1	0.127
Question 11: *I knew what the purpose and effects of the procedures were.*	5.34, 6.00	5.45, 6.00	0.28	1	0.596
Question 12: *If I asked my midwife or doctor to do something differently during labour and delivery they usually did.*	5.28, 6.00	5.02, 5.00	1.43	1	0.231

*mean included alongside median to give clearer indication of direction of difference

Table 19 Perceived Control in Childbirth individual questions for wired and telemetry groups

	Telemetry n = 64 Mean, median score*	Wired n = 64 Mean, median score*	Chi-square test for trend (χ^2 trend)	Degrees of freedom (df)	Probability p
Question 1: *In most ways, my childbirth experience was close to my ideal.*	3.81, 3.50	4.31, 5.00	1.58	1	0.210
Question 2: *My baby's birth did go the way I wanted it to go.*	3.66, 3.00	4.48, 4.00	3.90	1	**0.048**
Question 3: *The conditions of my childbirth were excellent.*	5.75, 6.00	5.22, 6.00	3.26	1	0.071
Question 4: *If I could do it over, I would change nothing about my childbirth experience.*	3.33, 3.00	3.97, 4.00	2.61	1	0.106
Question 5: *I am satisfied with the experience of my baby's birth.*	5.41, 6.00	5.64, 6.00	0.62	1	0.430
Question 6: *I got what I wanted out of my childbirth experience.*	5.06, 6.00	5.33, 6.00	0.65	1	0.420
Question 7: *If I could do it over, I would change almost nothing about my childbirth experience.*	3.91, 4.00	4.23, 5.00	0.72	1	0.396

***mean included alongside median to give clearer indication of direction of difference**

Table 20 Satisfaction with Childbirth Scale individual questions for wired and telemetry groups

6.4.1 Sub-group analysis questionnaire data

A decision was made, post hoc, to examine the time that women spent on telemetry as a proportion of their time spent on CEFM, as during analysis it became evident that women in the telemetry group were spending a variable proportion of their labour using telemetry. Following discussion with the research team it was agreed that a cut-off of women spending more, or less, than 50% of their total time on CEFM using telemetry would be a meaningful length of time to investigate. Data for the proportion of time spent >50% on telemetry is presented for each site in Table 19. Out of the 64 women in the telemetry questionnaire group 48 (75%) had telemetry for over 50% of their time on CEFM.

	Overall	Forest (% within trust)	Beach (% within Trust)
Number of women on telemetry >50% of time on CEFM (%)	N=48/64 (75)	N=28/35 (80)	N=20/29 (69)

Table 21 Proportion of time on CEFM spent on telemetry

6.4.1.1 Aggregate score sub-analysis

Aggregate score data analysis was re-run for both PCCh and SWCh and is presented in Table 20. Pair-wise comparisons were done between the three groups; telemetry >50%, telemetry <50% and wired. The aggregate score for the PCCh scale was statistically different between the telemetry >50% group and the wired group with the telemetry >50% group having a higher overall score than the wired group (mean ± SD; 5.3 ±0.8 telemetry vs. 4.9 ± 0.9 wired, p = 0.047). There was no difference between the other groups for the PCCh aggregate scores or for any of the SWCh aggregate scores.

	Telemetry >50% of CEFM n = 48	Wired n = 64	Probability p[a]	Telemetry <50% of CEFM n = 16	Wired n = 64	Probability p[a]	Telemetry >50% of CEFM n = 48	Telemetry <50% of CEFM n = 16	Probability p[a]
Mean aggregate score for PCCh (SD)	5.3 (0.8)	4.9 (0.9)	**0.047**	4.8 (0.7)	4.9 (0.9)	0.719	5.3 (0.8)	4.8 (0.7)	0.032
Median	5.5	5.1		5.0	5.1		5.5	5.0	
Range	2.7 to 6.0	2.5 to 6.1		3.08 to 5.58	2.5 to 6.1		2.7 to 6.0	3.08 to 5.58	
95% CI for mean	5.0 to 5.5	4.7 to 5.2		4.5 to 5.2	4.7 to 5.2		5.0 to 5.5	4.5 to 5.2	
Mean aggregate score for SWCh (SD)	4.5 (1.5)	4.7 (1.7)	0.539	4.0 (1.2)	4.7 (1.7)	0.122	4.5 (1.5)	4.0 (1.2)	0.227
Median	4.6	4.9		3.8	4.9		4.6	3.8	
Range	1.6 to 7.0	1.0 to 7.0		2.3 to 6.9	1.0 to 7.0		1.6 to 7.0	2.3 to 6.9	
95% CI for mean	4.1 to 5.0	4.3 to 5.2		3.4 to 4.7	4.3 to 5.2		4.1 to 5.0	3.4 to 4.7	

a) Independent samples t-test

Table 22 Aggregate scores for PCCh and SWCh for telemetry <50% of CEFM, telemetry >50% of CEFM and wired monitoring

6.4.1.2 Individual score sub-group analysis

Sub-analysis and results for each individual question in the PCCh and SWCh scales are given in tables as outlined below.

Telemetry >50% of CEFM compared to wired group – tables 21 and 22

Women having telemetry for >50% of the time they were on CEFM scored **higher** than those on wired monitoring for three of the individual PCCh questions:

- Question 6: That I was in control of the situation ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.023)
- Question 8: That what I said made a difference to what occurred ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.026)
- Question 10: If I wanted to I could change the procedures I was receiving ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.029)

Women having telemetry for >50% of the time they were on CEFM scored **higher** that women having wired monitoring on one of the SWCh questions:

- Question 3: The conditions of my childbirth were excellent ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.030)

Telemetry <50% of CEFM compared to wired group – tables 23 and 24

There were no differences in any of the PCCh questions between women having telemetry for <50% of CEFM compared to women having wired monitoring. There was a statistical difference for three of the SWCh questions. Women having telemetry for <50% of CEFM scored **lower** than women having wired monitoring in two questions

- Question 2: My baby's birth did go the way I wanted it to ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.022)
- Question 5: I am satisfied with the experience of my baby's birth ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.031)

Telemetry >50% of CEFM compared to Telemetry <50% of CEFM – tables 25 and 26

Women having telemetry >50% of CEFM scored **higher** than those having CEFM for <50% of the time for three PCCh questions

- Question 6: That I was in control of the situation ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.006)
- Question 8: That what I said made a difference to what occurred ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.046)
- Question 10: If I wanted to I could change the procedures I was receiving ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.037)

Women having telemetry for >50% of CEFM scored **higher** than those having CEFM for <50% of the time in one of the SWCh questions:

Question 5: I am satisfied with the experience of my baby's birth ($\chi^{2\ test\ for\ trend}$, df = 1, p = 0.012)

6.4.1.3 A note on multiple testing

It should be noted that performing multiple independent or dependent statistical tests simultaneously on a data set can increase the chances of a type I error. That is, the more tests that are performed the increased chance of obtaining a false-positive result. The chances of this are also increased with post hoc testing as this increases the number of statistical tests being performed on the data set (Sedgwick, 2012). One way of adjusting for this is to use the 'Bonferonni' correction. This correction involves adjusting the significance level of 0.05 by dividing it by the number of statistical tests that are performed (Sedgwick, 2012). For multiple testing of the individual scores for each of the control and satisfaction scales the adjusted p value would be p = 0.004 for control questions and p = 0.007 for satisfaction question testing. If the Bonferonni correction was made within this study then only the one finding in the sub-group analysis section would be significant; women having telemetry for >50% of the time compared to women having telemetry for <50% of this time felt more in control of the situation.

There are some criticisms of this technique however as 'the correction is conservative and not recommended if a large number of tests are performed, since few if any tests will be significant after the correction has been applied' (Sedgwick, 2012, p 1). This method will also increase likelihood of false-negatives (Type II errors). The test also assumes that all of the hypothesis tests are statistically independent, which is often not the case, as for this study. Findings should be treated with caution but also bear in mind these criticisms.

	Telemetry >50% of CEFM n=48 Mean, Median score*	Wired n = 64 Mean, Median score*	Chi-square test for trend (χ^2 trend)	Degrees of freedom (df)	p[a]
Question 1: *I was able to participate in making decisions about how to manage my labour and birth.*	5.44, 6.00	5.36, 6.00	0.171	1	0.679
Question 2: *I was given choices before procedures were decided upon.*	5.60, 6.00	5.41, 6.00	1.24	1	0.265
Question 3: *I felt that I was in control of my birth environment.*	4.74, 5.00	4.58, 5.00	0.25	1	0.618
Question 4: *That I could question my health professional's (midwife or doctor) decisions.*	5.35, 6.00	5.14, 6.00	0.71	1	0.400
Question 5: *That I had some influence over what procedures were done.*	5.29, 6.00	4.86, 6.00	2.34	1	0.123
Question 6: *That I was in control of the situation.*	5.00, 5.00	4.38, 5.00	5.13	1	**0.023**
Question 7: *That I could get all my questions answered.*	5.73, 6.00	5.61, 6.00	0.61	1	0.433
Question 8: *That what I said made a difference to what occurred.*	5.50, 6.00	4.86, 6.00	5.00	1	**0.026**
Question 9: *I was not at a loss to know what I would be experiencing.*	5.00, 6.00	4.59, 5.00	2.10	1	0.148
Question 10: *If I wanted to, I could change the procedures I was receiving.*	4.71, 5.00	3.98, 4.00	4.80	1	**0.029**
Question 11: *I knew what the purpose and effects of the procedures were.*	5.44, 6.00	5.45, 6.00	0.01	1	0.941
Question 12: *If I asked my midwife or doctor to do something differently during labour and delivery they usually did.*	5.29, 6.00	5.02, 5.00	1.33	1	0.250

*mean included alongside median to give clearer indication of direction of difference

Table 23 Perceived Control in Childbirth individual questions for wired and telemetry >50% of CEFM

	Telemetry >50% of CEFM n=48 Mean, median score*	Wired n = 64 Mean, median score*	Chi-square test for trend (χ^2 trend)	Degrees of freedom (df)	p[a]
Question 1: *In most ways, my childbirth experience was close to my ideal.*	3.94, 4.00	4.31, 5.00	0.77	1	0.381
Question 2: *My baby's birth did go the way I wanted it to go.*	3.90, 3.00	4.48, 4.00	1.75	1	0.186
Question 3: *The conditions of my childbirth were excellent.*	5.92, 6.00	5.22, 6.00	4.72	1	**0.030**
Question 4: *If I could do it over, I would change nothing about my childbirth experience.*	3.46, 3.00	3.97, 4.00	1.40	1	0.237
Question 5: *I am satisfied with the experience of my baby's birth.*	5.69, 6.00	5.64, 6.00	0.02	1	0.883
Question 6: *I got what I wanted out of my childbirth experience.*	5.08, 6.00	5.33, 6.00	0.45	1	0.500
Question 7: *If I could do it over, I would change almost nothing about my childbirth experience.*	3.85, 4.00	4.23, 5.00	0.80	1	0.371

*mean included alongside median to give clearer indication of direction of difference

Table 24 Satisfaction with Childbirth Scale individual questions for wired and telemetry >50% groups

	Telemetry <50% of CEFM n = 16 Mean, median score	Wired n = 64 Mean, median score	Chi-square test for trend (χ^2 trend)	Degrees of freedom (df)	p
Question 1: *I was able to participate in making decisions about how to manage my labour and birth.*	5.38, 6.00	5.36, 6.00	0.00	1	0.954
Question 2: *I was given choices before procedures were decided upon.*	5.56, 6.00	5.41, 6.00	0.34	1	0.557
Question 3: *I felt that I was in control of my birth environment.*	5.00, 6.00	4.58, 5.00	0.94	1	0.333
Question 4: *That I could question my health professional's (midwife or doctor) decisions.*	4.88, 5.00	5.14, 6.00	0.45	1	0.502
Question 5: *That I had some influence over what procedures were done.*	4.69, 5.00	4.86, 6.00	0.15	1	0.697
Question 6: *That I was in control of the situation.*	3.94, 4.50	4.38, 5.00	0.93	1	0.335
Question 7: *That I could get all my questions answered.*	5.56, 6.00	5.61, 6.00	0.04	1	0.835
Question 8: *That what I said made a difference to what occurred.*	4.81, 5.50	4.86, 6.00	0.01	1	0.923
Question 9: *I was not at a loss to know what I would be experiencing.*	4.38, 5.00	4.59, 5.00	0.27	1	0.602
Question 10: *If I wanted to, I could change the procedures I was receiving.*	3.69, 4.50	3.98, 4.00	0.37	1	0.542
Question 11: *I knew what the purpose and effects of the procedures were.*	5.06, 6.00	5.45, 6.00	1.42	1	0.234
Question 12: *If I asked my midwife or doctor to do something differently during labour and delivery they usually did.*	5.25, 6.00	5.02, 5.00	0.34	1	0.530

*mean included alongside median to give clearer indication of direction of difference

Table 25 Perceived Control in Childbirth individual questions for wired and telemetry <50% groups

	Telemetry <50% of CEFM n = 16 Mean, median score	Wired n = 64 Mean, median score	Chi-square test for trend (χ^2 trend)	Degrees of freedom (df)	Probability p
Question 1: *In most ways, my childbirth experience was close to my ideal.*	3.44, 3.00	4.31, 5.00	1.90	1	0.169
Question 2: *My baby's birth did go the way I wanted it to go.*	2.94, 2.00	4.48, 4.00	5.22	1	0.022
Question 3: *The conditions of my childbirth were excellent.*	5.25, 6.00	5.22, 6.00	0.00	1	0.952
Question 4: *If I could do it over, I would change nothing about my childbirth experience.*	2.94, 2.50	3.97, 4.00	2.56	1	0.110
Question 5: *I am satisfied with the experience of my baby's birth.*	4.56, 4.00	5.64, 6.00	4.67	1	0.031
Question 6: *I got what I wanted out of my childbirth experience.*	5.00, 5.50	5.33, 6.00	0.39	1	0.531
Question 7: *If I could do it over, I would change almost nothing about my childbirth experience.*	4.06, 4.00	4.23, 5.00	0.08	1	0.779

*mean included alongside median to give clearer indication of direction of difference

Table 26 Satisfaction with Childbirth Scale individual questions for wired and telemetry <50% groups

	Telemetry >50% of CEFM n=48 Mean, median score	Telemetry <50% of CEFM n = 16 Mean, median score	Chi-square test for trend (χ^2 trend)	Degrees of freedom (df)	Probability p[a]
Question 1: *I was able to participate in making decisions about how to manage my labour and birth.*	5.44, 6.00	5.38, 6.00	0.04	1	0.845
Question 2: *I was given choices before procedures were decided upon.*	5.60, 6.00	5.56, 6.00	0.04	1	0.847
Question 3: *I felt that I was in control of my birth environment.*	4.74, 5.00	5.00, 6.00	0.37	1	0.544
Question 4: *That I could question my health professional's (midwife or doctor) decisions.*	5.35, 6.00	4.88, 5.00	1.75	1	0.187
Question 5: *That I had some influence over what procedures were done.*	5.29, 6.00	4.69, 5.00	2.50	1	0.116
Question 6: *That I was in control of the situation.*	5.00, 5.00	3.94, 4.50	7.46	1	0.006
Question 7: *That I could get all my questions answered.*	5.73, 6.00	5.56, 6.00	0.66	1	0.416
Question 8: *That what I said made a difference to what occurred.*	5.50, 6.00	4.81, 5.50	3.97	1	0.046
Question 9: *I was not at a loss to know what I would be experiencing.*	5.00, 6.00	4.38, 5.00	2.07	1	0.150
Question 10: *If I wanted to, I could change the procedures I was receiving.*	4.71, 5.00	3.69, 4.50	4.33	1	0.037
Question 11: *I knew what the purpose and effects of the procedures were.*	5.44, 6.00	5.06, 6.00	1.06	1	0.304
Question 12: *If I asked my midwife or doctor to do something differently during labour and delivery they usually did.*	5.29, 6.00	5.25, 6.00	0.02	1	0.900

*mean included alongside median to give clearer indication of direction of difference

Table 27 Perceived Control in Childbirth individual questions for telemetry >50% CEFM and telemetry <50% CEFM groups

	Telemetry >50% of CEFM n=48 Mean, median score	Telemetry <50% of CEFM n = 16 Mean, median score	Chi-square test for trend (χ^2 trend)	Degrees of freedom (df)	Probability p
Question 1: *In most ways, my childbirth experience was close to my ideal.*	3.94, 4.00	3.44, 3.00	0.58	1	0.441
Question 2: *My baby's birth did go the way I wanted it to go.*	3.90, 3.00	2.94, 2.00	2.00	1	0.157
Question 3: *The conditions of my childbirth were excellent.*	5.92, 6.00	5.25, 6.00	3.17	1	0.075
Question 4: *If I could do it over, I would change nothing about my childbirth experience.*	3.46, 3.00	2.94, 2.50	0.73	1	0.394
Question 5: *I am satisfied with the experience of my baby's birth.*	5.69, 6.00	4.56, 4.00	6.32	1	0.012
Question 6: *I got what I wanted out of my childbirth experience.*	5.08, 6.00	5.00, 5.50	0.03	1	0.871
Question 7: *If I could do it over, I would change almost nothing about my childbirth experience.*	3.85, 4.00	4.06, 4.00	0.12	1	0.732

*mean included alongside median to give clearer indication of direction of difference

Table 28 Satisfaction with Childbirth Scale individual questions for telemetry >50% CEFM and telemetry <50% CEFM gro

Clinical outcome data were collected for all women in the study (n = 161) and are presented in Table 27. The power calculation for the sample size (n = 128 returned questionnaires) was based on the questionnaire data and not on an ability to detect statistical differences in clinical outcome data. Exploratory analysis of the clinical outcome data is useful however for determining trends and potential larger future studies.

In all but one variable there was no significant difference between the two groups for any clinical outcome data. There were more babies admitted to the NICU unit in the telemetry group than the wired groups (n = 4, 5.4% telemetry vs n = 0, 0%, wired p=0.028). The comparisons for clinical outcomes were underpowered and therefore some differences may be present that aren't statistically significant. Notable crude differences were present within some of the clinical outcome data. The caesarean section rate was higher for women having telemetry than those having wired monitoring (21.6% telemetry vs 13.8% wired). The crude epidural rate was lower for women having telemetry than women having wired monitoring (39.2% telemetry vs 46.0% wired). Fetal blood sampling was lower for women having telemetry than women with wired monitoring (9.5% telemetry vs 19.5% wired). Women having telemetry had higher rates of giving birth in an upright position than those having wired monitoring (29.7% telemetry vs 12% wired) and women having wired (26%) had more intact perineum's than women with telemetry (16.2%). These findings should be treated with caution due to the underpowered comparisons but are worth noting for discussion.

	Telemetry n=74	Wired n=87	p
Length of 1st stage of labour, hours (SD)	n=63	n=75	0.128[a]
	5.0 (3.7)	4.4 (3.3)	
Mean time 2nd stage of labour, hours (SD)	n=61	n=75	0.054[a]
	1.4 (1.4)	0.9 (1.0)	
Artificial rupture of membranes, N (%)	60 (81.1)	69 (79.3)	0.779[c]
Oxytocin used in labour, N (%)	56 (77.8)	67 (77.0)	0.909[c]
Mean Time spent on any CEFM, hours (SD)	10.0 (5.2)	8.5 (5.6)	0.085[a]
Range	1.5 to 23.9	1.5 to 23.0	
Mean time spent on telemetry, hours (SD)	6.3 (4.0)		
Range	1.5 to 17.3		
Mode of birth, N (%)			
• **Spontaneous vaginal**	37 (50.0)	50 (57.5)	{0.324[b]
• **Ventouse**	9 (12.2)	7 (8.0)	
• **Forceps**	12 (16.2)	18 (20.7)	
• **Emergency Caesarean section**	16 (21.6)	12 (13.8)	
Pain relief, N (%)			
• **Water/pool**	5 (6.8)	0 (0.0)	
• **Entonox**	65 (87.8)	68 (78.2)	0.106[c]
• **Pethidine**	9 (12.2)	8 (9.2)	0.542[c]
• **Diamorphine**	11 (12.6)	7 (9.5)	0.523[c]
• **Remifentanyl**	15 (20.3)	18 (20.7)	0.948[c]
• **Epidural**	29 (39.2)	40 (46.0)	0.386[c]
• **Spinal anaesthetic**	9 (12.2)	4 (4.6)	0.079[c]
• **General anaesthetic**	1 (1.4)	0 (0.0)	0.277[c]
Fetal Scalp electrode use, N(%)	19 (25.7)	26 (31.0)	0.463[c]
Fetal blood sampling, N (%)	7 (9.5)	17 (19.5)	0.073[c]
Birth position (normal birth only), N (%)			
• **Semi-reclined/side**	21 (56.8)	31 (62.0)	{0.077[c]
• **Lithotomy**	5 (13.5)	13 (26.0)	
• **All fours/upright/standing/pool**	11 (29.7)	6 (12.0)	

Perineum (normal birth only), N (%)			
• **Intact**	6 (16.2)	13 (26.0)	{0.134[b]
• **1st degree tear**	18 (48.6)	16 (32.0)	
• **2nd degree tear**	10 (27.0)	15 (30.0)	
• **3rd degree tear**	0	0	
• **4th degree tear**	0	0	
• **Episiotomy**	3 (8.1)	6 (12.0)	0.727[c]
Estimated blood loss, mls, mean (SD)	509 (401.6)	550 (426.3)	0.459[d]
Breastfeeding within first hour (for those intending to breastfeed), N (%)	53 (82.8)	47 (71.2)	0.117[c]
***Delayed cord clamping, N (%)**	52 (71.2)	55 (64.7)	0.382[c]
Mean time of delayed cord clamping, mins (SD)	3.6 (3.12)	2.6 (2.11)	0.071[c]
Admission to NICU within first hour, N (%)	4 (5.4)	0 (0)	**0.028**[c]

a) Mann-Whitney b)Chi-square test for trend c)Chi-square d) t-test *delayed cord clamping defined as >1 minute.

Table 29 Clinical outcome data for wired and telemetry groups

6.5.1 Outcome data sub-group analysis

As with the questionnaire data, a sub-group analysis was done comparing clinical outcome data between the group of women who had telemetry for >50% of their time on CEFM and women who had wired monitoring. Data is presented in Table 28.

Four of the variables showed a significant difference between the groups The association between birth position and type of monitoring was significant (χ^2=6.185, df=2, p=0.045) with women in the 'telemetry >50% of CEFM' group giving birth in more upright positons and women in the wired group more likely to give birth in lithotomy or semi-reclined/lying. Women in the 'telemetry >50% of CEFM' group were also statistically more likely to breastfeed within the first hour and have a longer duration of delayed cord clamping. There were more babies admitted to the NICU unit in the telemetry group than the wired groups (n = 4, 8.7% telemetry >50% vs n = 0, 0% wired, p = 0.014). Obvious differences that are present that were not statistically significant are the lower epidural rate for women in the 'telemetry >50% of CEFM' compared to the wired group (32.1% telemetry >50% vs 46% wired) and the lower use of a fetal scalp electrode (17% telemetry >50% vs 31% wired) and fetal blood sampling (7.5% telemetry >50% vs 19.5 wired) for women in the

'telemetry >50% of CEFM' group. Again, these observations should be treated with caution due to underpowered comparisons.

	Telemetry >50% of time on CEFM n=53	Wired n=87	p
Mean Length of 1st stage of labour, hours (SD)	n= 46	n=75	0.442[a]
	4.7 (3.7)	4.4 (3.3)	
Mean time 2nd stage of labour, hours (SD)	n=45	n=75	0.183[a]
	1.3 (1.4)	0.9 (1.0)	
Artificial rupture of membranes, N (%)	41 (77.4)	69 (79.3)	0.785[c]
Oxytocin used in labour, N (%)	37 (71.2)	67 (77.0)	0.441[c]
Mean Time spent on any CEFM, hours (SD)	8.8 (4.9)	8.5 (5.6)	0.085[a]
Range	1.5 to 21.83	1.5 to 23.0	
Mean time spent on telemetry, hours (SD)	7.6 (4.0)		
Range	1.5 to 17.3		
Mode of birth, N (%)			
• **Spontaneous vaginal**	29 (54.7)	50 (57.5)	(0.656[b]
• **Ventouse**	6 (11.3)	7 (8.0)	
• **Forceps**	7 (13.2)	18 (20.7)	
• **Emergency Caesarean section**	11 (20.8)	12 (13.8)	
Pain relief, N (%)			
• **Water/pool**	4 (7.5)	0 (0.0)	
• **Entonox**	44 (83)	68 (78.2)	0.486[c]
• **Pethidine**	8 (15.1)	8 (9.2)	0.287[c]
• **Diamorphine**	5 (9.4)	11 (12.6)	0.563[c]
• **Remifentanyl**	8 (15.1)	18 (20.7)	0.409[c]
• **Epidural**	17 (32.1)	40 (46.0)	0.104[c]
• **Spinal anaesthetic**	8 (15.1)	4 (4.6)	0.057[c]
• **General anaesthetic**	53 (0.0)	0 (0.0)	
Fetal Scalp electrode use, N(%)	9 (17.0)	26 (31.0)	0.068[c]
Fetal blood sampling, N (%)	9 (7.5)	17 (19.5)	**0.054**[c]
Birth position (normal birth only), N (%)			
• **Semi-reclined/side**	15 (51.7)	31 (62.0)	**0.045**[c]
• **Lithotomy**	4 (13.8)	13 (26.0)	
• **All fours/upright/standing/pool**	10 (34.5)	6 (12.0)	

Perineum (normal birth only), N (%)			
• **Intact**	5 (17.2)	13 (26.0)	0.077[b]
• **1st degree tear**	14 (48.3)	16 (32.0)	
• **2nd degree tear**	9 (31.0)	15 (30.0)	
• **3rd degree tear**	0	0	
• **4th degree tear**	0	0	
• **Episiotomy**	1 (3.4)	6 (12.0)	0.252[b]
Estimated blood loss, mls, mean (SD)	507 (437.2)	550 (426.3)	0.577[a]
Breastfeeding within first hour (for those intending to breastfeed), N (%)	**41** (89.1)	47 (71.2)	**0.023**[c]
***Delayed cord clamping, N (%)**	33 (73.3)	55 (64.7)	0.526[c]
Mean time of delayed cord clamping, mins (SD)	4 (3.12)	2.6 (2.11)	**0.014**[d]
Admission to NICU within first hour, N (%)	4 (8.7)	0 (0)	**0.014**[b]

a) Mann-Whitney b) Chi-square test for trend c)Chi-square d) t-test *delayed cord clamping defined as >1 minute.

Mobility in labour data were collected for 58 women in the study and is presented in Table 29. Women in the telemetry group spent a greater proportion of their time in labour off the bed (or on knees over the back of the bed) compared to women in the wired group (n = 41, 59% telemetry vs n = 17, 22%, wired; independent samples t-test, p<0.005). Women in the telemetry group were also less likely to spend a greater proportion of the time in labour semi-reclined or lateral in the bed (n = 41, 28% telemetry vs n = 17, 61% wired; independent samples t-test, p <0.005). There was no difference between the groups for the proportion of time spend upright in the bed or in lithotomy.

	Wired N = 17	Telemetry N = 41	Test statistic[a]	Degrees of freedom	Probability, p
Off the bed (or knees over back of bed), mean % (SD)	22 (34.0)	59 (24.6)	-4.60	56	<0.005
Semi-recumbent or lateral in the bed, mean % (SD)	61 (27.5)	28 (18.7)	5.42	56	<0.005
Sitting upright in bed, mean % (SD)	15 (15.0)	11 (15.5)	0.81	56	0.421
Lithotomy, mean % (SD)	1 (2.7)	1 (3.7)	-0.73	56	0.468

a) independent samples t-test

Table 31 Proportion spent in labour in different positions for wired v telemetry groups.

6.6.1Sub-group analysis

As for the questionnaire and clinical outcome data a sub-group analysis of mobility in labour was undertaken and compared for the groups 'telemetry >50% of CEFM', 'telemetry <50% of CEFM' and wired groups. This is presented in Table 30.

This showed that women in the group 'telemetry >50% of time on CEFM' spent a greater proportion of their time off the bed (or on knees over the back of the bed) compared to the wired group (n = 31, 62% telemetry vs n = 17, 22% wired; p = <0.005). Women who were in the group 'telemetry <50% of the time' also spent a higher proportion off the bed when compared to the wired group (n = 10, 53% telemetry vs n = 17, 22% wired; p = 0.030). The same effect was also observed when comparing semi-recumbent/lateral positions between the groups with women having any amount of telemetry (>50% or <50%) spending a lower proportion of their labour in this position. Women having different amounts of telemetry spent a similar amount of time off the bed and in semi-recumbent /lateral positions.

	Telemetry >50% of CEFM N=31	Wired N = 17	Test statistic (t-test)	Degrees of freedom	P	Telemetry <50% of CEFM N = 10	Wired N = 17	Test statistic (t-test)	Degrees of freedom	p	Telemetry >50% of CEFM N = 31	Telemetry <50% of CEFM N = 10	Test statistic (t-test)	Degrees of freedom	p
Off the bed (or knees over back of bed), mean % (SD)	62 (22.9)	22 (34.0)	4.72	46	**<0.005**	53 (29.5)	22 (34.0)	2.30	25	**0.030**	62 (22.9)	53 (29.5)	1.01	39	**0.317**
Semi-recumbent or lateral in the bed, mean % (SD)	27 (20.5)	61 (27.5)	-5.01	46	**<0.005**	32 (11.7)	61 (27.5)	-3.25	25	**0.003**	27 (20.5)	32 (11.7)	-0.74	39	**0.462**
Sitting upright in bed, mean % (SD)	10 (12.4)	15 (15.0)	-1.20	46	**0.236**	15 (23.0)	15 (15.0)	0.4	25	**0.967**	10 (12.4)	15 (23.0)	-0.68	39	**0.514**
Lithotomy, mean % (SD)	2 (4.1)	1 (2.7)	0.90	46	**0.372**	1 (1.6)	1 (2.7)	-1.6	25	**0.876**	2 (4.1)	1 (1.6)	0.86	39	**0.397**

Table 32 Proportion of time spent in different labour positions for the groups 'telemetry >50% of CEFM', telemetry <50% of CEFM and wired groups

This Chapter has presented data analysis from the quantitative cohort comparing data from a group of women using telemetry during labour with a group of women having conventional wired monitoring. There were no difference between the groups in either of the aggregate scores for the Perceived Control in Childbirth (PCCh) Scale or the Satisfaction with Childbirth (SWCh) scale. When scores for each question were analysed individually there was a difference for one question; women who had wired monitoring reporting higher scores for the question focused on whether birth had gone the way they wanted it to.

A sub-group analysis comparing women who had telemetry for more than 50% of the time they were on CEFM with women using wired monitoring, found that the telemetry group had higher aggregate scores for the PCCh scale. There was no difference between groups for the SWCh scale. When individual scores for each question in the scales were analysed then women who had telemetry for greater than 50% of the time they were on CEFM reported higher scores than the wired group on; being more in control of the situation, that what they said made a difference, that they could change procedures that were happening and that the conditions of their childbirth were excellent.

There were no differences between the groups in any of the clinical outcome data. When a sub-group analysis was done comparing clinical outcome data, this showed that women who had telemetry for greater than 50% of the time they were on CEFM were more likely to give birth in an upright position, to breastfeed in the first hour and to have delayed cord clamping. Mobility data analysis showed that women who used telemetry spent a greater proportion of their time in labour off the bed when compared to women having conventional wired monitoring.

Chapter Seven: Integration of findings and discussion

Chapter Seven presents an integration of the qualitative and quantitative findings and a discussion of findings in relation to existing literature, the context of midwifery care in the UK and implications for practice. Four major themes are presented for discussion;

- telemetry and the benefits of mobility and upright positions for labour and birth
- telemetry and its impact on control and subsequent benefits
- telemetry and its impact on dignity, normality and humanising birth
- the impact of maternity unit culture and environment on the use of telemetry

Integration, or merging of qualitative and quantitative findings when using a convergent parallel design can occur in two different ways. One technique is to independently analyse both quantitative and qualitative data and to then also transform the data so that qualitative data are quantitised and vice versa (Creswell and Plano Clark, 2011). The more common approach is to analyse both sets of data using methods best suited to the type of data (and accompanying methodology) and then compare, contrast and integrate both sets of data. This second approach is the one adopted for this study. Questions may be asked of the data such as; 'How do the qualitative and quantitative data converge?' and 'To what extent do the qualitative findings contribute to understanding the quantitative findings? These questions will be addressed in the following sections.

7.2.1 Control and satisfaction questionnaire findings integrated with qualitative findings

Control was explored as a sub-category of the category 'Being free' in the grounded theory developed from the qualitative data. Women in this study who used telemetry were more mobile and this mobility led to increased feelings of control over their environment, control over what was happening in labour and perceived control over pain relief and levels of intervention. The Perceived Control in Childbirth (PCCh) scale used in the questionnaire was designed to assess women's perceptions of control over the birth environment (Stevens et al, 2012). There was no difference in

the aggregate questionnaire control scores between the telemetry groups and the wired groups, suggesting that women who used telemetry did not feel more in control of their birth environment than those using wired monitoring. There was also no difference in the aggregate scores for the Satisfaction with Childbirth (SWCh) scale between the groups.

As women in the telemetry group of the quantitative cohort experienced different amounts of time using telemetry in labour, the sub-group analysis was performed. This showed that when women had experienced telemetry for more than 50% of their time on CEFM they had higher aggregate scores for control over the birth environment. This supports the qualitative interview findings that women did feel more in control of their birth environment. This was expressed as being able to access personal belongings, use different pieces of equipment in the room, such as birthing balls, and control lighting and music. Given that all but one of the women interviewed used telemetry for the whole of their labour then the quantitative findings in relation to using telemetry for >50% of the time on CEFM correlate with the interview findings.

When the questions for both scales were analysed individually there was a difference in the question 'My baby's birth did go the way I wanted I wanted it to'. Women in the telemetry group had a lower combined score for this question than the wired group; that is, they felt that their birth did not go as well as they wanted it to when compared to the wired group. When the sub-group analysis was performed, women in the group that used telemetry for less than 50% of the time they were on CEFM also had a lower combined score for this question when compared to the wired group. This was, perhaps, an unexpected finding but may be partly explained by taking into account experiences of some of the women in the telemetry group who had varying amounts of telemetry during their labour. One of the women interviewed in the qualitative phase, where the telemetry did not work, described that this experience made her feel disappointed and resulted in a sense of failure. These types of experiences, particularly if women have telemetry for only a short period of time due to it not working, may influence how women feel overall about the birth of their baby. It may be that using telemetry, realising the benefits that it could confer such as mobility, and then having the option removed may have a greater negative influence on labour, and how women feel that the birth went, than when having wired monitoring alone.

When individual questions were examined, then women who used telemetry for over 50% of their time on CEFM scored statistically higher in the questions 'That I was in control of the situation', 'That what I said made a difference to what occurred', 'If I wanted to I could change the procedures I was receiving', and 'The conditions of my childbirth were excellent'. These findings support the qualitative analysis and many aspects of the grounded theory developed and presented. Women interviewed were not asked these specific questions but expressed feeling not only in control of their environment, but in control of their whole labour and what was happening (which could be viewed as the 'situation'). Women described good communication with birth partners and midwives which affected input into decision-making during birth with some women describing they felt more involved in what was going on. It seems probable that this could also lead to women feeling they could influence and change the procedures they were receiving. The majority of the women interviewed that used telemetry spoke in positive terms about their labour, birth and the environment in which it occurred, which is supported by the final question concerned with excellent childbirth conditions.

7.1.2 Mobility data analysis integrated with qualitative findings.

The mobility data, presented in the quantitative analysis, demonstrates that women who used any amount of telemetry in labour spent significantly more time off the bed, or on knees over the back of the bed, and statistically less time in a semi-recumbent or lateral position on the bed. This was also true for women who spent less than 50% of their time on CEFM on telemetry. This supports the interview findings where women described being mobile when using telemetry. It also suggests that even when women had a small amount of telemetry during labour they were more mobile and spent more time off the bed than women who had wired monitoring. Birth position of the women was collected in the clinical outcome data and is discussed in the following section.

7.1.3 Clinical outcome data integrated with qualitative findings

Some of the clinical outcome data supports findings from the qualitative phase of the study. Midwives reported that some women were able to use a birthing pool with telemetry and the clinical data showed that 6.8% of women in the telemetry group used a birthing pool for pain relief. None of the women in the wired group used a birthing pool for pain relief (but were in effect excluded from this option due to the type of monitoring). Subgroup analysis showed that more women who had telemetry for more than 50% of their time on CEFM had a birth position that was on all fours,

upright, standing or in a birth pool than women who had wired monitoring. This supports the findings from the interviews, and other quantitative analysis, that women are more mobile with telemetry than with wired monitoring. It could be extrapolated that when women are more mobile in labour this leads to women giving birth in positions that are not in the bed semi-reclined.

Issues such a breastfeeding and delayed cord clamping were not explored in the interviews, nor raised by the women or midwives themselves, so these significant quantitative findings stand alone. The effect that using telemetry would have on breastfeeding rates within the first hour after birth or whether there was delayed cord clamping is not immediately obvious and these findings may have been influenced by other confounders such as the influence of different sites.

7.2.1 Aims and objectives of the study

The study aims were to gather in-depth knowledge about the experiences of women and midwives using telemetry to monitor the fetal heart in labour and to assess the impact that the use of telemetry has on clinical outcomes, mobility in labour and control and satisfaction. The study design, using a parallel mixed method approach ensured that the objectives of collecting and analysing in-depth interview data alongside demographic, clinical and control and satisfaction data were achieved. Integration of the data has given a much deeper understanding of contemporary telemetry use in the UK.

The findings of this study are novel and important in the context of midwifery care provision in the UK. The impact that the use of telemetry has for the experiences of women giving birth in obstetric-led settings are discussed in this section. The major findings presented from the grounded theory, the quantitative cohort and the integrated analysis are discussed and four major areas for discussion have been identified and will be expanded on:

- telemetry and the benefits of mobility and upright positions for labour and birth
- telemetry and its impact on control and subsequent benefits
- telemetry and its impact on dignity, normality and humanising birth
- the impact of maternity unit culture and environment on the use of telemetry

7.2.2 Telemetry and the benefits of mobility and upright positions for labour and birth

Findings from both phases of the study were that women were more mobile when using telemetry during labour; women reported they were more mobile, and they spent more time off the bed. Being mobile and upright meant that women were able to access other pieces of equipment in a birthing room for support such as a ball or rocking chair and they could be given physical support, such as back massage, by birth partners or health professionals. Women were able to respond instinctively to what their bodies were wanting them to do which led to the adoption of more upright positions which aid optimal positioning of the fetus in preparation for the birth.

Optimal position of the fetus and pressure on the cervix aids contractions of the uterus, cervical dilatation and descent of the fetus. In addition, when women are more upright, this reduces pressure from the fetus on the maternal major blood vessels connected to the uterus and negates adverse physiological effects of lying supine such as deceleration of the fetal heart and fetal hypoxia (Lawrence et al., 2013). There is some evidence that walking and upright positions in the first stage of labour decreases the length of labour, the risk of caesarean section and the need for epidural anaesthesia (Priddis et al, 2012; Lawrence *et al.*, 2013). Clinical outcome data for the study reported in this thesis did not report a significant difference in epidural rate between the groups. However, in the main analysis the epidural rate was lower for the telemetry group than the wired group (39% vs 46%) and similarly, for the sub-group analysis, the epidural rate for the telemetry group was lower than the wired group (32% vs 46%). The study was not powered to detect differences in the epidural rate but the differences are notable and worth exploring with larger numbers in each group to determine if there is a true drop in epidural rate for women using modern telemetry. The NICE meta-analysis also reported no significant difference in the length of labour for women using telemetry compared to wire monitoring, echoing data from this study.

Clinical outcome data from this study showed that women who had telemetry for the majority of their labour gave birth in more upright positions (all fours, standing, upright in the bed, or in a pool), Evidence shows that when women are upright in the second stage of labour there may be a small reduction in the duration of the second stage and a reduction in episiotomies and assisted births (Gupta et al., 2017). There may also be a small increase in the number of women having a blood loss greater than 500ml which may be related to increased perineal oedema in

upright positons (Priddis et al, 2012). Much of the evidence around the clinical benefits of different positions in the first and second stage of labour should be interpreted with caution however, as there is large heterogeneity between the studies and inconsistency between the classification of different positions (De Jonge et al., 2010).

This study showed that women who used telemetry during labour were more mobile and adopted more upright positons during labour. There was no statistical difference however, between the two groups in any of the clinical outcome measures that mobility may have an impact on such as length of labour or duration of the second stage. Fewer women in the telemetry group had an epidural for pain relief and any fetal blood sampling in labour but this did not reach statistical significance. This study was not adequately powered to detect any differences in clinical outcomes and may have reported non-significant outcomes that may be significant, a type II error (Whitley and Ball, 2002a). Within a larger study with greater power then these this type of errors can be reduced. A larger adequately powered trial examining the use of telemetry and its impact on the clinical benefits of mobility is required for definitive answers.

Women's satisfaction with different positions in labour is difficult to measure and reported less widely in the literature. Freedom to move during labour has been linked to increased feelings of control and satisfaction (Green and Baston, 2003) and upright positioning has been linked to reduced pain and increased satisfaction (De Jonge et al., 2004; Gupta et al., 2017). Women's satisfaction with different positons adopted in labour was not examined in this study, but the ability to be mobile when using telemetry was linked to increased control and this will be examined in further discussion.

7.2.3 Telemetry and its impact on control and satisfaction during labour

Findings from both phases of this study found that women who used telemetry during active labour felt more in control of their environment, of events during labour, and the way their body was instinctively able to respond to labour. Many studies have found control in labour to be an important factor in contributing to a woman's overall birth experience (Hodnett, 1989; Lavender et al., 1999; Green and Baston, 2003; Namey and Lyerly, 2010; Meyer, 2013). Lavender et al (1999) found that control was seen as a positive aspect of labour and Hodnett (1989) found that women who birthed at home had significantly higher levels of perceived control

during childbirth. Of relevance to this study, Hodnett found that freedom to ambulate was a major variable contributing to a conceptual model of control.

The concept of control however, has not been defined in the same way for each study or indeed for each women or the context that she births in. It is also contested that the sense of 'being in control' is also subjective (Green and Baston, 2003) and therefore difficult to define. Namey and Lyerly (2010) state that control 'is a complex and polysemous term' (p774). There have been many attempts to define and understand what control means for women during childbirth, the various concepts and phenomena that make up this definition, and how they relate to each other. Control is often examined in terms of '"external" control (control over what is 'done to' you, events and environment) and "internal" control (control over body and behaviour including emotions) (Green and Baston, 2003; Ford et al, 2009). Green and Baston (2003) considered three control outcomes and how they related to each other. These outcomes were 'feeling in control of what staff do to you, feeling in control of your own behaviour, and feeling in control during contractions' (p235). They concluded that pain in labour affects internal control and that being cared about affects external control. Namey and Lyerly (2010) analysed birth narratives to deconstruct the term control and report a concept analysis of its domains. A concept analysis 'is designed to clarify and refine concepts that are currently embedded in the literature by taking them apart, examining the pieces and putting them back together' (Meyer, 2013, p 219). Namey and Lyerly found that women's use of control corresponded to five distinct domains positively linked to birth: 'self-determination, respect, personal security, attachment, and/or knowledge' (p 774). The authors concluded that rather than focussing on control as an all-encompassing word the constitutive meanings would be more useful to maternity care. More recently, Meyer (2013) also reported a concept analysis of control in childbirth. The concept was developed following a literature review focused on the terms 'control' and 'childbirth'. Attributes of the concept were decision-making, access to information, personal security, and physical functioning. The decision-making attribute was defined by women having control over decisions around pain relief, decisions on place of birth and creating plans for birth. Women's sense of freedom was also included in the decision-making attribute.

Control in labour has also been shown to affect satisfaction in a wide variety of literature on control and satisfaction with childbirth. Much like control, satisfaction has been ill-defined in health literature but birth satisfaction refers to 'a woman's satisfaction with her birth experience throughout labour, birth and the immediate

postpartum period' (Fair and Morrison, 2012, p 28). McCrea and Wright (1999) found that feelings of personal control 'influenced positively the women's satisfaction with pain relief' (p 877). In their study Goodman et al (2004) found that when they examined the association of selected variables with childbirth satisfaction, personal control was a statistically significant predictor. Fair and Morrison (2012) examined the relationship between perceptions of antenatal control, expectations for birth and experienced control in labour. This study indicated that experienced control in the labour room was the only significant predictor of birth satisfaction. Similarly, Stevens (2012) found that perceived control explained more of the variance in satisfaction than other characteristics of birth such as duration of labour. Satisfaction with childbirth may also contribute to longer-term emotional wellbeing of women. Negative birth experiences may lead to post-natal depression or post-traumatic stress disorder and lack of control has been identified as associated with negative birth experiences and lower satisfaction (Waldenström et al., 2004; Henriksen et al., 2017).

The findings reporting in this study resonate with much of the literature and language on control and satisfaction. Use of telemetry was ascribed to increased feelings of control by the women interviewed and women who experienced telemetry for the majority of the time they had CEFM reported higher aggregate scores on the Perceived Control in Childbirth Scale. Control was described and defined in different ways during the interviews. Women expressed that telemetry influenced external control, in that they felt more involved with decision-making and procedures being done. Women felt less like a patient when mobilising with telemetry, more an active participant in labour, and less that things were being 'done to' them. The women's ability to access equipment within the birthing environment and increased physical and emotional support from partners that telemetry conferred also influenced external control. Internal control was influenced in a positive way by telemetry in that women were able to adopt different positions during labour, they were freer, and for some women this led to a perceived ability to cope with pain and avoid unnecessary interventions. Women also reported increased feelings of autonomy, dignity, self-determination and agency when using telemetry during labour and conviction in their ability to labour and give birth when able to be mobile. The ability to perform basic bodily functions independently also affected the control that women felt during labour.

The aspects of control that women reported in the interviews align well with the concept analysis of control in childbirth reported by Namey and Lyerly (2010). When

women used telemetry during labour there was potential influence on all five of the domains positively linked to birth and defined and described in the concept analysis. The five domains and definitions are outlined in Table 29, along with the potential influence that telemetry had on each of the domains.

Domain and definition (adapted from Namey and Lyerly, 2010)	Influence of Telemetry on Domain
Self-determination	
The ability to have a birth that is shaped and guided by one's own inclinations and values rather than those of others. Encompasses notions of authority, decision-making, agency and presence. Control of bodies and what happened to them, pain management, the environment, events of labour. "In control of" or "Having control over" one's birth. Meaningful access to options or choices. Agency – the woman as "the birther", the primary agent of her child's birth.	Facilitates women to mobilise and labour and birth in response to their body's signals. Facilitates women to have the active birth that they may desire. Increases feelings of personal autonomy and agency. Enables women to control the environment including access to equipment and lighting/temperature. Influences perceived ability to cope with pain and perception of interventions being minimised. Increases monitoring options and choice for women with more complex labours. Feel less like a 'patient' and less 'being done to'
Respect	
Self-respect or dignity. Respect for her of those attending the birth. "Maintaining control" – not acting in ways that women felt would later compromise their feelings of dignity.	Increased feelings of dignity particularly in relation to using the bathroom. Feel more an active participant in birth. Ability to respond to physiological needs during labour including adoption of birth positions that maintain dignity.
Personal security	
Feelings of physical safety and emotional and psychological attributes of security such as comfort and confidence in one's surroundings. Order or management of birth experience "under control". Minimisation of anxiety or fear.	Enables access to birthing equipment in the room such as birthing balls, mats and pools. Increases feelings around having ownership of the room which leads to physical safety. Increases partner support, both physical and emotional, and minimises anxiety.

Attachment	
Emotional closeness, sense of connectedness to other people involved in the birthing event.	Increases attachment with birth partners and communication with midwives and other health professionals.
Trust in others.	Working as a team develops trust in health professionals.
Knowledge	
Access to information, understanding, intuition, familiarity with physical and psychological aspects of birth.	Use of telemetry aligns with knowledge around how being mobile and upright can positively influence labour.

Table 33: The influence of telemetry on the domains within a concept analysis of control in childbirth

The increased control expressed by women and resulting PCCh scores did not translate into higher aggregate scores for the Satisfaction with Childbirth scores which is not in line with the majority of literature on control which indicates that this is a major predictor of satisfaction. However all of the women interviewed for the study described a satisfaction with their labour experience and the use of telemetry, particularly if it was compared to a previous labour with conventional wired monitoring.

7.2.4 Telemetry and its impact on normality, dignity and human rights.

7.2.4.1 Scope of the midwife and normal birth

The international Confederation of Midwives (ICM) defines the scope of a midwife:

> "*The midwife is recognised as a responsible and accountable professional who works in partnership with women to give the necessary support, care and advice during pregnancy, labour and the postpartum period, to conduct births on the midwife's own responsibility and to provide care for the newborn and the infant. This care includes preventative measures,* ***the promotion of normal birth****, the detection of complications in mother and child, the accessing of medical care or other appropriate assistance and the carrying out of emergency measures" (www.internationalmidwives.org).*

It is clear that the promotion of normal birth, protection of physiology and minimising intervention is an integral part of a midwife's role in supporting women in labour. Normal birth matters as it is best for mothers and babies in both physical and

psychological terms (Dahlberg et al., 2016) . The use of the term 'normal birth' has been vilified however in some areas of the media in the last two years, in response to the Royal College of Midwives replacing their *Normal Birth Campaign* with the *Better Births Initiative*. Social media also played a part in this campaign against midwives and Dahlen (2017) noted in a guest editorial "highly emotive terms like 'the cult' of midwifery and the 'ideology of vaginal birth' continued to erroneously conflate the issues of normal birth.' (p 351). Various definitions of what 'normal birth' is has also clouded the waters. Some definitions describe normal birth in terms of what it is; spontaneous onset of labour at term, low risk at the beginning and throughout, spontaneous vaginal birth of the baby and the mother and baby in good condition throughout (World Health Organisation, 1997). Other definitions describe what it isn't; without induction of labour, augmentation or use of epidural or spinal anaesthetic (Gould, 2000; Scamell and Alaszewski, 2012) and there is a wide variety of literature focused on normal birth and the wide continuum it inhabits. Even midwives, the champions and protectors of normality find it difficult to define (Davis, 2010; Scamell and Alaszewski, 2012). Davis (2010) perhaps provides the most sound observation, and one that resonates with the researcher, that 'the concept of normalcy emerged from statistical science, and to assert that childbirth is normal is to generalise population-based parameters and descriptors to the experience of a unique labouring woman' (p 214). Davis (2010) then observes that by narrowly defining normal birth this may disadvantage women's experience if they then have a birth that is outside of the construction of normalcy.

7.2.4.2 Increasing intervention

The number of women going into spontaneous labour at term and having a normal vaginal birth without assistance is decreasing year on year in the UK (Office for National Statistics, 2017). A recent report found that the number of women having their first baby without intervention (spontaneous onset, progression and birth, without epidural/spinal/general anaesthesia or episiotomy) was 23.5% (NMPA Project Team, 2019). There is a paradox within the maternity world where normal birth is valued and low-risk healthy women are advised to birth in midwifery-led settings, where the chances of having a minimal intervention, normal birth are greater (Brocklehurst et al., 2012). This is becoming less common and more difficult to achieve. Recent data shows that the vast majority of women (81%) are giving birth in obstetric-led maternity units irrespective of their risk stratification (NMPA Project Team, 2019).

The majority of women in this study were having an induction of labour for maternal or fetal indications and were recommended to labour and birth on an obstetric-led maternity unit. More common reasons for induction of labour are; fetal growth restriction, hypertension, a large fetus, reduced fetal movements and maternal disease such as diabetes or cardiac disease. The rates of induction at the maternity units included in this study were around 34 - 40% and reflect the national increase in induction of labour rates (Office for National Statistics, 2017) . The reasons for this increase are many and varied but reflect an increased focus on reduction in perinatal death and morbidity. The Saving Babies Lives Care Bundle (NHS England, 2016), introduced to reduce rates of stillbirth, include both increasing detection rates of fetal growth restriction and raising awareness of reduced fetal movements as priorities and may have influenced induction of labour rates. The increasing complexity of the maternity population may also be playing a part. Induction of labour also reflects the rising pathologisation and medicalisation of birth, escalating use of technology and surveillance, and a steady move over the twentieth century from a social model of care to a risk-centric medical model of care (Gould, 2000; MacKenzie et al, 2010; Scamell and Alaszewski, 2012; Page, 2016; Newnham et al, 2017). Scamell and Alaszewski state: 'there has been an apparent relentless expansion of 'the birth machine' whereby birth is increasingly defined through the medicalised practices of intensive surveillance and technocratic intervention' (p 207). This was reflected in some of the interviews with midwives who described the maternity unit Beach as a 'factory', highly medicalised and difficult to provide personalised care in. All women will need, and have, a midwife with them when they are in labour in the UK but the rising risk culture, increasing use of technology, surveillance and intervention in childbirth has placed midwives and midwifery philosophy in a difficult, challenging and peripheral position (Scamell and Alaszewski, 2012; Healy et al., 2017). Over medicalisation has also contributed to rising rates of caesarean section in high-income countries (Boerma et al., 2018; Sandall et al., 2018) and has been identified as a threat to dignity for women (Morad et al., 2013).

7.2.4.3 Normality, dignity and human rights in an obstetric-led setting

The great paradox that exists between increased intervention to reduce perinatal mortality versus the evidence-based benefits of midwifery 'interventions' such as continuity of care and birth in midwifery-led settings is one set to challenge midwifery and medical leaders, researchers and policy makers in the future. The consideration of experience and not viewing the 'taking home of a healthy baby as

all that matters' is a crucial area for investigation also. Increasing the numbers of women birthing in midwifery-led settings should be a priority but perhaps one of the questions that we should *also* be asking is: how can we improve promotion of normality, physiology and positive birth experience for *all* women, irrespective of risk, in *all* settings? In their qualitative meta-synthesis of what matters to women for labour and birth Downe et al (2018) found that most women wish to birth 'normally' but that 'even when intervention is needed or wanted, women usually wish to retain a sense of personal achievement and control by being involved in decision-making'.

Women and midwives in this study used the term 'normal' and 'normalise' frequently even though they were providing, or receiving care in obstetric-led 'high-risk' settings. Midwives felt that telemetry could contribute to 'normalising' a woman's labour, and rather than a woman lying on a bed in a patient role she could move around much like a woman in 'normal' labour would do. The focus on technology was minimised when women were using telemetry and women felt more like themselves. Women spoke of being able to do 'normal' things like get personal items from bags and use the bathroom without assistance or supervision and this engendered a sense of de-medicalisation despite labours that had been induced or were being augmented. Women also expressed that they felt involved in decision-making and the quantitative data suggested that women who used telemetry for the majority of their labour felt able to influence procedures they were receiving and that what they said made a difference. Bodily dignity was a crucial element in the interviews with women, and telemetry was seen to facilitate this. In the Dignity in Childbirth Survey (Birthrights, 2013) women who were labelled high risk were perceived to be less likely to receive care that upheld their dignity. Control over women's private space, such as the bathroom, when using telemetry contributed to increased feelings of dignity in labour. When women used telemetry during labour the benefits were not only physical but psychological, both for the women and the midwives. The researcher contends that the use of telemetry during labour contributes to what women want in labour by facilitating greater freedom and mobility, and subsequent feelings of control, active participation, dignity and normality. This is crucial for the experiences of women giving birth in obstetric-led settings within the context of increasing intervention and medicalisation.

The impact that telemetry has on dignity, agency, autonomy and control links intrinsically with the subject of human rights in childbirth. Human rights 'protect dignity and promote equality' and are protected by the Universal Declaration of Human Rights (UDHR) (United Nations, 1948). Many health care practitioners and

midwives may view the protection of human rights during childbirth as something more aligned with care in low and middle-income settings. Hill (2019) states however, 'the notion that the violation of women's rights in childbirth is something that happens 'elsewhere' and not in the privileged 'developed' world, is all too prevalent' (p 286). When considering accounts of women (from both the literature and from interviews for this thesis) who have experienced conventional continuous electronic fetal monitoring, then terms used such as 'mechanical medicalisation/monster', 'restriction' and the ubiquitous 'being strapped or tied to the bed' very much bring the protection of human rights to the forefront of discussion. Central also to human rights is the issue of consent. Increasing intervention and medicalisation of childbirth has resulted in some care that women receive very much routinised within protocols and done without consent. The use of conventional wired CEFM is one such routine with women nearly always cared for on a bed without this being posed as a choice. Findings from this study show that the use of telemetry during labour can contribute vastly to upholding many of the underlying premises of human rights; namely dignity, respect and autonomy and align with the concepts of humanising birth and respectful care. When viewing care in labour and birth through a human rights lens then the benefits of telemetry for women in labour become hugely powerful.

7.2.5 The impact of maternity unit culture and environment on the use of telemetry

A surprising finding from the qualitative phase of this study was the difference in maternity cultures between the two units that were used for recruitment and the influence that this had on the use of telemetry. One of the units was chosen as the researcher had worked there and knew the unit well and was aware that they used telemetry. The second maternity unit was chosen as the researcher was made aware that the unit had recently purchased more telemetry and were wanting to use it more. Being present in each of the units and speaking to and interviewing women and midwives highlighted major differences in the units and the impact that these differences potentially had on the use of telemetry and how it was viewed.

Hammond and Foureur (2019) note that 'organisational culture is both constructed and reflected by modern birth rooms and the activities and behaviours that occur within them' (p 187). The second and smaller unit, Forest, viewed telemetry as part of a 'package of care' for the women who were in labour and birthed there. Environmental changes had been made but this went hand-in-hand with a

philosophy of care that was focused on ensuring that women requiring more complex care were able to labour and birth in calm, quiet spaces that facilitated mobility with telemetry, increased the potential for physiology, and promoted normality. Telemetry was used for the majority of women requiring CEFM. The birthing environment at Forest aligned with the concept of 'sanctum' outlined by Fahy and Parratt (2006) in their Birth Territory theory. A 'sanctum' is defined as 'a homely environment designed to optimise privacy, ease and comfort of the women…it protects and potentially enhances the women's embodied sense of self' (p 46). The larger unit Beach viewed telemetry as an add-on option for women, and was mostly used for those women who requested it and promoted by a minority of midwives who valued the benefits it could give to women. The birthing environment at Beach was clinical and minimal effort had been made by staff to make the birthing rooms more inviting and calming for the women. These rooms were more like a 'surveillance room', a 'clinical environment designed to facilitate surveillance of the women and optimise the ease and comfort of the staff' (Fahy and Parratt, 2006, p 46').

In a theoretical sense Forest could be viewed as having adopted a more social model of care philosophy and Beach a more medical model. A social model of care views birth as a normal physiological event where experience is as important as outcome, it is community and family oriented, the environment is central, care is women centred and the woman feels in control of the experience (Walsh and Newburn, 2002; MacKenzie Bryers and van Teijlingen, 2010). A medical model of care views birth as only normal after the event, it is interventionist, paternalistic, hospital and profession-led with staff in control of the birth, and the environment is peripheral (Walsh and Newburn, 2002; MacKenzie Bryers and van Teijlingen, 2010). It is acknowledged that there is a continuum between the models and that maternity care professionals, or indeed most women, may not all necessarily sit at either end of the continuum (with the assumption that obstetricians adhere to the medical model and midwives to the social model). Indeed there will be some midwives that practice very much within a medical model within large obstetric-led units where 'the environment is geared towards a medical risk approach' (MacKenzie Bryers and van Teijlingen, 2010, p 494).

It is acknowledged that not every member of staff in each of the units that were in this study viewed birth in these dichotomous terms and the researcher did speak to midwives from Beach that wished to practice in a more social model of care. It was apparent however, that the dominant discourse of risk within Beach had influence

over how birth was viewed, and how the issue of environment and increasing choice and experience, such as facilitating mobility with telemetry, was not given priority. The issues observed and discussed with midwives and women about environment and maternity unit culture and how telemetry merged or clashed with this are areas that could be explored in further research.

7.2.6 Reflexivity

As outlined within Chapter Four it is important to maintain a reflexive stance throughout any research project. This includes acknowledging previous experience in both a personal and professional capacity that may have an impact on any pre-existing assumptions, and ensure authenticity of the work. My clinical experience includes being self-employed as an independent midwife in New Zealand and working in two of the busiest maternity units within the UK, caring for both low and high-risk women. This background and experience has enabled me to reach a deep understanding of the data and implications for practice for midwives. At the core of my midwifery practice is a deep belief that childbirth is a profound primal life event that can have a huge impact on both mother and baby. The protection and promotion of normal childbirth and physiology is crucial for societal health and wellbeing, as is ensuring that women receive the highest quality care and experience, not matter what their risk or needs are. These beliefs, along with personal experience of having two active normal births, were acknowledged as having an impact on the study. However, having worked in obstetric-led settings and cared for women where intervention was needed this also ensured that my view of childbirth is very pragmatic and acknowledges that not all women will experience normal physiological birth. I entered the study with the view that telemetry must be the best way to monitor the fetal heart in labour and why wasn't everybody using it? By adopting a reflexive stance, this enabled all viewpoints (both positive and negative) on telemetry to be listened to and considered and challenge some of my pre-existing views. Recruiting from two different sites, including one that I had previously worked in, enabled the cultures of both units to be examined and viewed through a reflexive and critical lens which added strength to the study.

This Chapter has presented an integration of the findings from the qualitative and quantitative phases of the study and showed that the use of telemetry had a positive impact on the amount of control that women experienced during labour and birth. This control was manifested in jurisdiction over the birthing room and what was

happening during labour. Telemetry increased mobility in labour for women and they were more likely to be in positons off the bed for labour and give birth in more upright positions which have a positive effect on physiology. Telemetry also had a positive impact on issues around normality and dignity in obstetric-led settings. The different maternity unit environments and cultures had an influence on the how telemetry was used and viewed and this is an area for exploration.

Humanised birth has been described as 'putting the woman giving birth in the centre and in control' (Wagner, 2001). Humanised birth also means recognising the benefits of modern technology and medicine without losing sight of the women's experience and physiological capability. Writing over 30 years ago Michel Odent (Odent, 1986) discussed how moving the bed away from the centre of the room encouraged and gave permission for women to behave instinctively during labour. Perhaps by removing the wires from conventional monitoring telemetry this has the power to hand back control to women and be one piece in the puzzle towards humanising birth for all, not matter what the risk or setting.

Chapter Eight: Conclusions

This Chapter will present strengths and limitations of the study, discuss the unique contribution that this study has made to midwifery knowledge and make recommendations for practice, policy, education and future research. A personal reflection on the research journey is also given.

8.2.1 Strengths of the study

This study is unique and the only study that has explored the use of modern telemetry within maternity units in the UK. The mixed methods approach gave strength to the findings of both the quantitative and the qualitative phases of the study and has given an understanding of how telemetry impacts the experience and outcomes of women giving birth in obstetric-led units who require CEFM. It is also unique in giving a voice to midwives and partners on their experiences of the use of telemetry. The nature of qualitative inquiry and the small numbers in the qualitative interviews may not lead to broad generalisations, but the insights and findings may be relevant to many women and birthing units up and down the country who use telemetry. Given that the quantitative findings echoed some of the qualitative findings this increases the generalisability of the study. Using two different sites for recruitment also gives strength to the study as women from each site expressed similarities in their experiences of telemetry.

Each phase of the study followed a systematic and transparent process of recruitment, data collection and analysis which also leads to credibility of the study. As this study was part of a doctoral degree and training programme this meant that the researchers initial thoughts and ideas about undertaking research on telemetry (almost 5 years ago) were able to be followed through from beginning to end. This meant developing and writing the initial application for NIHR funding through to designing and conducting the research herself and writing this thesis. The researcher was immersed in the study right from the beginning and has meant being close to the data and presenting findings that are relevant and useful to the midwifery profession and women. Having a highly experienced supervision team, who were involved from the initial NIHR application, also adds strength to the work. Their wealth of knowledge ensured that the researcher was challenged and justified decisions to the research team throughout the process. The research has produced

some unexpected findings particularly around dignity and the cultures of maternity units and these are areas, along with the impact on clinical outcomes, that may be able to be pursued and inform future pieces of research.

Charmaz (2014) outlines criteria for grounded theory studies; credibility, originality, resonance and usefulness. The researcher argues that these themes could be applied to this mixed method study as well. The study has achieved 'intimate familiarity' (p 337) with the topic, has offered new and deeper insights into the use of telemetry and offered interpretations and analysis that women and midwives can use in the birth world.

8.2.2 Limitations of the study

There are several limitations to this study which will be addressed. The study recruited from two NHS Trusts in the Northwest of England and therefore may not be applicable or transferable to other maternity units within the UK. Each maternity unit is unique and has slightly different cultures, processes and guidelines for caring for women who need CEFM in labour. However, maternity units also have many similarities and it is thought that some of the findings will be transferable and relatable for other units and midwives.

The overall sample did not include women who did not speak or understand English. This meant that these women were excluded from the study and may have different experiences from other women who speak English. Within the qualitative interviews, all but two women were white, of British Origin and the majority educated to a professional level. All of the women were over 25 years of age. This may have introduced some bias into the sample as this group of women may be highly motivated to achieve active normal births and have sought out telemetry to contribute to this. Younger women and non-white British women did complete consent to contact forms but were not able to be contacted to be interviewed or declined to be interviewed. This is an inherent problem within healthcare research in the UK and strategies to specifically look at increasing involvement of BAME groups in health research is needed (Smart and Harrison, 2017).

The difference in telemetry use at each site resulted in more women being recruited from 'Forest' than 'Beach' for the telemetry group for the quantitative study. As 'Beach' used telemetry far less frequently than 'Forest' this also may have meant that the women who did use telemetry from 'Beach' were more likely to have asked for it following a discussion about the study from the researcher. These women may

therefore have been more likely to desire to be mobile in labour and report positive benefits of telemetry. There may have also been a Hawthorne effect (Bowling, 2014) at 'Beach' where telemetry was used more frequently only because there was a research study happening and women were being recruited and asking to use it. The quantitative cohort was also not powered to detect differences in any of the clinical outcomes and was an observational study so any differences seen in the outcomes for the quantitative arm may have been the result of other factors such as parity or site. Regression analysis is one way of adjusting for these confounders but the main outcome measure, control, is an ordinal outcome and therefore would make regression more complicated. Examination of the data and statistical advice led to the conclusion that it is unlikely that adjusting for confounders would have made a big difference in the findings.

The study could have been strengthened by altering the design from a convergent parallel one to an exploratory sequential mixed methods design. This would have resulted in the qualitative phase being conducted in full and any findings from the analysis built into and tested in the quantitative phase. Questions around dignity and the birth environment could have been one area to explore in the quantitative phase and could have been incorporated into the questionnaire. Time and ethical constraints prevented this design from being enacted. The initial protocol and ethics approvals for the study also included undertaking observations of women in labour using telemetry in the qualitative phase. This would have also strengthened they study in terms of triangulating what the women and midwives expressed in the interviews about telemetry and what was actually observed and heard in labour. Time and recruitment issues also prevented these from being undertaken. The perspectives of obstetricians would have also been valuable to include but were not included as a group in the initial protocol or ethics approvals. The perspectives of partners were valuable and it would have also strengthened the study to have more of their perspectives along with interviews with women who had used the pool in labour. Both qualitative and quantitative data revealed that the numbers of women that used a birthing pool in labour were small and this was reflected in difficulty in recruiting women to be interviewed that used the pool.

The collection of data on mobility in labour was more difficult than anticipated and resulted in small numbers for the wired group. Data collection was originally to be done by midwives and partners but this proved unsuccessful and data were thereafter collected from the clinical notes. This is another area that could have been strengthened by observations of women using telemetry in labour.

This study has explored the use of telemetry to monitor the fetal heart in labour in two maternity units in the Northwest of England. The majority of maternity units in the UK have some form of telemetry for women to use in labour but prior to this study very little was known about the implications for its use or any impact its use may have for women and their labour and birth experience. The aims and objectives set out at the beginning of the study have been met. It has gained in-depth knowledge on the experiences of both women and midwives using telemetry and integrated these findings with quantitative data investigating control and satisfaction and clinical outcomes including mobility. The study is unique in being the only study to interrogate telemetry used within the UK within the last 16 years and the findings of this study provide an evidence-base for its use.

The main summary findings and implications are set out below:

- Women interviewed found telemetry to be a positive experience and superior to conventional wired monitoring.
- Telemetry was found to facilitate increased mobility in labour for women. Women were able to adopt different positions in labour and give birth in more upright positions. Women were also able to use the pool with telemetry.
- The use of telemetry to monitor the fetal heart in labour engendered a sense of normality for women. This was manifested in perceptions of a birth that was more normal, less medicalised and of being able to do more normal activities such as use the bathroom independently during labour. This led to increased feelings of dignity in labour.
- The use of telemetry contributed to increased feelings of control over the birth environment, control over what was happening during labour and control over levels of pain relief and intervention. Telemetry had a positive impact on the domains of self-determination, respect, personal security, attachment and knowledge described in a concept analysis of control in childbirth.
- Midwives echoed many of the sentiments expressed by the women about telemetry; that it facilitated mobility, increased control and dignity. Midwives

also found that they were drawing on different midwifery skills when caring for women using telemetry.

- There were some issues identified with the quality of recording with some telemetry and midwives found ways to improve the quality.
- Telemetry was used more frequently when it was viewed as part of a package of care that contributed to equity of experience for women requiring care in an obstetric-led setting. This package of care also incorporated environmental additions such as dark, quiet rooms and the option of water for pain relief.
- The use of telemetry when continuous monitoring of the fetal heart is recommended positively impacts on the experience of women having care in an obstetric-led setting.

8.4.1 Practice

- The benefits of using telemetry to monitor the fetal heart in labour are now more widely understood and maternity units should continue to purchase and use telemetry for use when women require CEFM.
- If maternity units are considering the purchase of telemetry they should undertake trials of the different types of telemetry available to determine which is best suited to them.
- The different ways of monitoring the fetal heart during labour should be discussed with women in the antenatal period and this should include Pinard stethoscope, Doppler, CEFM with conventional wired monitoring and telemetry. The risks, benefits, advantages and disadvantages of each type of method of monitoring the fetal heart should be discussed with women.
- If the maternity unit has telemetry, and it is available, then the benefits of telemetry should be discussed with women who require CEFM of the fetal heart in labour and women should be given the option to use it.

8.4.2 Policy

- Current national policy (NICE, 2014) recommends that all women who require CEFM of the fetal heart in labour should be offered telemetry. This recommendation should continue and when this guideline is updated the recommendation can be strengthened with this research.

8.4.3 Education

- Midwives working within maternity units with telemetry should be shown how to use the machines and how to trouble-shoot problems.
- Student midwives should experience caring for women in labour using telemetry

8.4.4 Future research

- A large randomised controlled trial of telemetry versus conventional monitoring should be conducted and powered to determine if the use of telemetry has any impact on clinical outcomes in labour such as use of pain relief, length of labour, and mode of birth. This may be more difficult to undertake as more units purchase and use telemetry and would need to be undertaken in maternity units where telemetry was used only as part of a trial. A health economic evaluation should be included as part of any trial to ensure that cost/benefit analysis is understood.
- Research should be undertaken on the different types of telemetry available to maternity units and advantages and disadvantages of each.
- Future research should be undertaken on the impact of the birth environment on labour outcomes, control and satisfaction in labour for women who require CEFM in labour. Telemetry as part of a 'package of care' that includes a more home-like environment for women who require a more complex level of care should be explored.
- The culture of obstetric-led maternity units should be explored and the effects that different cultures and the changing nature of maternity work has on midwives and women's experiences determined. Ethnographic work at several maternity units could be undertaken to explore this further.

Given the personal nature of this section it is written in the first person.

I feel incredibly fortunate to have had the experience of undertaking a PhD, and particularly one that has been funded through the NIHR. I have found the last three years incredibly challenging but also hugely enjoyable. I have enjoyed taking a step away from clinical midwifery and management and immersing myself in the academic world. I have met some amazing people along the way and opened up new networks and opportunities. It has also been such a privilege to experience and

learn from the vast talent of my supervisory team. I have valued highly learning about both quantitative and qualitative methodologies and dipping my toe into mixed methods. The training offered by the University and further afield has contributed to this and my progress as a researcher.

One of the major challenges I faced, which I am sure is not unique, is recruiting for the study. This was particularly challenging for the quantitative phase as one of the sites was almost ninety minutes away and I quickly learnt that the recruitment was going to be all down to me going there every day. I also learnt a lot about the difference in recruiting from a site that you are familiar with and known in, and one you are an outsider. There are certainly things that I would have done differently on reflection. Some are small, such as including an option for women to leave contact details if they wished to be involved as part of a PPI group. Other bigger changes, such as undertaking an exploratory sequential study, and undertaking observations, probably required more time and were unrealistic for a PhD study. These were all valuable lessons I will take forward in my research career.

My future plans include publishing findings from this study in peer-reviewed journals, continuing my research career journey and working out how to be a clinical academic! To undertake my own research and be given the opportunity to answer important clinical questions for women is an incredible opportunity and I hope to have done it justice.

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Appendices

1. Hawker's Quality appraisal tool

Subject area	Evaluation & scoring criteria [Good=4 ; Fair =3 ; Poor=2 ; Very poor=1]
1. Abstract and title	**Did they provide a clear description of the study?** Good Structured abstract with full information and clear title. Fair Abstract with most of the information and clear title. Poor Inadequate abstract. Very Poor No abstract.
2. Introduction and aims	**Was there a good background and clear assessment of the aims of the research?** Good Full but concise background to discussion/study containing up-to date literature review and highlighting gaps in knowledge. Clear statement of aim AND objectives including research questions. Fair Some background and literature review. Research questions outlined. Poor Some background but no aim/ objectives/questions, OR Aims/ objectives but inadequate background. Very Poor No mention of aims/objectives. No background or literature review.
3. Methods and data	**Is the method appropriate and clearly explained?** Good Method is appropriate and described clearly (e.g. questionnaires included). Clear details of the data collection and recording. Fair Method appropriate, description could be better. Data described. Poor Questionable whether method is appropriate. Method described inadequately Very Poor No mention of method, AND/OR Method inappropriate, AND/OR No details of data.
4. Sampling	**Was the sampling strategy appropriate to address the aims?** Good Details (age/ race/ gender/ context) of who was studied and how they were recruited. Why this group was targeted. The sample size was justified for the study. Response rates shown and explained. Fair Sample size justified. Most information given, but few descriptive details. Poor Sampling mentioned but few descriptive details. Very Poor No details of sample.
5. Data analysis	**Was the description of the data analysis sufficiently rigorous?** Good Clear description of how analysis was done. Qualitative studies: Description of how themes derived/

	respondent validation or triangulation. Quantitative studies: Reasons for tests selected hypothesis driven/ numbers add up/ statistical significance discussed. Fair Qualitative: Descriptive discussion of analysis. Quantitative. Poor Minimal details about analysis. Very Poor No discussion of analysis.
6. Ethics and Bias	**Have ethical issues been addressed, and what has necessary ethical approval gained? Has the relationship between researchers and participants been adequately considered?** Good Ethics: here necessary issues or confidentiality, sensitivity, and consent were addressed. Bias: Researcher was reflexive and/or aware of own bias. Fair Lip service was paid to above (i.e. these issues were acknowledged). Poor Brief mention of issues. Very Poor No mention of issues
7. Results	**Is there a clear statement of the findings?** Good Findings explicit, easy to understand, and in logical progression. Tables, if present, are explained in text. Results relate directly to aims. Sufficient data are presented to support findings. Fair Findings mentioned but more explanation could be given. Data presented relate directly to results. Poor Findings presented haphazardly, not explained, and do not progress logically from results Very Poor Findings not mentioned or do not relate to aims.
8. Transferability or generalisability	**Are the findings of this study transferable (generalizable) to a wider population?** Good Context and setting of the study is described sufficiently to allow comparison with other contexts and settings, plus high score in Question 4 (sampling) Fair Some context and setting described, but more needed to replicate or compare the study with the others, PLUS fair score or higher in Question 4. Poor Minimal description of context/setting. Very Poor No description of context/setting.
9. Implications and usefulness	**How important are these findings to policy and practice?** Good Contributes something new and/ or different in terms of understanding /insight or perspective. Suggests ideas for further research. Suggests implications for policy and/ or practice.

	Fair Two of the above (state what is missing in comments). Poor Only one of the above. Very Poor None of the above.

2. Table of excluded papers for literature review of women's views and experiences of fetal monitoring

	Full reference	Reason for exclusion
1.	Jackson, J. E., Vaughan, M., Black, P., D'souza, S.L.W. (1983). Psychological aspects of fetal monitoring: maternal reaction to the position of the monitor and staff behaviour. *Journal of Psychomatic Obstetrics and Gynaecology* 2(2), pp 97-102.	Full text not available
2.	Morgan, B., Bulpitt, C. J., Clifton, P., Lewis, P.J. (1984). The consumers' attitude to obstetric care. *British Journal of Obstetrics and Gynaecology* 91, pp 624-628.	Minimal information on monitoring
3.	Kruse, J. (1984). Long term reactions of women to electronic fetal monitoring during labour. *Journal of Family Practice* 18(4), pp 543-548.	Full text not available
4.	Killien, M., G., Shy, K. (1989). A randomized Trial of electronic Fetal Monitoring in Preterm Labour: Mother's Views. *Birth* 16(1), pp 7-12.	Pre-term
5..	Luthy, D. A., Kirkwood, K.S., Van Belle, G., Larson, J.P., Hughes, T. J., Benedetti, Z.A., Brown, Z. A., Effer, S., King, J.F., Stenchever, M.A. (1989). A randomized trial of electronic fetal monitoring in pre-term labour. *Obstetrical and Gynecological Survey* 42(10), pp 618-619.	Not primarily focussed on fetal monitoring views and experience, pre-term
6..	Arikan, G.M., Haeusler, M.C., Deutsch, M.T., Greimel, E.R., Dorfer, M. (1998). Maternal perceptions of labor with fetal monitoring by pulse oximetry in a research setting. *Birth 25(3),* pp 182-189.	Pulse oximetry

7.	Hundley, V., Ryan, M., Graham, W. (2001). Assessing women's preferences for intrapartum care. *Birth* 28(4), pp 254-262.	Not primarily focussed on fetal monitoring views and experience
8.	O'Cathain, A., Thomas, K., Walters, S. J., Nicholl, J., Kirham, M. (2002). Women's perceptions of informed choice in maternity care. *Midwifery* 18, pp 136-144.	Not primarily focussed on fetal monitoring views and experience
9.	East, C.E., Chan, F. Y., Brennecke, S. P., King, J.F., Colditz, P. B. (2006). Women's evaluations of their experience in a multicentre randomized controlled trail of intrapartum fetal pulse oximetry (The FOREMOST Trial). *Birth* 33(2), pp 101-109.	Comparing pulse oximetry with CEEFM.
10.	Albers, L. L. (2007). The evidence for physiologic management of the active phase of the first stage of labour. *Journal of Midwifery and Women's Health* 52(3), pp 207-215.	Not primarily focussed on fetal monitoring views and experience
11.	Tillet, J. (2007). Intermittent auscultation of the fetal heartbeat: can nurses change the culture of technology? *Journal of Perinatal and Neonatal Nursing* 21(2), 80-82.	Not primarily focussed on fetal monitoring views and experience
12.	Mancuso, A., Di Vivo, A., Fanara, G., Denaro, A., Lagana, D., Accardo, M.F. (2008). Effects of antepartum electronic fetal monitoring on maternal emotional state. *Acta Obstetrica et Gynecologica* 87, pp 184-189.	Antenatal not labour
13.	Montague, E. N. H., Winchester, W., W., Kleiner, B. M. (2010). Trust in medical technology by patients and healthcare providers in obstetric work systems. *Behaviour and Information Technology* 29(5), pp 541-554.	Not primarily focussed on fetal monitoring views and experience
14..	Parisaei, M., Harrington, K.F., Erskine, K.J. (2011). Maternal Satisfaction and acceptability of foetal electrocardiographic (STAN) monitoring system. *Archives of Gynecology and Obstetrics* 283, pp 31-35.	STAN not conventional EFM
15..	Kelly, G., Hauck, Y.L., Bayes, S. (2013). Women's perceptions of contributory factors for not achieving a vaginal birth after caesarean (VBAC). *International Journal of Childbirth* 3(2), 106-116.	Not available
16.	Nilsson, C. (2014). The delivery room: is it a safe place? A hermeneutic analysis of women's negative birth experiences. *Sexual and reproductive Healthcare* 5, pp 199-204.	Not primarily focussed on fetal monitoring views and experience
17.	Wickham, S. (2016). Thinking outside the box: Midwives matter more than monitors. *The*	Commentary

Practising Midwife 19(5), pp 36-37.

3. Critical Appraisal and scoring for literature review of women's views and experiences of fetal monitoring

Study details (1.)	Aims/objectives	Participants	Data collection	Analysis	Quality Score (Hawker, 2002).
Full reference Starkman, M. 1976. Psychological responses to the use of the fetal monitor during labor. *Psychosomatic Medicine,* 38 (4): 269-77 **Country** America **Study Type** Prospective observational **Study design** Structured interviews **Setting/context** Large university medical centre,	To gain insight into the psychological effects of new monitoring technology. Emphasis on effect of monitor on maternal anxiety and on total experience of childbirth	**Sampling strategy and size** 25 women, Permission of obstetrician sought first and then woman's name placed on a list to be interviewed. **Characteristics** 15 primigravidas, 10 multigravidas. Mostly current or prior pregnancy difficulties including previous loss and LSCS	Interviewed post-natally. More likely to be interviewed if have LSCS as stayed in hospital longer. Demographic information followed by questions on general reaction to monitor, antenatal information about monitoring, concerns about labour and delivery before monitor introduced, if an explanation was given by staff about monitor use, describe feelings about monitor, effect of monitor on interactions with husband and physicians. Reactions to the monitor was scored as 'strongly positive', 'moderately positive',	Likelihood of a relationship between a positive or negative reaction to monitor and each of the demographic variables (except age) was tested by placing data into a series of 2x2 tables and using Fisher Exact Probabilities test. Student's t=test was used to assess difference in mean age between positive and negative responders to monitors.	20

private and public patients			'weakly positive', 'negative', 'moderately negative'		
Summary of findings	**The fetal monitor as protector** – ability to control the doctor, tell when examinations needed, magical powers **The monitor as extension of the patient** – give information about contractions when women couldn't feel them **The monitor as an aid to communication** – give information about the labour without talking **The monitor as an extension of the baby** – monitor trustworthy source of baby wellbeing **The monitor affecting interactions with husband** – positive (alerting women to contractions, increased involvement, sharing experience), negative (had to leave room when monitor showed distress) **The monitor as a distraction** **The monitor as an aid in mastery** - could tell women when contractions were over **Competitive feelings toward the monitor** – jealousy, physicians and husbands look at monitor more **The fetal monitor as a mechanical monster** - increased physical discomfort, wires dangling between legs, enforced immobility lying still on back, mechanical difficulties with the equipment resulting in more people in room and lost privacy, fear of sounds emitted by machine **The monitor producing increased anxiety** - injury to baby from scalp electrode, FH output noise, frightened when heard FH rate slow, **Overall 14 positive responses, 10 negative responses, 1 no response.** **P<0.01 for positive response if previous prior pregnancy loss.**				
Further comments and overall evaluation	No mention of ethics or consent. No mention of whether interviews were transcribed, read by another author. Despite discussion using statistical tests to assess relationships between variables and reaction to monitor this was only done for previous loss. No method given for analysis of qualitative interviews. No details given on any demographics Most monitoring was using internal uterine transducers and monitoring also sometimes used for normal labour. Very old study				
Study details (2.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Sheilds, D. 1978. Maternal reactions to fetal monitoring.	To assess overall attitudes to (internal) fetal monitoring	**Sampling strategy and size** 30 women postnatal No details on how sampled and from	Developed and used a "Mood and Feelings Inventory" to assess general attitudes. 8 negative words and 6	Mean positive and negative scores tabulated for each patient, 2 scores then subtracted and the	13

American Journal of Nursing **Country** Canada **Study type** Prospective observational **Study design** Interviews **Setting/context** No details		where **Characteristics** 19 married, 9 single, 2 separated Age range 17 – 42 16 women white, 14 black 18 primiparas, 12 multiparas All full term 8 = NVD, 13 = forceps, 2 = ventouse, 7 = caesarean section Mean length of monitoring 5 hours and 2 minutes (1 hour and 5 minutes – 12 hours and 16 minutes)	positive words. List of adjectives – patients marked on a scale from 1 (not at all) to 6 (very much).	difference served as an indication of overall positive and negative reaction. Chi-square analysis done for inventory scores and background variables. Open ended questions also used in interviews	
Summary of findings	22 patients in positive range, 8 in the negative. 2 in highly negative category and 3 in highly positive category No significant results for correlation with background variables Most frequent complaint reported was 'difficulty in getting comfortable'				
Further comments and overall evaluation	Data and results very poorly reported Self-developed scale with unclear validity No justification for 8 negative words and 6 positive No information on where or how women were recruited No information on ethical considerations including consent No methods given for analysis of open ended interviews Most monitoring was using internal uterine transducers and monitoring also sometimes used for normal labour				

	Very old study No inclusion/exclusion criteria				
Study details (3.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Beck, C. 1980. Patient Acceptance of Fetal Monitoring as a Helpful Tool. *JOGN Nursing*, 9 (6): 350-53 **Country** America **Study type** Observational **Study design** Interviews **Setting/context** 350-bed university affiliated community hospital, Baltimore, Maryland.	Replication of a study done in 1972 of reactions to fetal monitoring	**Sampling strategy and size** 50 postpartum women Convenience sample **Characteristics** Age range 14 – 37 60% white, 40% black 64% married, 36% single 54% primiparas, 46% multiparas 46% private patients, 54% clinic patients. Mean length of monitoring 4 hours and 42 minutes (30 minutes – 16 hours)	Interviews during first 3 days postpartum. Responses divided into initial (first reaction to thought of fetal monitoring and equipment itself) and subsequent (total reaction to monitoring as she recalled her entire experience). Responses categorized into positive, negative or neutral.	Minimal details. Simple descriptive. Chi-square analysis to test for associations between demographics and responses. Simple thematic analysis of interviews	17
Summary of	Initial responses – equal number positive and negative but more than half (56%) had neutral responses. Author compared to				

findings	her previous study where not one woman had a positive response. She suggests that this means women are initially reacting more positively to fetal monitoring. Chi-square analysis – significant relationship between age and initial responses (older women react more positively than younger women). Married women more positive initial reaction than single women. 'Many women remarked that they felt secure after they had been on the monitor for a while because it was reassuring to hear the baby's heartbeat'. Fascinated, kept minds off things, closer to baby, saved baby's life as told doctor when to do caesarean. Mostly liked being able to hear baby's heartbeat. Dislike of tight belts, tied to bed, afraid would hurt baby Authors conclude that initially, fetal monitoring is a much less upsetting experience for women than in 1972. Had been told about it in classes etc. Implications for practice – initial exposure to fetal monitoring crucial time to explain what it does, reasons for using, explain to husband, make sure monitor is facing patient so she can watch it. Young and single women need more support and reassurance about fetal monitoring				
Further comments and overall evaluation	Reliability of categories checked by another faculty member who independently categorized No mention of any ethical considerations including consent No methods given for analysis of interviews Only English speaking women included				
Study details (4.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Molfese et al, 1982. Reactions of Women to Intrapartum Fetal Monitoring. *Obstetrics and Gynaecolog,* 59 (6): 705-709.	Examined the reactions of women to routine intrapartum fetal monitoring at a medical centre and a community hospital. Gain information from a large sample of women on the extent to which women agree with published reactions of a few	**Sampling strategy and size** Randomly (state this but unclear how) Experienced internal and external monitoring during labour and volunteered postpartum to participate in response to verbal request.	Women interviewed about their experiences with monitoring and completed a questionnaire developed by the authors that asks for reactions to statements obtained from interviews reported by Starkman and Shields	Descriptive statistics Factor analysis yielded 11 factors for each sample Canonical correlation analysis	23

Country America **Study type** Prospective observational **Study design** Interviews and questionnaires **Setting/context** University medical centre – heterogeneous urban population and a Community hospital that serves heterogeneous rural population	women to monitoring.	**Characteristics** University medical centre = 80 women aged 16 – 38. 8 = LSCS, 8 pre-term (30 – 37.5 weeks) Community hospital = 100 women aged 18 – 38. 18 = LSCS, 3 preterm. Average family income and amount of education higher in university hospital sample	(above). Two phases of testing 1-2 days after delivery. Phase 1 – describe orally their overall reaction to monitoring (score = 3 if only positive responses given, 2 if both positive and negative, 1 if only negative), demographic details questionnaire, hospital records used to calculate an obstetric complication score (using 41 items). Phase 2 – written questionnaire containing 61 statements derived from comments by women in Starkman and Shields studies. Agree or disagree on 5 point Likert scale. Statements equally positive and negative and in random order.		
Summary of findings	Obstetric complication scores mean 100.82 (medical centre) 103.5 (community hospital) Interview responses mean 2.62 (medical centre) 2.60 (community hospital). Mean scores for positive and negative items 2.44 and 3.81 respectively (medical centre) and 2.56 and 3.98 respectively				

	(community centre). Canonical correlation analysis for medical centre – women of lower income were more likely than those of upper to view monitoring as a protector for the baby and to have positive feelings about it. They were less apt to view monitoring as providing information to nurses and themselves and were less likely to use if for contractions. Women with a more optimal obstetric complication scale score, who are older, and who have more education are more likely than those with the opposite characteristics to view the monitor as nonintrusive and not as a competitor for attention but as an understandable provider of information. Canonical correlation analysis for community centre – women whose interview reactions to intrapartum FM were more positive, who were in the upper income groups, and who were lower in parity were more likely than those with the opposite characteristics to view the monitoring as helpful and understandable, not a source of worry, and of benefit to the staff and the baby, but not useful for contractions. Most women – monitoring positive part of labour and delivery process. Strongest agreements were to statements that women felt confident that monitoring was there to help, staff knowledgeable, not competing for attention for it Dislikes – equipment breakdowns, strap uncomfortable				
Further comments and overall evaluation	No mention of any ethical considerations including consent Unclear sampling strategy No information on where women recruited from or context. No inclusion/exclusion criteria				
Study details (5.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Garcia et al. 1985. Mothers' Views of Continuous Electronic Fetal Heart Monitoring and Intermittent Auscultation in a Randomized	Study addressed following hypotheses • That women monitored with EFM feel more restricted in their movements during labour and delivery (a) • That the	**Sampling strategy and size** Two subsamples of 100 women each were selected at random from each arm of a large RCT comparing EFM and IA. **Characteristics** Both groups	Visited in hospital and asked for views on care. All 200 women asked same question without reference to type of monitoring. At end of questionnaire, women were asked specific questions about the method of monitoring to which	Chi-squared and t-test Analysis by method of monitoring randomised to. No discussion of how questions about method of monitoring were analysed.	30

Controlled Trial. *Birth*, 12 (2): 79-85. **Country** Ireland **Study type** Experimental **Study design** Semi-structured questionnaires **Setting/context** Large urban hospital with 8000 births per year	attention of midwives, doctors and husbands may be divided between the monitor and the mother so that mothers who receive EFM report they receive less support (b) • That EFM will be more reassuring than IA (c). • That the presence of the monitor will lead mothers to ask more questions of staff, and that staff will volunteer more information (d)	comparable for demographic and socioeconomic comparison	each women had been allocated		
Summary of findings	a).P<0.05 for freedom of movement. Minority of women who felt that they could not move about freely were in EFM group. No difference of leading to increased pain or need for analgesia b). not supported by data. Suggestion that women allocated to EFM were more often left alone for short periods though c).EFM more reassuring not supported by data. No differences in worries or anxieties in two groups d). no difference between groups				

	All women were asked which method of monitoring they would prefer if they had another baby – 8% of women who had EFM would prefer auscultation in another labour, 32% of those who had auscultation would choose EFM the next time. Conclusions – policy of EFM likely to make more women feel restricted in their movements, unlikely to influence the support that women feel they receive or reassure them significantly or make them feel more or less in control. EFM may result in them being left alone for short periods. Method of monitoring not the most salient aspect of a woman's care, support and reassurance from staff and companions were far more likely to be referred to.				
Further comments and overall evaluation	No consent sought from those having normal care (IA). Consent gained from those having EFM. Women having EFM could take off and walk around or go to toilet for short periods. Auscultation mentioned as being painful – pressure from pinnard stethoscope No inclusion/exclusion criteria.				
Study details (6.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Hansen et al, 1985. Maternal attitudes to fetal monitoring. *European Journal of Obstetrics, Gynaecology and Reproductive Biology*, 20 (1), 43 – 51. **Country** Denmark **Study type** Observational	To elucidate pregnant women's views on fetal surveillance techniques	**Sampling strategy and size** All pregnant women at 32 weeks from Jan – Aug 1981 attending the antenatal clinic received written information concerning a RCT about EFM and IA. 655 interviewed antenatally. 535 then went on to be in the main investigation with knowledge that there would be a 50% possibility of randomization to the less preferred way of	Women interviewed at 36 weeks to discuss main trial and get consent. Women were asked at this visit about their knowledge of fetal surveillance during labour, source of information and their preference. Semi structured interview they were asked to give opinion of two methods and to state advantages and disadvantages of both. Lasted on average 20 minutes. All women who had a	Analysis of variance for age and parity. Chi-squared also used. Descriptive statistics	22

Study design **Setting/context** No information apart from Denmark		surveillance. 385 postpartum interviews done (248 had IA and 137 had EFM) **Characteristics** Some demographics given	pre-delivery interview were interviewed on day 2 or 3. Interviewer did not know what the antenatal preference had been.		
Summary of findings	**Antenatal interviews** (655) 28.1% undecided, 39.5% preferred EFM, 32.4% preferred IA. 78% of latter group would accept or demand EFM and only 7% declared that they would continue with IA. Undecided significantly younger, parity not a factor. Obstetric high risk group preferred EFM, obese and former still births/neonatal deaths. 85% had prior information of EFM. EFM found more advantages to EFM than IA group (promoted husbands involvement, mother positively influenced by signal trace, possibility of quick intervention, continuous precise surveillance). 48% of IA group found IA more natural way of delivery, no discomfort form sensors or belts. **Postnatal interviews** A majority of those who had surveillance contrary to their primary wish pointed to IA irrespective of their newly gained experience (but insignificant). Undecided generally preferred what they had tried, 55% of IA and ^60% of EFM recommended the same method in a possibly future delivery. If women had their preferred surveillance a high rate in each group would prefer same in future delivery. A majority who preferred EFM antenatally but got IA found their new experience so good that they would recommend it for another delivery. Enforced mobility of EFM major disadvantage. Only 42% who preferred IA and got EFM would prefer EFM again.				
Further comments and overall evaluation	No ethics mentioned at all. Difficult to understand analysis clearly. No example questions given for interviews. Inclusion/exclusion criteria not specified				
Study details (7.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Hindley et al, 2008. Pregnancy women's views about choice of	To investigate the degree of choice pregnant women at low obstetric risk had in making informed decisions on the use of	**Sampling strategy and size** Convenience. 63 pregnant women at low obstetric risk (no underlying medical	Questionnaire. Completed between 34 and 40+ weeks of pregnancy. No valid reliable existing tool so	Data coded and transferred into SPSS. Descriptive analysis, frequency counts, cross tabulation used to compare answers to	33

intrapartum monitoring of the fetal heart rate: A questionnaire survey. *International Journal of Nursing Studies* 45 (2): 224-231. **Country** England **Study type** Exploratory descriptive design (part of larger multi-method study) **Study design** **Setting/context** 2 hospital providers – general obstetric population for 2 hospitals was similar, and	intrapartum fetal monitoring techniques	disorders and a predicted spontaneous vaginal delivery) approached to complete antepartum and postpartum questionnaires. 63 completed antepartum, 38 completed postpartum (letters sent out postpartum). 60 women asked to complete postpartum survey but only 38 completed (63%). **Characteristics** Full demographic characteristics given. Demographics for both groups did not differ dramatically. Mistake in manuscript – says 26 of 38 women were aged 30 or over but this should be 26 of 63 women.	questionnaire adapted from a validated tool for informed choice across a wider spectrum of issues in maternity care. Tool made more specific to fetal monitoring. Piloted with NCT classes and was shortened. Themes identified from literature review. Antepartum - 28 items designed to elicit information on knowledge and preference and demographics. Postpartum – 21 items, piloted with volunteers who had recent experience of maternity services. No questionnaires supplied.	two or more questions.	

comparable to national population					
Summary of findings	**Four themes** **Women's' preferences for intrapartum-monitoring methods and mobility** antepartum 56% combination of intermittent EFM and continuous. Postpartum 61% had received some form of EFM. Antepartum 76% (46/63) preferred to stay mobile or off bed in labour. Postpartum 40% (16/38) reported staying on the bed during labour. Postpartum all women receiving IA did not choose epidural. 53% of women having cont. EFM (20/38) all had epidural or narcotic analgesia. 23.5% (9/38). Some problems with numbers not adding up in this section **Decision-making/decision role preferences** Antepartum women wanted to make a final choice after considering the midwife's opinion. Postpartum 38% (14/38) women conceded decision-making powers to midwives during intrapartum period. **Choice/control** All 63 women felt that choice/control was either very important or quite important in their general lives and 61/63 (97%) felt was important in antenatal and intrapartum. Age, parity, ethnicity, education level and social deprivation scores had no impact on responses. 59/63 (94%) had not had a choice facilitated in intrapartum fetal monitoring method. 25/63 (40%) said that they had enough information and discussion with midwives about how to monitor baby's heart in labour. **Sources of information** aantepartum 94% (59/63) knew all of the methods for monitoring except pinnard. Antenatal 86% (54/63) thought being given info on monitoring was very/quite important but changed postpartum to 39% (15/38). Media and past experiences sources of information. 65% (41/63) thought midwife had not given enough info about monitoring, 40% (25/63) felt had had or partly had 'informed choice'. Postpartum 39% (15/38) felt had informed choice.				
Further comments and overall evaluation	Full ethical approval details given (information pack given, consent forms, questionnaire, stamped addressed envelope for return). Only one reminder permitted at next antenatal appointment. No data table for who actually received IA and EFM in the postpartum group of 38 respondents so some of the data analysis is confusing. Could have had further questions asking about why women had EFM in labour. Authors state that women having IA did not elect to have epidural but it may have been those that had epidural had it following IA and then had EFM. Good reflective section on why only 38 returned questionnaires postpartum and how this may have influenced results (those returning may have an increased awareness of issues of choice and control because of involvement with AN questionnaire. All women were white. Make conclusions that women received EFM inappropriately but have no information to base this statement on.				
Study details (8.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**

Full reference Mangesi and Woods, 2009. Assessing the preference of women for different methods of monitoring the fetal heart in labour. *SAJOG* 15 (2): 58-59. **Country** South Africa **Study type** Quantitative, cross sectional, prospective **Study design** **Setting/context** Ceceli Makiwant Hospital, Eastern Cape Province	To assess which of three different methods of monitoring the fetal heart in labour was preferred by labouring women.	**Sampling strategy and size** Convenience. Women in active labour. Those approaching second stage, with twins, in pre-term labour or with evidence of fetal distress were excluded. Verbal consent taken after study explained. **Characteristics** None reported	Researcher spent 30 minutes with each woman. 10 mins explaining study to woman, 10 mins monitoring fetus with fetal stethoscope and wind up Doppler, 10 mins performing cardiotocograph trace. Alternated starting with stethoscope and then doppler. Participants asked to choose which one of the three methods they were most comfortable with.	Data entered into Epi-Info 2002 computer softward	20
Summary of	13/97 preferred fetal stethoscope, 72/97 preferred wind-up doppler, 12 preferred CTG. Second preference - 58 fetal				

findings	stethoscope, 17 wind up doppler, 22 CTG. 2 women couldn't decide and data lost for one woman. Fetal stethoscope disliked because of the discomfort experience during the examination, while the belts of CTG restricted woman's movement and often confined her to the bed.				
Further comments and overall evaluation	Hand help Doppler was wind up and had no batteries – for use in low resource settings. Women enrolled when in active labour Intervention applied in a very short period. Not clear when they were asked about preference				
Study details (9.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Barber et al, 2013. Electronic fetal monitoring during labour and anxiety levels in women taking part in a RCT. *British Journal of Midwifery* 21(6): 394 - 403. **Country** England **Study type** Mixed methods sub-study **Study design** **Setting/context** Royal	Investigate whether the use of electronic fetal monitoring during labour increases or reduces anxiety levels among women, and whether the addition of decision support software has a positive or negative effect on these anxiety levels.	**Sampling strategy and size** **Quantitative** Jan – July 2010 469 women randomized to pilot phase of INFANT study 234 CTG only 235 CTG plus decision support Women admitted in early labour were approached by midwife if >35 weeks, >16 years, clinically indicated for cont EFM, able to give informed consent. **Qualitative** 18 women from other 2 centres were interviewed about their	**Quantitative** Anxiety levels evaluated using standard 1-10 Visual Analogue Scale – Anxiety (VAS-A) where 1 was not anxious and 10 was very anxious. Anxiety levels evaluated at 1-3 centimeters, active phase of labour (4-7cm) and within 48 hours postpartum. **Qualitative** Semi-structured interviews Purposive sampling used to ensure interviews equally divided between CTG only and CTG plus	**Quantitative** Change in VAS-A scores in 2 groups from latent to active phase of labour, and from latent to postpartum was analysed using ANCOVA. The correlation between scores between phases was calculated suing Pearson's correlation coefficient. Two-sided significance tests were used, taking p=0.05 as significant. Used Stat software. **Qualitative** Thematic coding and analysis using Nvivo. Followed by framework	30

Blackburn Hospital, Warrington and North Staffordshire		experiences of birth and monitoring. **Characteristics** No demographic or other info given about quantitative groups.	decision support as well as range of levels of concern. Statistician identified cases and informed researcher of study number. Researcher blinded to study allocation until after the interviews.	analysis	
Summary of findings	**Quantitative** No difference between groups in the change in anxiety from latent to active phase or latent to postpartum. **Qualitative** *Women in both the control and decision support arms commonly reported finding monitoring reassuring. Several women reported that the monitor helped reassure the father too, and could generate a sense of involvement because they could see a contraction coming and support their partner appropriately. When objections were raised to monitoring, this was most commonly because of restrictions on freedom of movement. Some women did not find the monitor restrictive or uncomfortable.* Monitor inhibited moving around to relieve pain and to go to the toilet. *Some would have preferred a portable wireless monitor, and one woman heard this was available in other hospitals.* Varying degrees of resignation about being immobile anyway eg if had an epidural. Qualitative interview findings confirm that CTG -……does not cause significant anxiety in most women. Concerns were most commonly around discomfort and restricted movement. Some women found monitoring actively reassuring.				
Further comments and overall evaluation	Full ethics approval sought and gained No information on where or when interviews were taken. Mixed method methodology not really utilized – very little synthesis of findings or discussion of how one phase influenced the other.				

4. Scoring table for literature review of women's views and experiences of fetal monitoring

Study #	Author/ Year	Study Population	Sample size	Design	Quality assessment - Hawker's checklist: Score range 1-4 for each item [Total score: Range = 9-36]									
					Abst.	Intro.	Methods & data	Sampling	Data analysis	Ethics /bias	Results	Generasability/ Transferability	Implications	**Total score**

1	Starkman 1976	Postnatal women	25	Observational	3	2	2	2	2	1	3	2	3	**20**
2	Shields 1978	Postnatal women	30	Observational	1	2	1	2	2	1	2	1	1	**13**
3	Beck 1980	Postnatal women	50	Observational	2	2	2	2	2	1	2	2	2	**17**
4	Molfese et al 1982	Postnatal women	180	Observational	3	2	3	3	3	1	3	2	3	**23**
5	Garcia et al 1985	Postnatal women	200	Experimental	4	4	3	3	3	2	4	3	4	**30**
6	Hansen et al 1985	Antenatal and postnatal women	655 (AN)l 385 (PN)	Observational	3	2	3	3	3	1	3	2	2	**22**
7	Hindley et al 2008	Antenatal and postnatal	63 (AN) 38 (PN)	Exploratory descriptive	4	4	4	4	3	3	3	4	4	**33**
8	MAngesi and Woods 2009	Active labour	97	Prospective cross-sectional	3	2	2	2	2	2	3	2	2	**20**
9	Barber et al 2013	Labour and postnatal	469 (quant) 18 (qual)	Mixed methods	4	4	3	3	3	3	3	4	3	**30**

5. Table of excluded papers for literature review of health professionals experiences and views of fetal monitoring.

	Full reference	Reason for exclusion
1.	Sinclair, M. (2001). Midwifery managers' perspectives on midwives' use of birth technology. *All Ireland Journal of Nursing and Midwifery* 1(6), pp 213-219.	Not available
2.	Luyben, A. G., Gross, M.M. (2001). Intrapartum fetal heart rate monitoring: do Swiss midwives implement evidence into practice? *European Journal of Obstetrics and Gynecology and Reproductive Biology 96(2), pp 179-182.*	Not primarily focussed on fetal monitoring views and experiences.
	Striner, M. (2002). Technology in the birthing room. *Nursing Clinics of North America* 37(4), pp 781-793	Not available
3.	Mead, M. (2003). Midwives perception of the intrapartum care they and their colleagues would normally suggest for women suitable for midwifery-led care. *Evidence Based Midwifery*	Not primarily focussed on fetal monitoring views and experiences
4.	Graham, I.D., Logan, J., Davies, B., Nimrod, C. 2004. Changing the use of electronic fetal monitoring and labor support: a case study of barriers and facilitators. *Birth* 31(4), pp 293-301.	Change management rather than health professional views
5.	Reime, B., Klein, M.C., Kelly, A., Duxbury, N., Saxell, L., Liston, R., Prompers, F.J.P.M., Entjes, R.S.W., Wong, V. (2004). Do maternity care provider groups have different attitudes towards birth? *BJOG: an International Journal of Obstetrics and Gynaecology* 111, pp 1388-1393.	Not primarily focussed on fetal monitoring views and experience
	Barton, L. (2005). Strapped to a machine, deprived of control….the miracle of birth for British women. *Guardian Newspaper.*	Newspaper article, not primarily focussed on fetal monitoring views and experience, not availalble.
6.	Blix, E. The labour admission CTG. An assessment of the test's predictive values, reliability and effect. (2006).	Abstract only
7.	Blix, E. (2007). Norwegian midwives' perception of the labour admission test. *Midwifery* 23(1), pp 48-58.	Admission test views, not in labour.
8.	Sleutel, M., Shultz, S., Wyble, K. (2007). Nurses' views of factors that help and hinder their intrapartum care. *JOGNN: Journal of Obstetric, Gynecologic and Neonatal Nursing* 36(3), pp	Not primarily focussed on fetal monitoring views and experience

	203-211.	
9.	Parisaei, M. (2010). Acceptability of the fetal electrocardiographic (STAN). *Journal of Perinatal Medicine* 38(2), pp 187-190.	STAN not conventional EFM
	Nilsson, C. (2014). The delivery room: is it a safe place? A hermeneutic analysis of women's negative birth experiences. *Sexual and Reproductive Healthcare* 5(4), pp 199-204.	Not primarily focussed on fetal monitoring views and experience
10.	Brown, J., McIntyre, A., Gasparotto, R., McGee, T.M. (2016). Birth outcomes, intervention frequency, and the disappearing midwife-potential hazards of central fetal monitoring: a single centre review. *Birth: Issues in Perinatal Care* 43(2), pp 100-107.	Not primarily focussed on fetal monitoring views and experience

6. Critical Appraisal and scoring for literature review of health professionals experiences and views of fetal monitoring

Study details (1.)	Aims/objectives	Participants	Data collection	Analysis	Quality Score (Hawker, 2002).
Full reference Cranston CS, 1980. Obstetrical Nurses' Attitudes Toward Fetal Monitoring. *JOGN Nursing* 9 (6): 344-347 **Country** United States **Study Type** Observational **Study design** Questionnaire **Setting/context** 14 US hospitals	Identification of nurse attitudes toward fetal monitoring	**Sampling strategy and size** 124 RGNs working in a labour and delivery unit and had worked with the fetal monitor at least once. Selected from 14 hospitals in St Louis, Missouri. Research assistant at each hospital; non-probability. Letters sent to every labour and delivery nurse inviting to take part. Consent form used, signed and then sent back. Questionnaire then received. Research assistant supervised completion and then sent back. **Characteristics** Range of shift work, age, education and experience. 95% had on the job training with	Rate feelings towards fetal monitoring using a Likert-type scale. Positively and negatively worded statements were interspersed	One-way ANOVA means, SD and frequency counts (percentages). In hypothesis testing p=0.05 was used.	26

		fetal monitor. No significant group differences			
Summary of findings	The majority of obstetrical nurses in the study appeared to have a positive attitude toward fetal monitoring. For each statement the responses were over 50% positive. Half of the 24 items positive responses were 90% or higher. 52% thought that routine continuous EFM of all patients in labour would be ideal. 88% thought that EFM cannot be matched by IA 59% did not feel that FM causes more anxiety 96% felt that fetal monitoring can decrease perinatal morbidity and mortality 76% fetal monitoring is indicated for normal labour because potential complications can occur at any time 90% patients seem to be reassured by the presence of the nurse and the fetal monitor.				
Further comments and overall evaluation	Says that reliability and validity of questionnaire was checked prior to application but no details of how this was done. Content validity done by having three staff evaluate the statements – if disagreed then wasn't used. Internal consistency – pretest questionnaire to pilot group. 24 items selected out of 46 using Pearson's correlation. Not enough information about sampling or about research assistant role. Overall simple study but clear and reasonably thorough with clear results.				
Study details (2.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Dover SL, Gauge SM, 1995. Fetal Monitoring – midwifery attitudes. *Midwifery* 11 (1): 18 – 27. **Country** England	To survey midwives' attitudes and practices related to intrapartum fetal monitoring. What were midwives' preferred methods of fetal monitoring? What factors influenced midwives' choice of methods? What are the educational implications?	**Sampling strategy and size** All midwives invited to participate 242 questionnaires administered and 117 returned (48% response rate). Two maternity units (One: teaching hospital with 4800 births, Two: smaller unit with 2500 births). 135 sent to	Questionnaire modified and developed after expert review by 10 senior midwives, also psychologist and statistician. Pilot testing done with random selection of midwives. Three parts to questionnaire. A: professional and demographic. B:	Used SPSS. Analysis included frequencies, cross-tabulation, correlation, chi square, t-test and ANOVA.	33

Study type Descriptive correlational study **Study design** Questionnaires **Setting/context** Regional and district maternity unit and related community area within one health authority		teaching hospital, 58 t district, 49 to community. Midwives worked in geographical teams. Personally addressed letter with questionnaire left for every midwife. Final collection 6 weeks after original administration. **Characteristics** Unit one 70% Caucasian 30% other ethnic groups Unit Two 60% Asian and Afro-Caribbean	describe training, indicate which guidelines resembled their unit's policy and guidelines, extent to which agreed or disagreed with policy, place in rank order their preferred methods for monitoring women at low and high obstetric risk. C: collect relevant information about attitudes to fetal monitoring – Likert scale (20 items).		
Summary of findings	Overall response rate 48% 59% not received any formal education in CTG interpretation 49% chose policy of continuous FHR monitoring for women at high risk, otherwise midwives discretion. Likert scale attitudes to practice – true mean = 60 (min 20 max 100). Sample mean 72.9, SD 9.9. 72% agreed or strongly agreed that the method of FHR monitoring chosen was more likely to be continuous when staffing was poor 92% thought they were capable of deciding which method best 85% confident with IA Significant correlation: midwives who believed childbirth to be prospectively normal did not agreed that continuous EFM was a safer method than IA Despite responses around monitoring low risk women with IA 83% of women at regional unit had continuous EFM. Comments about private opinion and public practice. 'Organisational/structural inhibitors may result in environmental				

	constraints which account for the attitude/behavior discrepancy' p 25 Discussion section about influential factors in monitoring – major one is confidence (in ability to choose appropriate method, to use method and to support choice of method).				
Further comments and overall evaluation	Permission from management. Did not need ethics. Well written and relevant paper.				
Study details (3.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Thompson B, Birch, L. 1997. Survey into fetal monitoring practices and attitudes. *British Journal of Midwifery* 5(12): 732-735. **Country** England **Study type** Survey **Study design** Questionnaire	An audit of attitudes to, and practice of, monitoring the fetal heart rate during labour.	**Sampling strategy and size** **Characteristics** Response rate was 50% across all grades of staff. 96 responses in total (41 hospital midwives, 19 community midwives, 18 team midwives, 2 midwifery managers, 5 SHOs, 5 registrars, 4 consultants, 2 unidentified). Age 22-59 Experience 7 months to 35 years.	Midwives and doctors asked to complete and anonymous questionnaire	Simple descriptive	23

Setting/context North West tertiary hospital with 4500 births per year.					
Summary of findings	Overall 63% thought that EFM had improved maternal or neonatal outcome over past 30 years – most evident amongst doctors (85%). If low risk 82% would prefer IA for themselves (or partner) A third of hospital midwives and 40% of SHOs prefer EFM when looking after someone else – detection of fetal distress, reassurance of mother and partner IA definition – most believed that a CTG for 20 mins each hour was definition of IA. Discrepancy in different clinical situations – low risk, breech, meconium, IOL with syntocinon Conflict between theory and practice Recommended standardization of views across disciplines, education for all grades of staff,				
Further comments and overall evaluation	Brief and simple article with basic descriptive analysis. No discussion of how staff were sampled No details of questionnaire				
Study details (4.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Sinclair M, 2001. Midwives' attitudes to the use of the cardiotocograph machine. *Journal of Advance Nursing* 35 (4): 599 – 606.	Explore how midwives view technology in childbirth issues using as the central focus the CTG machine	**Sampling strategy and size** All midwives working in labour wards in Northern Ireland. Calculated using working role data that would be 741 midwives working on labour wards or who had recent experience. 446 responses – 60%	45 item questionnaire 25 item attitude scale (initially 40 item but was piloted and refined). Likert scale	SPSS Descriptive and inferential analysis (factor and ANOVA).	31

Country Northern Ireland **Study type** Descriptive observational **Study design** Postal questionnaire **Setting/context** Northern Ireland midwives with labour ward experience		response rate. **Characteristics** No real in-depth analysis but was included in variable analysis			
Summary of findings	66% medical colleagues rely too much on CTGs 74% CTGs unnecessarily used 80% disagreed that CTGs essential for ensuring safe deliveries Three factors highlighted and then analysis (groups of questions) 'Appropriateness and desirability', 'dependency' 'problematics' *The anecdotal position that midwives are becoming dependent on technology such as CTGs as their personal skills are argued to be undermined was also clearly addressed in the clustering of items in Factor 2 [dependency]. These indicated a rejection of the notion of any dependency, over-reliance or blind trust* p603 Variable analysis (age, skill level, confidence). *…regardless of the category any respondent fell into under any of the variables considered, the perception that midwives were in any way dependent on CTGs outside of their own professional choice or policy compliance, was roundly rejected* p604 Midwives who trust machines are more disposed to their use and trust is affected by perceived competence. Essential that midwives recognize problems of becoming over dependent on technology and do not relinquish their hold on				

	the craft skills of midwifery.				
Further comments and overall evaluation	Limitations – lack of any objective measure of respondents competence in using technology or their confidence in interpreting CTG readings. No mention of ethics or not. ?Northern Ireland relevance to UK.				
Study details (5.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Sinclair M, Gardner J. 2001. Midwives' perceptions of the use of technology in assisting childbirth in Northern Ireland. *Journal of Advanced Nursing* 36 (2): 229 – 236. . **Country** Northern Ireland **Study type** Descriptive observational **Study design**	Explore how midwives view technology in childbirth issues using as the central focus the CTG machine	**Sampling strategy and size** All midwives working in labour wards in Northern Ireland. Calculated using working role data that would be 741 midwives working on labour wards or who had recent experience. 446 responses – 60% response rate. **Characteristics** 20 – 60 years 47% 30-39 age group 67% E grade	45 item questionnaire 25 item attitude scale (initially 40 item but was piloted and refined). Likert scale	SPSS Descriptive and inferential analysis (factor and ANOVA).	28

Postal questionnaire **Setting/context** Northern Ireland midwives with labour ward experience					
Summary of findings	**Policy and Practice relating to CTG usage.** 48% recorded view that the use of CTG was laid down by policy or by custom and practice. Given choice to deliver with or without labour ward technology 63% would choose to deliver without machinery. How technology affects practice – negative, positive or both. Benefits included 'supports midwife in role' 'helps if baby is pre-term' 'assesses fetal wellbeing' 'reassures anxious mother' 'guards against litigation' 'ensures safer outcome for mother and baby'. Negative comments 'technology takes over from the mother' 'midwives rely too much on it' 'inaccurate and unreliable' mothers don't want it' 'increases intervention' 'spoils the beauty of natural birth'. **Women's choice on routine monitoring** 78% felt that women should be given a choice **Labour ward technology training and usage** 55% felt that training had not prepared them for using CTG **Multi professional education** 63% believed important to have various professionals involved trained together on technology **General** Midwives concerned about the safety and accuracy of labour ward technologies, their own competence and training readiness to use them. General acceptance of the benefits that technology offers, particularly in difficult births where it affords re-assurance for the professionals concerned and for women in labour.				
Further comments and overall evaluation	No mention of ethics Same sample as previous paper but report more focused on technology. Didn't include any example questions and could have included more free text. Could also have looked at technology in relation to length since qualification.				
Study details (6.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Country Walker et al.	Background of continuous EFM being done for low risk	**Sampling strategy and size** 5 hospital labor and	Part 1 – age gender, years of experience etc Part 2 – 18	SPSS appropriate to level of data and type of study question.	32

2001. Labor and Delivery Nurses' Attitudes Toward Intermittent Fetal Monitoring. *Journal of Midwifery and Women's Health* 46(6): 374 – 380. **Study type** Descriptive correlational **Study design** Two part questionnaire **Setting/context** Five south eastern Michigan hospitals.	women when guidelines recommend IA. What are labor and delivery nurses' attitudes toward IA? What is the relationship between selected demographic variables and nurses' attitudes toward IA.	delivery units in Michigan. Convenience sample of 150 hospital-based nurses. 4/5 hospitals mix of low and high risk, 1/5 primarily low risk. Nurse/patient ratios 1:2 or sometimes 1:3 when busy. Staff given definitions of continuous and intermittent. Research team visited hospitals and asked staff to participate. Visited more than once so that different shifts sampled. Given cover letter and definitions. Voluntary and anonymous. Took 15 minutes to do. Completion interpreted as consent. 145 final responses **Characteristics** Mean age 37, mean 14	statements, Likert scale. Pilot testing done. Investigated IA monitoring policies – all 5 policies deemed similar and gave clear guidance on used of IA and when it could be used.		

		yrs practice as nurse and 8.6 years labour and delivery. 65.5% birth themselves and 85.3% some form of electronic fetal monitoring			
Summary of findings	74.4% disagreed that continuous EFM should be the standard of care 72.4% agreed IA should be standard of care 87% agreed will provide IA but 53.9% thought patient ratio was a problem in providing IA 40.9% thought that hospital guidelines not clear Only demographic variable of significance was education level – less than a BSc degree were less supportive of IA Almost a half had little knowledge about research on continuous EFM. Essentially positive attitude to IA but barriers to implementing it. Nurses attitudes have changed since Cranston article.				
Further comments and overall evaluation	Permission obtained from institutional review boards Limitations – convenience sample from one geographic area, sites were slightly different Instrument not validated				
Study details (7.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Hindley C, Thomson A. 2005. The rhetoric of informed choice: perspectives from midwives	To investigate midwives' attitudes, values and beliefs on the use of intrapartum fetal monitoring.	**Sampling strategy and size** 58 registered midwives 4000 births at centre A (28 recruited) 2200 births at centre B (30 recruited). Purposive sample – experience in the use	Semi-structured tool developed from literature review. • Advantages/disadvantages of intrapartum FHR monitoring methods • Decisions	General thematic analysis. 20 transcripts analysed by another researcher to verify themes. Said that there wasn't enough time to do a grounded theory analysis.	30

on intrapartum fetal heart rate monitoring. *Health Expectations* 8 (4): 306 – 314. **Country** England **Study type** Qualitative **Study design** Semi-structured interviews **Setting/context** Two hospitals in the north of England. Urban populations with variable socio-economic and ethnic mix.		of fetal monitoring. Two researchers – one in each hospital, introduced as researchers not as midwives. Written information made available to midwives. **Characteristics** Range of experience 2 - 30 years. Equal mix of nurse trained and 3 year midwifery training.	influencing practice • Definition of low risk status • Influence of research on practice • Implementation of guidelines • Effects of technology on practice and process of birth • Influence of information given by midwives on women's choice • Concept and application of informed choice		
Summary of findings	**Consensus on informed choice** professional viewpoint that informed choice should not be contrary to the woman's best interest. Midwives may consciously or unconsciously exert control over women's choices because their knowledge is often viewed as legitimate by women. **Power of the midwife** midwives well-meaning approach was often tempered by their power in influencing women's ultimate decisions. 'Strategic communication'. *Midwives consistently discussed the importance of liberating women from a system which promoted a technological model of birth…….Yet there were obvious contradictions, as the decisions fostered around intrapartum monitoring techniques appeared to predominantly emanate from the midwife rather than the woman……some*				

	midwives found it difficult to reconcile the informed choice ideal with the pressures of their daily working lives. *Use of technology increased professional status – relegated intuitive knowledge and skills to a lower level.* *When offering an informed choice, midwives communicating the risk of intrapartum fetal monitoring techniques to women had to be negotiated within a complex system of competing priorities. This influenced midwives' perceptions and attitudes towards how information on intrapartum FHR monitoring should be divulged.* Influenced outcome and distorted information by attempting to control what they told women. Due to fear of litigation, felt limited in the face of political power in obstetrics. Not easy to negotiate informed choice in a maternity system immersed in a blame culture. *In reality informed choice for women is a slogan that often does not apply to practice.*				
Further comments and overall evaluation	Both Trusts had standard of 30 minute admission CTG, IA for low risk and continuous EFM for high risk. Ethics committee approval granted and good details. Good reflexivity on midwives knowing that one of the researchers was a midwife and possible influences on selection and interviewing of midwives. Research diary used. No mention of limitations or future research.				
Study details (8.) **Full reference** Altaf et al, 2006. Practices and views on fetal heart monitoring: a structured observation and interview study. *BJOG* 113 (4): 409 – 418). **Country** England **Study type** Observational	**Aims/objectives** Identify deviations from NICE guidelines in relation to fetal monitoring. Explore midwives views on fetal heart monitoring in labour.	**Participants** **Sampling strategy and size** Labour ward and midwifery led unit. Observations **66 hours** (25 labours) - labours purposively selected to include different midwifery staff, day and night shifts and high and low risk pregnancies. Consent from midwife and woman via information sheet and verbal explanation of study. Interviews **20** – midwives purposively	**Data collection** **Observations** undertaken by a medical student (with extensive training and experience in fetal monitoring(??) over a 1 month period. Not expected to intervene. Structured observation proforma based on NICE guidelines was used. Midwife also asked to describe indications for EFM, errors commonly made with EFM and the value of EFM. Field notes.	**Analysis** Classification of the data recorded on observation proforma undertaken by a consultant and the medical student. Constant comparative method – open codes. No theoretical sampling according to GT analysis. Audit trail kept of development of categories. QSR N5 software used.	**Quality Score** 28

Study design Structured observation and semi-structured interviews **Setting/context** Large teaching hospital with 5800 births		selected to reflect different levels of experience and grade. Tape recorded and transcribed verbatim. **Characteristics** 66 hours of observation of 25 labours were undertaken. 22/25 labours involved some period of EFM. All live births, APGARS 6 – 9 (one minute). 10 LSCS, 2 forceps, 3 ventouse, 10 SVD Interviews – varying grades of midwife, experience 6 months to 30 years.	**Interviews** semi-structured prompt guide. Participants who had been observed were not asked to comment on the specific case that had been observed.		
Summary of findings	243 deviations from NICE guidelines, 11 per labour. Most common in relation to documentation. **Role of technology** *Faith in EFM*; trusting, authoritative resource, provide a documented account of monitoring. *Cautious about EFM;* limited, one element of care. *Sceptical about EFM;* not necessary, used inappropriately, eroding and undermining professional skills. All midwives expressed concern about its use. All accounts referred to the potential for discomfort and anxiety in labouring women. Perception that EFM overused, clinically unjustified and for defensive reasons. Tension between personalized care and focusing on machine and documentation about it. **Professional roles** EFM deskilling midwives, expertise of midwives less authoritative than the machine. Doctors coming into rooms and making decisions on CTG alone. **Training and equipment** generally satisfied with training. Frustration with quality, availability and maintenance of equipment				

	for FHR monitoring. *Deviations from recommended practice need to be understood within an organisational and social context:…..initiation, management and interpretation of fetal heart monitoring is a highly complex process distributed across time, space, and professional boundaries. EFM has a very ambivalent status in midwifery practice and confirm earlier suggestions of disquiet about EFM among (at least some) health professionals, including concerns that EFM can cause the 'art of midwifery' to be lost to technology, and that EFM is lacking in credibility as an intervention.* Dilemmas about professional boundaries and judgments, midwifery control to medical control. Tension between personalized care and documentation. Findings demonstrate tensions between the kinds of experiential, tacit knowledge that experienced practitioner's value (particularly in the context of contested technologies) and the rational model of decision making and practice implied by guidelines.				
Further comments and overall evaluation	Full ethics committee approval. Constant comparative method but don't specifically mention grounded theory. Limitations – only one hospital, small sample study, could have included a wider range of events.				
Study details (9.)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Hindley C, Wren Hinscliff S, Thomson A. 2006. English midwives' views and experiences of intrapartum fetal heart rate monitoring in women at low obstetric risk: conflicts and compromises. *Journal of*	Evaluate midwives attitudes and experiences about the use of fetal monitoring for women at low obstetric risk.	**Sampling strategy and size** 58 midwives at 2 hospitals in the north of England. Midwives given cover letter and consent form. Interviews lasted 30 – 60 minutes. 28 midwives from one hospital, 30 from another. Recruited by practitioner researchers who were also midwives. **Characteristics**	Semi-structured interview tool derived from the literature • Advantages/dis advantages of intrapartum FHR monitoring methods • Decisions influencing practice • Definition of low risk status • Influence of research on	Interviews transcribed verbatim. General thematic analysis. 20 interviews randomly selected and reviewed by separate researcher to validate.	31

Midwifery and Women's Health 51 (5): 354 – 360. **Country** England **Study type** Observational **Study design** Semi-structured interviews **Setting/context** Two hospitals in the north of England. Urban populations with variable socio-economic and ethnic mix.		Wide range of clinical experience and work environments. 2 – 30 years practice, average of 15 years.	practice • Implementation of guidelines • Effects of technology on practice and process of birth		
Summary of findings	**Intermittent auscultation** 1. Freedom/liberating effects of intermittent auscultation for women; low tech facilitated more natural approach to birth. Opposing cascade of intervention associated with EFM. 2. Closeness/proximity of the midwife; enhanced importance of sitting with the woman. 3. Quicker progress in labour; reported association between IA and efficient progress in labour. Positive features of IA tempered significantly by fear of missing some pathologic event in FHR. **Electronic Fetal Monitoring** 1. Oppressive/restrictive; 'chained' 'tied' to bed. Machine associated with connotations of restriction rather than the midwives perceiving themselves as administrators of the technology that was restricting them. 2.				

	Midwife by proxy; dehumanized birth by distracting midwife away from communicating with the woman. Time taken up with surveillance. Women put on EFM when short staffed despite risk status. 3. Pain relief; indirect references to maternal position or restricted mobility as factors affecting pain relief. Midwives *had little doubt that pharmacologic methods and epidural analgesia were resorted to earlier and more frequently in those women experiencing EFM.* Midwives reported personal experiences of the cascade effects of EFM, yet they still used it despite their espoused allegiance to a normal approach to birth. Traditional watchful approach of midwives has been devalued in favor of routine practices such as EFM. Deemed scientific – more reliable than gaze or touch. **The midwives did not think that the use of EFM promoted the midwife's proximity to the birthing process** Easier for midwife to 'busy' herself with the monitor rather than engage on a deeper, personal level with the woman.				
Further comments and overall evaluation	Both Trusts had standard of 30 minute admission CTG, IA for low risk and continuous EFM for high risk. Ethical approval from hospitals and university. Reflexivity addressed by keeping diaries Limitations – only two hospitals in one region				
Study details (10.) **Full reference** Blix E, Ohlund L. 2007. Norwegian midwives' perception of the labour admission test *Midwifery* 23 (1): 48 – 58. **Country** Norway	**Aims/objectives** To explore what information and knowledge the labour admission test is perceived to provide and what meaning the test carries in the daily work of practicing midwives.	**Participants** **Sampling strategy and size** Purposive followed by theoretical sample of 12 practicing midwives. Working on labour wards. Midwives given written information sheet and consent form. **Characteristics** All women, workind in four different labour	**Data collection** What info and knowledge the labour admission test was perceived to contribute, how the midwife informed the woman about the labour admission test and what consequences the result of the test had had for the midwife when following up the	**Analysis** Interviews transcribed verbatim – grounded theory (Strauss and Corbin). Open, axial and selective coding used. Nvivo. Used a group of midwives to look at findings for validation.	**Quality Score** 34

Study type Qualitative – observational **Study design** In-depth interviews **Setting/context** Four different labour wards in Norway		wards. 2 weeks and 38 years' experience.	woman. Interviews lasted 30 -90 mins, workplace or home. Audiotaped and transcribed verbatim. Participants offered a transcript.		
Summary of findings	Subcategories **professional identity versus technology** – professional identity threatened by the increasing use of the CTG, holding up the CTG trace and not referring to other observations. Midwives losing skills in auscultation **Feeling safe versus feeling unsafe** having paper record of fetal heart as opposed to only midwife hearing it. **Power versus powerlessness** routine use of admission CTG as something decided by consultants (who had more power). Core category **'experiencing contradictions' -** Possible that increasing use of technology will cause midwifery skills to deteriorate, but it is also possible that midwives integrate and use technology in a way that keeps and develops their clinical skills.				
Further comments and overall evaluation	Ethics approval given. Study in Norway so hard to know if generalizable. Bias acknowledged in that one of the researchers has a critical approach to medicalisation of childbirth but tried to minimise this bias.				
Study details (11)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Hindley C, Thomsom A. 2007. Intrapartum fetal monitoring	Explore midwives' attitudes and beliefs when using intrapartum fetal monitoring techniques in clinical practice.	**Sampling strategy and size** 58 midwives at 2 hospitals in the north of England. Midwives given cover letter and	Semi-structured interviews • Effects of unit guidelines on fetal monitoring practices	Interviews transcribed verbatim. General thematic analysis. 20 interviews randomly selected and reviewed by separate researcher	30

and the spectre of litigation: a qualitative study of midwives views. *Clinical Governance: An International Journal* 12 (4): 233-243. **Country** England **Study type** **Study design** **Setting/context** Two hospitals in the north of England. Urban populations with variable socio-economic and ethnic mix.		consent form. Interviews lasted 30 – 60 minutes. 28 midwives from one hospital, 30 from another. Recruited by practitioner researchers who were also midwives. Purposive sample **Characteristics** Wide range of clinical experience and work environments. 2 – 30 years practice, average of 15 years.	• Unit philosophy of care around birth.	to validate.	
Summary of findings	**Defensive practice** clinical decisions were motivated primarily towards protecting themselves from a perceived threat of litigation. Proof of fetus not compromised. Midwives cited women's expectations of labour care; consumer preferences regardless of the quality of information influencing the women's decision were legitimately used to maintain the status quo. **Fear of Litigation** fear of legal claim strong motivator for using EFM. Practice driven by anxiety rather than evidence base.				

	Tension between translation of evidence into every day labour ward practice. **The paradox of EFM** seen to be doing something but not necessarily believing what was seen. Discrepancy in opinions but generally doctor opinion paramount				
Further comments and overall evaluation	Both Trusts had standard of 30 minute admission CTG, IA for low risk and continuous EFM for high risk. Ethical approval from hospitals and university. Reflexivity addressed by keeping diaries Limitations – only two hospitals in one region				
Study details (12)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference McKevitt et al, 2011. Midwives' and doctors' attitudes towards the use of the cardiotocograph machine. *Midwifery* 27 (6): e279 – e285. **Country** Northern Ireland **Study type** Exploratory descriptive **Study design**	To examine midwives and doctors attitudes towards the use of the CTG machine in labour ward practice	**Sampling strategy and size** Purposive sample – total population was those who had worked in labour ward during past 12 months 56 midwives (n = 29 53%) 19 doctors (n = 11 57.9%). 70% of respondents consented to being interviewed. 6 midwives and 2 doctors were purposively selected (2 from each age range. **Characteristics** Length of experience ranged from 5 months	Questionnaire (adapted from that used by Sinclair 2001). Included obstetricians. Piloted with 4 midwives and 2 doctors. Not included in main study. One question re-worded. Open-ended questions at end of questionnaire. Questionnaire posted out to total sample. Reminder letter sent out after 2 week. Semi-structured interviews: 20 – 30 minutes	SPSS. Descriptive statistics. Thematic analysis. Expert opinion (?) also obtained to verify analysis.	30

Questionnaire and interviews **Setting/context** Consultant-led NHS Trust hospital 3500 births		to 15 years. Table given with age, experience and grade.			
Summary of findings	**Questionnaire**72.5% score of 75 or over (out of 115) – largely positive attitude to CTG usage. Independent t-test failed to reject null hypothesis that there was no differences between doctors and midwives attitudes towards CTG in labour ward practice. 90% disagreed that CTG was essential for ensuring successful deliveries 82.5% agreed that CTG can lead to unnecessary intervention but 63.6% of doctors disagreed with this statement. Open-ended questions responses: role of CTG monitoring (reassurance, positive when used as part of clinical information), importance of effective teamwork, impact of CTG on the mother (increasing anxiety levels particularly when poor levels of agreement). **Interviews** 1. Determining appropriate usage; appropriate for mothers who had identified risk factors and in line with policy, more awareness for not using them for low risk mothers. 2. Reaching a decision; skills in interpretation, effective communication and collaboration, decision making limited to how well the information is interpreted by the health professional. 3. Professional concerns: all respondents expressed concern that there is limited evidence to support use of CTG, more intervention, and concern when used on low risk women and reducing midwives skills. 4. The way forward; more training in CTG usage, all agreed doctors and midwives should be educated together, more research, trust IA. **Overall** CTG sometimes viewed as dehumanizing and depersonalizing patient care. Respondents in interviews argued that this often had an adverse effect on the birthing atmosphere and in how relationships evolved between the mother and the professionals.				
Further comments and overall evaluation	Full ethical review and considerations. Limitations – sampling strategy and sample size may not be representative. Volunteers may have interest in the topic under discussion. Researcher was a midwife and known to the participants – bias in that participant may have molded response.				
Study details (13)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**

Full reference Rattray J, et al (2011). Foetal monitoring: a woman-centred decision-making pathway. *Women and Birth* 24 (2): 65-71. **Country** Australia **Study type** Qualitative **Study design** Grounded theory - interviews **Setting/context**	Explored midwives' decision-making processes related to the used of continuous electronic fetal monitoring on low risk labouring women. Examine complex interplay in midwives' clinical decision-making regarding CEFM.	**Sampling strategy and size** Midwives who used continuous fetal monitoring on low risk women in labour at two regional Queensland hospitals. 5 purposively selected midwives. Looked at notes for low risk women who had been monitored by CEFM and then midwives invited to participate. **Characteristics**	Semi-structured interviews. Audio-taped transcribed interview, verbatim.	Used Strauss and Corbin. Analysis started with first interview, used theoretical sampling and constant comparison until data saturation. Acknowledgment of midwife as researcher and enhancing theoretical sensitivity. Audit trail also kept with researchers self-awareness about assumptions, values, decision-making. Confirmation with other team members.	30
Summary of findings	Common decision-making pathway. MWs used personal schemas of clinical risk rather than evidence-based clinical guidelines leading to CEFM despite low risk. Decisions influenced by trust and workloads within a context of risk management and medical dominance. Four phases of pathway: **Gathering baseline information** some mw used baseline CTG as part of initial observations **Undertaking individual assessment** **Categorising according to risk** not necessarily congruent with clinical guidelines. **Deciding mode of fetal monitoring**				

	Also four key factors that explain midwives actions that were inconsistent with guidelines **Trust** more experienced – trust in own judgment, younger midwives - trust in policy. Trust also implicit from women – trust health professionals so passive in decision making about foetal monitoring. Trust and consent inferred by women. MWs didn't talk about offering women a choice of monitoring. **Workloads** increased rate of CEFM. Used CEFM as baby sitter and to provide ongoing assessment whilst caring for someone else. **Risk management** EFM precautionary measure in hope of reducing risk of an adverse event. **Medical dominance** Authors developed a woman centered decision-making pathway for fetal monitoring.				
Further comments and overall evaluation	Used a cut-off of < or > 5 years in terms of experience. Ethical approval sought and gained.				
Study details (14)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Smith V, Begley C, Clarke M, Devane D. 2012. Professionals' views of fetal monitoring during labour: a systematic review and thematic analysis. *BMC Pregnancy and Childbirth* 12: 166-174.	Offer insight and understanding, through systematic review and thematic analysis, of research into professionals' views on fetal heart rate monitoring during labour.	**Sampling strategy and size** Any study whose aim was to explore professional views of fetal monitoring during labour was eligible **Characteristics** 11 studies including 1194 participants	MEDLINE, EMBASE, MIDIRS, CINAHL. Data extraction tables developed to collect data.	Thematic analysis.	34

Country **Study type** Systematic review **Study design** **Setting/context**					
Summary of findings	Four themes were identified **Reassurance and safety:** 'proof' baby was not compromised, guarded against criticism and litigation, HPs felt improved outcomes for babies in some studies whilst in others did not. EFM can also provide a false sense of security **Technology:** 8/11 studies. More authoritative information than IA felt by some but rejected by others. CTG used unnecessarily and can lead to medical intervention. Reliance on EFM eroding traditional midwifery skills. EFM more restrictive and uncomfortable and leads to more requests for pain relief. **Communication/education:** EFM can be focus of care and distract from care provision and hinder effective communication. IA facilitated freedom for women and closeness, CTG increased anxiety in some studies but not in others. Education 4/11 studies – more education needed for all professionals, more research required, guidelines on IA needed. **Midwife by proxy:** 5/11 – associated with poor staffing levels and busy clinical environments. EFM more likely to be chosen when midwife-women ratios were reduced.				
Further comments and overall evaluation	Older studies demonstrated more faith in EFM than more recent studies Conflicting attitudes present that CTG used unnecessarily and lead to intervention but also that technology is helpful. Consideration that use of EFM no longer seen as an intervention and is part of routing practice Only 33 doctors out of 1194 participants Error in exclusion of one study but then referred to in paper frequently (same author)				
Study details (15)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Hill K.	To identify the experiences of	**Sampling strategy and size**	Tape recorded semi-structured interviews	Transcription and thematic analysis	33

2016. An exploration of the views and experiences of midwives using intermittent auscultation of the fetal heart in labour. *International Journal of Childbirth*, 6 (2) **Country** Ireland **Study type** Qualitative **Study design** Semi-structured interviews **Setting/context** Urban maternity unit	midwives using intermittent auscultation of the fetal heart in labour.	8 midwives, 3 from a DOMINO scheme and 5 from the labour ward **Characteristics**			
Summary of findings	Three core themes were identified; vulnerability, the culture of the organization, and walking the tightrope. Main challenges than inhibit use if IA – lack of professional guidelines, inconsistency in documentation, working in a biomedical model of care. DOMINO midwives more confidence in using IA. Call for guidelines on IA to be more accessible to midwives				

Further comments and overall evaluation	Small study but qualitative and valid interesting findings				
Study details (15)	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Rosenbaum AJ., Smith RM., Hade EM., Gupta A., Yilmaz A., Cackovic M. 2018. Use and experiences with external fetal monitoring devices among obstetrical providers. *The Journal of Maternal-fetal Medicine* **Country** United States of America **Study type** Quantitative + open-ended	Describe the use and experiences with external fetal monitoring devices among obstetrical providers	**Sampling strategy and size** 217 nurse, midwives and physicians invited to participate over e-mail. Had to have used EFM in practice. No exclusion criteria. **Characteristics** 63.1 % response rate N = 137 (54 obstetricians/junior doctors, 9 certified nurse midwives, 57 labour and birth midwives, 17 nurses)	Survey information – length of time in practice, satisfaction with current EFM devices, amount of time using devices. Asked if particular patients in which using EFM more challenging. Asked whether a new novel device would be a benefit and how they would like it to operate and features they would find useful.	Responses overall, 95% confidence intervals, associations using Fisher's exact test. Qualitative responses coded into categories	32

qualitative responses **Study design** Cross-sectional survey **Setting/context** Academic medical centre					
Summary of findings	98.5 % reported difficulties monitoring obese women, multiple and per-term pregnancies. 59.5% of nurses reported interacting with devices for greater than one hour during a twelve hour shift No associations between age, experience or time spent utilizing the devices				
Further comments and overall evaluation	Desire for new devices to have greater portability and wireless capability and reduced transducer size.				

7. Scoring table for health professionals views and experiences of fetal monitoring

Study #	Author/ Year	Study population	Sample size	Design	Quality assessment - Hawker's checklist: Score range 1-4 for each item [Total score: Range = 9-36]									
					Abst.	Intro.	Methods & data	Sampling	Data analysis	Ethics /bias	Results	Generisability/ Transferability	Implications	**Total score**
1	Cranston,	Nurses	124	Questionnaire	3	3	3	2	3	3	3	3	3	**26**

	1980													
2	Dover and Gauge, 1995	Midwives	117	Questionnaire	4	4	3	4	3	4	4	4	3	**33**
3	Thompson and Birch 1997	Midwives and doctors	96	Questionnaire	3	3	2	2	3	2	3	3	2	**23**
4	Sinclair 2001	Midwives	446	Questionnaire	4	4	4	3	4	1	4	3	4	**31**
5	Sinclair and Gardner 2001	Midwives	446	Questionnaire	4	4	3	3	3	1	3	3	4	**28**
6	Walker et al 2001	Nurses	145	Questionnaire	4	4	4	4	3	4	3	3	3	**32**
7	Hindley and Thomson 2005	Midwives	58	Semi-structured interviews	4	4	4	2	3	4	3	3	3	**30**
8	Altaf et al, 2006.	Midwives	66 hours of observation, 20 interviews.	Structured observations and semi-structured interviews	4	3	3	3	3	3	3	3	3	**28**
9	Hindley et al. 2006	Midwives	58	Semi-structured interviews	4	4	4	2	3	4	3	3	3	**30**
10	Blix and Ohlund 2007	Midwives	12	In-depth interviews	4	4	4	3	4	4	4	3	4	**34**
11	Hindley and Thomson 2007	Midwives	58	Semi-structured interviews	4	4	4	2	3	4	3	3	3	**30**
12	McKevitt et al 2011	Midwives	29 mw, 19 doctors	Questionnaire and semi-structured	4	4	3	3	3	4	3	3	3	**30**

			questionnaires 6 mw, 2 doctors interviews	interviews										
13	Rattray et al 2011	Midwives	5	Semi-structured interviews	4	3	3	3	4	4	3	3	3	**30**
14	Smith et al 2012	Health Professionals	1194	Systematic review	4	4	4	4	3	3	4	4	4	**34**
15	Hill 2016	Midwives	8	Semi-structured interviews	4	4	4	3	4	3	4	3	4	**33**
16	Rosenbaum et al 2018	Health professionals	217	Cross-sectional survey	4	4	3	4	4	3	4	4	3	**32**

8. Table of excluded papers for literature review of telemetry.

	Full reference	Reason for exclusion
1.	Neuman, M.R., Critchfield F.H., Lin W.C. (1970). An Intravaginal Fetal ECG Telemetry System. *Obsetrics and Gynaecology,* 35 (1), pp. 96-103	Description of radio system and application to fetal monitoring
2.	Lipshitz, J., Wade, J.E., Anderson, G.D., Sibai, B.M. (1981). Evaluation of the Corometrics 315 telemetry system for fetal monitoring. *American Journal of Obstetrics and Gyanecology* 15, pp. 199-203.	Report on functionality
3.	Vallejo, M.C., Firestone, L.L., Mandell, G.L., Jaime, F., Makishima, S., Ramanathan, S. (2001). Effect of Epidural Analgesia with Ambulation on Labor Duration. *Anesthesiology* 95 (4), pp 857-861.	Both groups with epidural
4.	Braun, T., Sierra, F., Seiler, D., Mainzer, K., Wohlschlager, M., Tutschek, B., Schmidt, S. (2004). Continuous telemetric monitoring of fetal oxygen partial pressure during labour. *Archives of Gynaecology and Obstetrics* 270, pp. 40-45.	Measuring fetal oxygen partial pressure
5.	Fox, D. (2011). Cordless and Waterproof cardiotocography. *Women and Birth*, 24(S1) pp. S38	Abstract/poster only
6.	Rauf, Z., O'Brien, E., Stampalija, T., Ilioniu F. P., Lavender, T., Alfirevic, Z. (2011). Home Labour Induction with Retrievable Prostaglandin Pessary and Continuous Telemetric Trans-Abdominal Fetal ECG Monitoring. *Plos One* 6(11), pp 1-5.	Monitoring at home, not in labour
7.	Harkey, K.T., Casale, M.B., Pantelopoulos, A. A., Zurcher, M.A. (2015). Assessing the Clinical Use of a Novel, Mobile Fetal Monitoring Device. *Plos One* 10(1), pp 1-12.	Testing functionality and acceptability in antenatal period
8.	Boatin, A., A., Wylie, B., Goldfarb, I., Azevedo, R., Pittel, E., Ng, C., Haberer, J. (2015). Wireless Fetal Heart Rate Monitoring in Inpatient Full-term Pregnant Women: Testing Functionality and Acceptability. *Plos One* 10 (1).	Testing functionality and acceptability in antenatal period
9.	Mugyenyu, G.R., Atukunda, E. C., Ngonzi, J., Boatin, A., Wylie, B.J., Haberer, J.E. (2017). Functionality and acceptability of a wireless fetal hear rate monitoring device in term pregnant women in rural Southwestern Uganda. *BMC Pregnancy and Childbirth* 17(178).	Testing functionality and acceptability in antenatal period
10.	Lafontan, S.R., Sundby, J., Ersdal, H.L., Abeid, M., Kidanto, H.L., Mbekenga, C.K. (2018). "I was	Fetal heart rate not continuously printed out,

	relieved to know my baby was safe": Women's attitudes and perceptions on using a new electronic fetal heart rate monitor during labor in Tanzania. *International Journal of Environmental Research and Public Health* 15(302).	low resource setting
11.	Lafontan, S.R., Kidanto, H.L., Ersdal, H.L., Mbekenga, C.K. Sundby, J. (2019). Perceptions and experiences of skilled birth attendants on using a newly developed strap-on electronic fetal heart rate monitor in Tanzania. *BMC Pregnancy and Childbirth* 19(165).	Fetal heart rate not continuously printed out, low resource setting

9. The Use of telemetry in labour: results of a national online survey of UK maternity units.

Research

The use of telemetry in labour: Results of a national online survey of UK maternity units

Abstract

Background Guidelines from the National Institute for Health and Care Excellence recommend that telemetry is offered to any woman who needs continuous cardiotocography in labour.

Methods An online survey of 168 maternity units in the UK was undertaken between November 2013 and February 2014 to determine how many units in the UK offered telemetry to women in labour and in what circumstances it was used.

Findings The response rate was 62% (n=101). Some 65% (n=65) of responding units had at least one cardiotocography machine that could monitor the fetal heart via telemetry. Telemetry was used most often for women who had experienced a previous caesarean section and respondents felt that mobility and satisfaction with labour experience were most likely to be positively influenced by telemetry.

Conclusion The survey gives an indication of how often and for whom telemetry is being used in the UK and describes the benefits that maternity units see for women using telemetry, such as increased choice and control.

Keywords

Fetal heart rate monitoring | Telemetry | Labour | Intrapartum care

Fetal heart rate monitoring in labour aims to identify fetuses who may be developing hypoxia, and allow timely intervention to prevent long-term poor neurological outcomes (Alfirevic et al. 2017). For most women who are healthy, have had normal pregnancies and no risk factors, evidence-based recommendations from the National Institute for Health and Care Excellence (NICE) are that the fetal heart rate can be monitored through intermittent auscultation every 15 minutes, using a Pinard or hand-held Doppler device (NICE, 2014). Continuous electronic fetal monitoring involves the use of two transducers (one to monitor the fetal heart and one to monitor uterine activity) attached to the woman's abdomen via leads and connected to a cardiotocograph machine (CTG). A continuous record of the fetal heart and uterine activity is recorded and printed. Continuous electronic fetal monitoring is recommended for women who enter labour with an underlying medical or fetal condition or in the event that complications develop during an otherwise low-risk labour. In the UK, approximately 60% of women will have continuous electronic fetal monitoring at some stage of their labour (NICE, 2014).

The advantage of electronic fetal monitoring is that the fetal heart and uterine activity can be continuously recorded showing trends over time. The CTG can then be systematically assessed and categorised per a set of criteria (NICE, 2014) and further assessment undertaken (such as fetal blood sampling or expediting the birth). Disadvantages are that clinical staff may focus on the recording and interpretation of the CTG rather than the woman, and that there are likely to be more interventions (Alfirevic et al. 2017). In addition, the leads prevent the woman from moving freely, changing position, or using the bath or pool. While women may derive a sense of reassurance from increased surveillance and hearing the fetal heart continuously they also view it as being associated with technical medicalisation of birth and enforcing immobility and discomfort (Mangesi et al. 2008; Barber et al. 2011).

Kylie Watson (corresponding author)
Senior midwife, Manchester University Foundation Trust and PhD student, University of Manchester

Tracey A Mills
Lecturer in midwifery,
University of Manchester

Dame Tina Lavender
Professor of Midwifery,
University of Manchester

kylie.watson@postgrad.manchester.ac.uk

Telemetry

Electronic fetal monitoring by telemetry also employs two transducers on the abdomen, but information about the fetal heart and contractions is transmitted wirelessly. The woman is freely mobile and as the transducers

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are waterproof, can be immersed in water. Telemetry machines can be purchased in addition to conventional electronic fetal monitoring equipment at an added cost, as well as being available as an integrated part of fetal heart rate monitoring equipment.

A meta-analysis of 6 randomised controlled trials ranging from 1978–2004 found no difference in the mode of birth or length of labour for women monitored using telemetry, compared with women monitored using conventional CTG (NICE, 2014), although use of telemetry was associated with lower rate of epidural use compared to conventional CTG (NICE, 2014). The majority of the literature used in this meta-analysis is outdated; much of the telemetry described required a fetal scalp electrode to be attached and for women to carry extra equipment around. The UK intrapartum guidelines (NICE, 2014) formally recommend that all women having continuous fetal heart monitoring in labour should be offered telemetry but caution that, given there is no recent peer-reviewed literature evaluating the use of telemetry, further research should be undertaken. Future research should explore any effect on neonatal outcomes, duration of labour, and use of pain relief, as well as evaluating women's and midwives' experiences of telemetry during labour (NICE, 2014). A recent service evaluation has been performed in one UK maternity unit following the introduction of 10 telemetry units to support active birth for all women (Morrall and Beach, 2017). Following the introduction of wireless monitoring, the normal birth rate increased over a 3 year period from 59.9% to 64.7%, and both staff and women evaluated the project positively.

Despite the recommendation from NICE, there was no indication of the number of maternity units in the UK that have telemetry, how often it is used and in what circumstances. This survey therefore aimed to gather information from maternity units on whether they offered telemetry in line with guidelines, and to gain a sense of how telemetry was used, the women for whom it was used and whether there were any perceived advantages or disadvantages to using telemetry for women in labour. A national online survey was therefore developed and sent to all maternity units in the UK.

Methods

An online survey method was chosen for practicality as it was thought that responses would be reasonably rapid once emails had been received. Ethical approval was not required. Given that there was very little contemporary literature on the use of telemetry to inform question development, the survey questions were developed pragmatically by the authors, drawing from clinical experience and expert opinion. Questions were entered into the online survey platform (surveymonkey.com)

Telemetry provides an alternative to hand-held Dopplers for fetal monitoring in women who wish to be more mobile or have a waterbirth

There were 20 questions in total; the initial 5 were closed geographical and demographic questions such as size and location of the maternity unit and the role of the health professional completing the questionnaire. The following 15 questions related directly to the use of telemetry; 8 of these questions also had space for free text comments and the final question was for any further comments the respondent wished to make.

Sample and data collection

The survey was undertaken over a 12-week period from November 2013–February 2014. Email addresses for Heads of Midwifery from 168 maternity units in the UK were obtained from local supervising authority midwifery officers, and a covering letter detailing the study, including contact details and a link to access the survey, was sent. In January 2014, a further email was sent to units that had not responded. Heads of Midwifery were asked to forward the survey on to another member of staff if they were unable to complete it themselves. A further email was sent to all consultant midwives in the UK with the link to the online survey, in order to increase uptake. Data were collected and managed via the online survey tool and response rates checked regularly.

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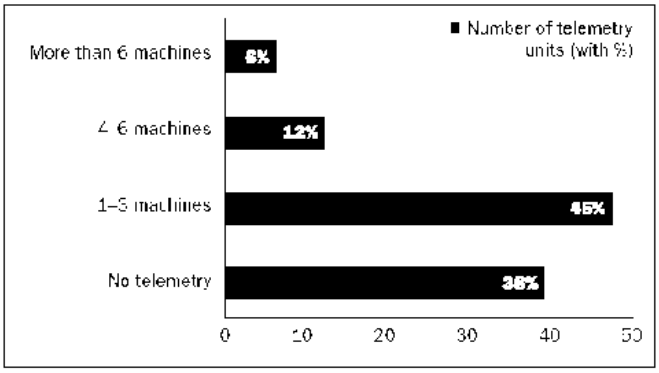

Figure 1. How many telemetry units do you have for providing continuous fetal heart monitoring in labour?

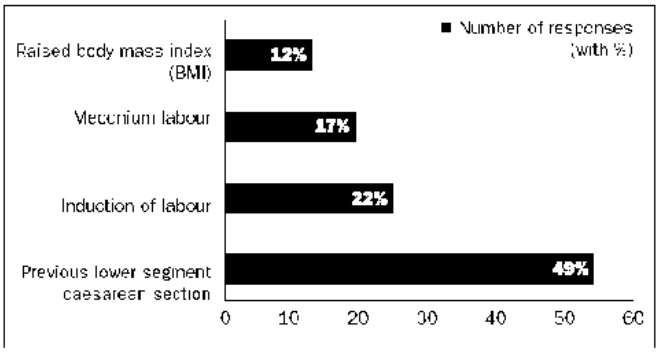

Figure 2. For which women is telemetry most used? (*n*=112)

Data analysis

Once the survey had closed, data were checked to ensure that units had not responded twice. Data were analysed descriptively and presented in tables. Free text content was thematically analysed using simple tables to allow collation of topics and development of themes.

Results

The response rate for the survey was 62% (*n*=104). Respondents were Heads of Midwifery (29%), consultant midwives (20%), midwifery matrons (19%) and senior midwives (32%). There was a spread of responses from throughout the UK including Wales, Northern Ireland and Scotland, with the highest number of responses coming from northwest England (13%), southwest England (11%) and London (14%). Of the units responding, 40% were for >5000 women per year, 32% between 3000 and 5000 per year, 21% between 1000 and 3000 per year and 7% for fewer than 1000 women per year.

Telemetry provision, frequency and guidelines

Responses for how many telemetry machines units had for providing continuous electronic monitoring of the fetal heart in labour are presented in *Figure 1*. In total, 38% (*n*=39) of maternity units did not have the facility to monitor with telemetry; 45% (*n*=47) had between 1 and 3 machines; 12% (*n*=13) had between 4 and 6 machines and 6% (*n*=6) had more than 6 machines. Overall, 63% (*n*=65) of responding units could provide telemetry for women in labour. One maternity unit responded in free text about the number of telemetry machines available:

> *'We have 18 units for intrapartum, all have telemetry, we have no others available for intrapartum.' (Obstetric and alongside maternity unit, >5000 births per year)*

Although there were 65 maternity units with telemetry, not all of the units responded to all of the questions (ranging from 59–62). The majority of responding maternity units that could provide telemetry (*n*=46/62; 74%) had been using it for more than 1 year. Of the 39 maternity units that did not have telemetry, 50% (*n*=18) were intending on purchasing in the next 6 months. Some maternity units had trialled machines that they were going to purchase, while others were raising business cases for purchase.

In order to get a sense of how often telemetry was used, maternity units were asked how many women per week would use telemetry in labour and 62 out of 65 units with telemetry responded to this question. 5% (*n*=3) stated that no women used telemetry; 50% (*n*=31) stated that between 1 and 4 women would use it per week; 21% (*n*=13) stated between 5 and 10 women per week and 24% (*n*=15) stated more than 10 women per week. Of responding maternity units with telemetry, 52% (*n*=32) had guidelines specifically related to telemetry and monitoring the fetal heart, with three free text comments stating that their guidelines were only related to electronic fetal monitoring and not telemetry specifically. A large proportion (82% (*n*=50/61)) of maternity units with telemetry machines stated that the machines could move around the unit, rather than being allocated to specific rooms. Some machines remained permanently in rooms with pools and 97% (*n*=59/61) of units with telemetry had a pool available for use. Maternity units with telemetry were asked what proportion of women using telemetry would also use the pool; 75% (*n*=44/59) of units stated that less that 25% of women would use the pool with telemetry.

Issues with telemetry machines

Maternity units were asked whether they had experienced any problems with telemetry monitoring

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and 52% (*n*=32/61) of units stated that they had. There were 78 free text comments including those relating to transducers breaking or being lost and expensive to replace, loss of contact resulting in poor quality recordings, and issues with coverage and connectivity. The most frequently cited problem was that there were occasions where transducers were not being returned for charging and so not ready for use.

For whom is telemetry used?

Responses to the question 'For which women is telemetry most used?' are given in *Figure 2*. Respondents could give more than one answer and, in total, 112 responses were provided. Women who had had a previous caesarean section were the group for whom telemetry was used the most (*n*=55, 49%). There were 17 additional free text responses, which commonly said that telemetry was used for any women requiring continuous fetal heart rate monitoring who wished to be mobile or wished to use the pool. As one free text comment explained:

> *'We use telemetry as standard for women requiring electronic fetal monitoring.' (Obstetric, alongside and freestanding maternity unit, >5000 births per year)*

Of the responses received, 12% (*n*=13) identified women with a raised body mass index (BMI) as a group for whom telemetry was used.

Influence on birth

Responses to the question 'In your experience, which labour outcomes are positively influenced using telemetry?' are given in *Figure 3*. The parsing of this question may have produced subjective responses but the authors felt that, as senior midwives were completing the survey, their knowledge and experience about perceived influences on outcome would be beneficial to gauge. More than one answer could be given, and a total of 166 responses were given from 56 maternity units. Mobility in labour (*n*=52; 31%) and satisfaction with labour experience (*n*=47; 28%) were given as the top two outcomes that respondents felt telemetry could influence. Comparatively smaller numbers were given for length of labour (*n*=10; 6%), use of pharmacological pain relief (*n*=21; 13%), mode of birth (*n*=17; 10%) and labour progress (*n*=16; 10%). Maternity units that had telemetry were asked if they collected any data on its use and only 10% (*n*=6/61) of units did. These units had not been collecting data for long and did not have any findings that were able to be shared with the authors.

General comments

Finally, maternity units were asked if they had any additional comments to make about the use of telemetry for continuously monitoring the fetal heart in labour. A total of 23 comments were received. Some of the comments related to telemetry being available but not being embedded well within the unit. One respondent commented that:

> *'We have had problems with the telemetry, and the midwives don't like it, though not sure why' (Obstetric unit, >5000 births)*

One comment highlighted that staff were not confident with using telemetry. Comments also related to capabilities of the machines including difference between models, fetal scalp electrode facility, and the difficulties of monitoring women with a higher BMI.

Most free text comments were positive and included themes of getting funding to introduce more, encouraging staff to use telemetry, promoting its use as standard and responding to women's choice. One respondent stated:

> *'Telemetry has enabled us to provide the same birth choices for women with risk factors as those who are low risk. High risk women in the past have been disadvantaged – but thankfully that is now not the case. We are changing any monitor that needs replacing to telemetry to improve choices for women.' (Obstetric, alongside and freestanding maternity unit, 3000–5000 births per year)*

A further response confirmed intentions to purchase more telemetry in the future.

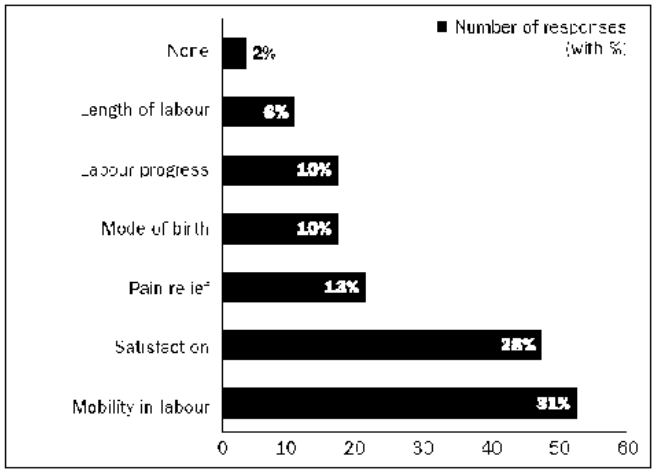

Figure 3. Which aspects of labour are positively influenced by the use of telemetry? (*n*=166)

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'We plan to introduce more units in the next year as this is what high risk women want to give them control over their delivery experience.' (Obstetric unit alongside maternity unit, 3000–5000 births per year)

Discussion

Limitations of this survey are that the response rate meant that only 104 maternity units provided responses, however, a 92% response rate is comparable with a recent national maternity surveys (Richens et al, 2015; Mills et al, 2016) and more favourable than others (Cooke et al, 2011; Jokhan et al, 2015). This online survey was designed as a snapshot look at the availability of telemetry within UK maternity units, to give a sense of how and when it was used, and any perceived advantages or disadvantages. It was not designed to investigate barriers or facilitators to the use of telemetry, including organisational and cultural factors and training for midwives, in detail, and future in-depth research is needed in this area. The survey was also not able to capture views and preferences of women on the use of telemetry and this is an additional area for further investigation.

The main strength of this study is that it is the only survey done of contemporary telemetry use in UK maternity units. It provides an insight into how telemetry is used and highlights a potential 'turn-of-tide' in the way that women are, and have the potential to be, continuously monitored in labour. There was excellent geographical spread of respondents, giving confidence that the survey could determine a realistic picture of telemetry use in maternity units in the UK. The survey responses from more than 100 maternity units indicate that telemetry is available in a majority and that many other maternity units are looking to purchase more to provide increased choice for women with more complex pregnancies and labours. It was evident from the survey that telemetry was used for the most common reasons for a woman to be continuously monitored, such as meconium, previous caesarean section, and induction of labour. Telemetry is also being used to monitor women with a raised BMI. While there is no clear guidance on obesity and continuous fetal heart rate monitoring (Centre for Maternal and Child Enquiries and Royal College of Obstetricians and Gynaecologists, 2010), it is evident that telemetry is being used for these women and aligns with telemetry use in the literature on how to increase normal birth rates for obese women (Swann and Davies, 2012; Kerrigan et al, 2015).

Some of the problems with telemetry were also highlighted, and there was an indication that issues such as transducers not being left to charge, or problems with the signal, may be affecting how units with telemetry are able to embed it. One of the assumptions about telemetry is that women will be more upright and

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mobile in labour, which was mirrored in the free text responses that concerned the benefits of telemetry. Both mobility and use of a birthing pool in labour have been shown to reduce length of labour and use of pharmacological analgesia (Cluett et al, 2009; Lawrence et al, 2013); however, there is no evidence that telemetry means that women are more mobile and upright during labour or use a birth pool more often, and more research is warranted in this area. Satisfaction with labour experiences also featured highly, an indication that the ability to be more mobile leads to increased satisfaction.

Conclusion

This survey showed that 59% of responding maternity units had telemetry to monitor the fetal heart in active labour, and 49% of units without telemetry were planning on purchasing some in the near future. The benefits that maternity units saw for women by providing telemetry were clear, primarily regarding providing choice for 'high-risk' women, and it is recommended that maternity units continue to provide this option. Further research is planned by the authors to broaden the understanding of telemetry use and to investigate whether telemetry has an effect on control or satisfaction in labour, mobility, and labour outcomes such as length of birth and use of regional anaesthesia.

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Ethical approval: Not required.

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Key points

- Guidelines for intrapartum care recommend that women who require continuous monitoring in labour are offered telemetry
- This survey showed that 63% of responding units have telemetry to monitor the fetal heart in labour
- Telemetry was thought to positively influence mobility and satisfaction with labour, and units felt that telemetry enabled them to offer more choice to women deemed as 'high risk'
- It is recommended that telemetry be offered to women in active labour but that more research be undertaken to obtain a deeper understanding of its use and potential impact on labour outcomes

CPD reflective questions

- Does your maternity unit offer telemetry monitoring for women to use during labour?
- Do you know how the telemetry works in your unit? If not, do you know who you could ask?
- Could you offer telemetry for the women you care for who require continuous fetal monitoring to help facilitate increased mobility in labour?

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Swann L, Davies S. (2012) The role of the midwife in improving normal birth rates in obese women. British Journal of Midwifery. 2012;20(1):7–12. https://doi.org/10.12968/bjom.2012.20.1.7

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10. Critical Appraisal and scoring for literature review of telemetry to monitor the fetal heart in labour

Study details (1).	Aims/objectives	Participants	Data collection	Analysis	Quality Score
Full reference Flynn A, Kelly J. 1976. Continuous fetal monitoring in the ambulant patient. **Country** England **Study type** Descriptive observational – non-comparative **Setting/context** No details	Report on outcomes for 30 women who had telemetry in labour.	**Sampling strategy and size** Non-random 30 women (18 normal and 12 "at risk"). **Characteristics** Spontaneous labour in 27 and IOL in 3. 10 Gravida 1, 14 G2, 6 G3	Length of labour, ambulation, IV fluids, oxytocin, questioned after birth but no details	No details	14
Summary of findings	A satisfactory, readable record was obtained in all cases with little signal interference. Mean duration of labour was 5 hours, ambulation was 2 hours All women questioned 24 hours after delivery were completely satisfied with their labour, 24/30 would have liked to be ambulant longer as they believed contractions were more comfortable standing or walking then when sitting or lying in bed. Staff enthusiastic – more 'natural' No cases of infection				

	28/30 normal births, 2/30 forceps. 8/30 had pethidine Mean APGAR scores 8.87 at one minute, 9.93 at five minutes. Conclude that bonding with baby might be increased and thromboembolism decreased.				
Further comments and overall evaluation	Forewater amniotomy if not ruptured membranes. Transmitter worn around woman's waist Display unit at nurses' station All women returned to bed for second stage. Old and poorly reported.				
Study details (2).	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Flynn A, Kelly J, Hollins G, Lynch P. 1978. Ambulation in labour. *British Medical Journal* 2 (6137): 591 - 593 **Country** England **Study type** Randomised controlled trial **Setting/context**	None given but RCT of ambulation in labour vs. recumbent.	**Sampling strategy and size** Women who expressed an interest in ambulation were when in labour randomly allocated to ambulant (telemetry) or recumbent – no details given how. Patients who remained in bed were told there were not more telemetry machines. **Characteristics** 34 women in each group – 17 primips and 7 multips. One breech in each group. Difference in station at	Minimal details – no details about how collected	No details	17

		entry.			
Summary of findings	Uterine action significantly better in ambulant group First stage of labour over 2 hours shorter inn ambulant group. Contractions less frequent but higher amplitude. Mean time spent ambulant was 2.2 hours, more of women in bed needed augmentation 31/34 normal birth in ambulant group, 22/34 bed group ($p<0.01$) 20/34 no analgesia ambulant group, 0/34 in bed group ($p<0.001$) Smaller mean dose pethidine in ambulant group No sig difference in blood loss. APGARS sig better in ambulation group				
Further comments and overall evaluation	Forewater amniotomy if not ruptured membranes. Electrode applied to presenting part and intrauterine pressure catheter also inserted. Transmitter worn around woman's waist. No inclusion exclusion criteria All women in bed for second and third stages. Vaginal examination every 2 to 3 hours Significant bias in that women who wanted to ambulate were randomized – not acknowledged. Primary study of ambulation vs recumbent – women may act differently if randomized to telemetry rather than ambulation.				
Study details (3).	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference MacLennan AH, Green RC. 1979. Fetal Heart Rate Monitoring During Ambulant Labour Using a Modified Adult Radio telemetry System.	Description of telemetry use during labour	**Sampling strategy and size** Women who wished to ambulate and were not confined to bed by IV infusions, intrauterine pressure catheters or epidurals. ?gestation or other characteristics. 300 women **Characteristics**	No information	No information	10

Australia and New Zealand Journal of Obstetrics and Gynaecology 19 (3), 135-138. **Country** Australia **Study type** Descriptive observational – non-comparative **Setting/context**		'Favourable' group mostly in spontaneous labour.			
Summary of findings	90% of tracings high quality Average length of time ambulant just over 2 hours, average length of labour 5.5 hours. 76% had spontaneous delivery, analgesic requirements less than average. Well accepted by women and staff, women appreciated freedom to ambulate and reassurance that fetus was being monitored without anxiety of the presence of the monitor. Suggest facilities should be redesigned to facilitate ambulation.				
Further comments and overall evaluation	Forewater amniotomy if not ruptured membranes. Electrode applied to presenting part. Transmitter fits into pocket on a belt that woman wears above fundus. If fetal distress then changed to conventional. Report that it was a feasibility study and had no control group Very poorly reported and analysed				
Study details (4).	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Calvert JP,	Assess the effect of telemetry on the	**Sampling strategy and size**	Within 24 hrs after birth all women asked to		17

Newcombe RG, Hibbard BM. 1982. An assessment of radiotelemetry in the monitoring of labour. *British Journal of Obstetrics and Gynaecology* 89 (4): 285-291. **Country** Wales **Study type** Randomised controlled trial **Setting/context**	pattern of labour, outcome and attitude of patients.	Eligible if had single fetus of at least 37 weeks gestation, vertex and no contraindication to vaginal birth. Previous stillbirth, neonatal death or previous LSCS were excluded. Included in trial if eligible, spontaneous labour, contracting every 10 minutes, at least 2.5 cm dilated. Random allocation to conventional CTG or telemetry by whether hospital number was odd or even. Those with telemetry were told could get out of bed to walk or sit in chair if they desired. **Characteristics** No differences between groups and mean gestational ages same but no data reported	complete a questionnaire to express experience of pain, anxiety, comfort and restriction of mobility during 1st stage of labour and degree of anxiety or reassurance attributed to the monitor – linear analogue scale (0 – 100) Multips with previous experience of conventional CTG were asked to compare experience in this labour.		
Summary of findings	CTG traces were indistinguishable in quality from conventional. Three groups (A) out of bed for any period with telemetry = 45 women (B) monitored with telemetry but elected to stay in bed				

	= 55 women (C) conventional monitoring = 100 women. Groups well matched and no statistical significant differences between them. (A)Out of bed for average time of 1hr 44 mins. One third out of bed for more than 3 hours No difference in duration of first stage of labour between groups Second stage significantly longer in (A) than (B) or (C) Highest pain score was for primips in group (A) Highest anxiety in group (B) No differences in comfort, anxiety Group A(A) statistically significant difference in how restricted they felt Primps more reassurance from monitoring than multips Compared to conventional monitoring in previous labour telemetry groups preferred this method, felt less restricted and less anxious Conclude no obstetric advantage to getting out of bed, however few patients elected to spend most of labour out of bed				
Further comments and overall evaluation	Forewater amniotomy if not ruptured membranes. Electrode applied to presenting part. Either intrauterine catheter or abdominal transducer. Monitor outside the room for telemetry, inside the room for conventional. Moved inside the room for second stage Vaginal examination every two hours All women in bed in lateral position.				
Study details (5).	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Haukkamaa M, Purhonen M, Teramo K. 1982. The monitoring of labor by telemetry. *Journal of*	1. To determine the duration of labour and need of analgesia in normal parturients monitored by telemetry.	**Sampling strategy and size** 60 women 38 – 42 weeks pregnant Matched for age (+/- 5 years), parity, and duration of pregnancy. After matching	Women monitored subjective pain very 30 mins by grading from 0-10. Also filled in a questionnaire about pain 2 hours after birth.	Student's t-test and Chi-squared	14

Perinatal Medicine 10 (1): 17-22 **Country** Finland **Study type** Randomised controlled trial **Setting/context**	2. Study the safety of telemetry during the upright position after ruptured fetal membranes	telemetry was randomly allocated to one or other of the women. Method not reported **Characteristics** 31 monitored by telemetry 29 monitored by conventional CTG IOL 32% of telemetry, 24% control			
Summary of findings	4/31 vacuum, 27/31 SVD. 2/29 vacuum, 1/29 forceps, 2/29 LSCS, 24/29 SVD in conventional. Duration of first stage of labour did not differ significantly between the groups. Upright position varied from 10% to 90%. 6/31 refused to get out of bed. Telemetry received less analgesia than controls. Secondparas in telemetry group experienced significantly less pain than conventionally monitored group (Chi-squared = 11.54, $p<0.01$). Telemetry women considered present labour less painful significantly more often than the controls (Chi-squared = 6.59, $p<0.05$).				
Further comments and overall evaluation	Forewater amniotomy if not ruptured membranes. Fetal scalp electrode applied to presenting part. Husband attended labour in 42% of telemetry and 59% of conventional.				
Study details (6).	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Hodnett E. 1982. Patient Control During Labor. *JOGN*	Investigation into maintenance of control in labor	**Sampling strategy and size** 30 low risk women who had attended antenatal classes, consented to	Each woman kept a written record of the amount of time spent out of bed until transferred to delivery	Interval and ratio data analysed using Student's t-test, Nominal data analysed using Fisher's exact	18

Nursing 11 (2): 94-99. **Country** Canada **Study design** Randomised controlled trial **Setting/context**		participate and had uncomplicated normal births. As admitted to labour and delivery unit was randomly assigned to either control or experimental group. No details given of randomisation method. **Characteristics** No details given.	room. Within 48 hours of birth each women completed the Labor Agentry Scale (not clear what range of scores were) and also an interview by investigator. Length of labour, analgesia use, use of oxytocin collected from medical records.	test or Chi square.	
Summary of findings	Telemetry group spent significantly more time out of bed (p<0.0005) – mean was 142.7 minutes. 6/15 telemetry group no anesthesia, 15/15 controls had epidural. No difference in length of labour or oxytocin use. Telemetry group scored significantly higher on Labor Agentry Scale 8/15 telemetry group indicated labours were more pleasant than had anticipated - less painful, more satisfying and/or shorter. 1/15 in control group. 14/15 telemetry positive responses to influence of fetal monitor. 10/14 had conventional monitoring prior to telemetry (?why) so were able to compare. Negative comments about conventional – interference with movement, discomfort. 5/15 controls felt monitor had a positive effect on labour experiences – reassurance and assistance with breathing at onset of contraction.				
Further comments and overall evaluation	Major bias – only included those who had a normal birth so whilst selected antenatally only the normal births have been reported. Those who consented at the pre-interview may have been more likely to want to ambulate during labour. Self-reporting of time spent out of bed right up until birth – how? Forewater amniotomy if not ruptured membranes. Fetal scalp electrode applied to presenting part. Only pain relief offered in unit was epidural – nothing else.				

Study details (7).	Aims/objectives	Participants	Data collection	Analysis	Quality Score
Full reference MacLennan AH, Crowther C, Derham R. 1994. Does the Option to Ambulate During Spontaneous Labour Confer Any Advantage or Disadvantage? *The Journal of Maternal-Fetal Medicine* 11 (2): 94-99. **Country** Australia **Study type** Randomised controlled trial **Setting/context** Australian maternity unit.	To determine if there is any advantage or disadvantage to giving the option to ambulate in labour compared with labour in a recumbent position in relation to length of labour, need for analgesia, mode of delivery, and maternal satisfaction.	**Sampling strategy and size** 196 women in spontaneous established labour with a singleton fetus in a cephalic presentation between 37 and 42 weeks who had the ability to ambulate in labour were randomized to either ambulation as desired or a recumbent group. Had to be 3cm or more, excluded if had IV fluids, hypertension, epidural or narcotic analgesia at or before entry, evidence of fetal distress, IOL. Randomisation by balanced variable blocks with stratification by parity. **Characteristics** Demographics of both groups similar	Case notes – demographics, length of labour from trial entry to delivery, analgesic requirements, need for augmentation, FHR abnormalities, FBS, mode of delivery, APGARs, major complications, time spent ambulating, sitting or recumbent. After labour each woman completed a visual analogue score rating her satisfaction or otherwise with the type of fetal monitoring and on capacity to ambulate (score 0 – 10).	Student t-test for continuous variables and Chi square test for nominal.	28

Summary of findings	No significant differences with regards to length of labour, oxytocin requirements or FHR abnormalities. No sig difference in use of analgesia. No sig difference in mode of delivery or APGARs. Only 37/96 (39%) of women in ambulation group chose to ambulate for 30 mins or more, mean time was 1.5 hours, mean time sitting 0.3 hours, mean time recumbent 4.5 hrs. Non-significant trend for higher mean satisfaction score for ambulation				
Further comments and overall evaluation	Forewater amniotomy if not ruptured membranes. Fetal scalp electrode applied to presenting part. Recumbent group 45 degrees or on side Allowed for variations in length of labour in association with parity and dilatation at time of trial entry. Only powered to 25% for analgesia – could not enroll enough women as didn't want to lose option to ambulate. Little details on setting or labour care ie 1:1, if partners were involved. Evaluates ambulation vs recumbent, therefore might have acted differently if allocated to telemetry.				
Study details (8).	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Karraz MA. 2003. Ambulatory epidural anesthesia and the duration of labour. *International Journal of Gynecology and Obstetrics* 80 (2): 117-122. **Country** France **Study type** Randomised	Testing that a method of analgesia that allowed women to walk had specific advantages regarding mode of delivery, duration. Consumption of local anesthetic, oxytocin requirement and labour.	**Sampling strategy and size** 221 women with uncomplicated pregnancies in spontaneous labour between 36 and 42 weeks or who were scheduled for IOL were randomly (no details given) divided into two groups – ambulatory and non-ambulatory. Excluded if LSCS or pre-eclampsia. All were given intermittent epidural. Women had a 2:1 chance of being	From case notes.	t-test and Chi square	30

controlled trial **Setting/context**		assigned to ambulatory groups. Ambulatory monitored by telemetry. Women who delivered <15 mins from epidural were excluded. All women in ambulatory group walked for 20 mins after epidural topped up. 141 in ambulatory group, 74 in non-ambulatory groups. **Characteristics** Comparable at baseline			
Summary of findings	No differences between group demographics No differences in use of oxytocin, or amount of epidural used. No differences in mode of delivery or APGARs. Significant difference in labour duration 173 min in ambulatory 236 in non-ambulatory.				
Further comments and overall evaluation	Women in ambulatory group allowed to walk if acceptable analgesia, acceptable systolic BP, and ability to stand on one leg. Major bias – only conducted in day time as women in labour at night are 'often tired and less inclined to walk'. Study was ambulation after epidural so women may have acted differently if assigned to telemetry rather than ambulation.				
Study details (9).	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Frenea S,	To investigate duration of labour and pain	**Sampling strategy and size**	Unclear how outcome data were	Student t test, Chi squared, Mann	33

Chirossel C, Rodriquea J-PB, Racinet C, Payen J-F. 2003. The Effects of Prolonged Ambulation on Labour with Epidural Analgesia. *Obstetric Anesthesia* 98: 224-9. **Country** France **Study type** Randomised controlled trial **Setting/context**	scores by comparing ambulation versus recumbence in women with uncomplicated term pregnancies receiving epidural analgesia.	61 women (calculated needed 26 in each arm for 80% power detecting 30% reduction in duration of first stage of labour). If requested epidural analgesia then randomly allocated to recumbent or ambulate group using sealed, numbered envelopes on first dose of epidural was in. Singleton pregnancies 37-42 weeks cephalic, uncomplicated, 3-5cm dilation. Spontaneous labour or IOL. Group 1 (31 women) – bed in dorsal or lateral positions, no telemetry. Group 2 (30 women) – asked to walk at least 15 mins of each hour. Returned to bed at full dilatation. **Characteristics** Similar in both groups.	collected.Level of pain assessed using visual analogue scale (0 – 100). Mean pain VAS score calculated. One day after birth women questioned about side effects and overall satisfaction using a 4 level scale. Analysis on intention to treat basis.	Whitney U test	
Summary of findings	25/30 in Group 2 walked for 29% of first stage of labour. Ambulant group required less oxytocin and less bupivacaine (p=0.03 and 0.01 respectively).				

	No difference in length of labour, need for oxytocin, mode of delivery or other outcomes. Ambulant group more likely to void spontaneously and less likely to need catheterization. Pain scores did no differ				
Further comments and overall evaluation	Amniotomy only if slow progress. Primary study of ambulation vs recumbent – women may act differently if randomized to telemetry rather than ambulation.				
Study details (9).	**Aims/objectives**	**Participants**	**Data collection**	**Analysis**	**Quality Score**
Full reference Watson K., Mills T., Lavender T. 2018. The use of telemetry to monitor the fetal heart in labour: results of a national online survey of UK maternity units. *British Journal of Midwifery* 26 (1), p 14-19. **Country** United Kingdom **Study type** On-line survey	To determine how many units in the UK offered telemetry to women in labour and in what circumstances it was used.	**Sampling size and strategy** Invitation to complete on-line survey sent to all Heads of Midwifery in the United Kingdom. **Characteristics** 104/168 units responded (62%).	On-line survey	Descriptive analysis, free text analysed thematically	31

Setting/context United Kingdom Maternity Units					
Summary of findings	• 63% of units could provide telemetry for use in labour ranging from 1 - >6 machines • 50% of units without telemetry were planning on purchasing in the next 6 months • 52% of units reported problems with machines including transducers breaking, becoming lost, loss of contact • Telemetry mostly used for women having had a previous LSCS, induction of labour, meconium in labour and raised BMI • Respondents felt that mobility in labour, satisfaction, pain relief and mode of birth could be positively influenced by the use of telemetry • Most free text comments positive about telemetry but some units stated that staff had not embraced its use and that staff were not confident using it.				
Further comments and overall evaluation	Did not investigate barriers or facilitators to using telemetry including organsational or cultural factors.				

11. Scoring table for literature on using telemetry to monitor the fetal heart in labour

Study #	Author/ Year	Study Population	Sample size	Design	Quality assessment - Hawker's checklist: Score range 1-4 for each item [Total score: Range = 9-36]									
					Abst.	Intro.	Methods & data	Sampling	Data analysis	Ethics /bias	Results	Generasability/ Transferability	Implications	**Total score**
1.	Flynn and Kelly, 1976	Women in labour	30	Descriptive observational	2	2	2	1	1	1	2	1	2	**14**
2.	Flynn et al, 1978	Women in labour	68	RCT	2	2	2	2	2	1	3	1	2	**17**
3.	MacLennan and Green, 1979	Women in labour	300	Descriptive observational	1	2	1	1	1	1	1	1	1	**10**
4.	Calvert et al, 1982	Women in labour	200	RCT	2	2	2	2	2	1	3	1	2	**17**
5.	Haukkamaa et al, 1982	Women in labour	60	RCT (matched)	1	2	2	2	2	1	2	1	1	**14**
6.	Hodnett, 1982	Women in labour	30	RCT	2	2	2	1	2	2	3	2	2	**18**
7.	MacLennan et al, 1994	Women in labour	196	RCT	4	4	3	3	3	3	3	2	3	**28**
8.	Karraz, 2003	Women in labour – all with epidural	221	RCT	4	4	4	3	3	3	3	3	3	**30**
9.	Frenea et al, 2004	Women in labour – all with epidural	61	RCT	4	4	4	4	4	4	4	3	3	**33**
10.	Watson et al, 2018	UK maternity units	104 units	On-line survey	4	4	3	3	3	3	4	4	3	**31**

12. Guideline for the use of telemetry in a birthing pool – 'Beach'

Appendix 1: Birthing Pool Criteria

PREREQUISITE CRITERIA	
Women must have	A singleton pregnancy, with cephalic presentation at 37 to 42 completed weeks gestation
	normal maternal observations - Pulse < 100bpm, Temp 37.5°C or below, BP < 140/90 (unless known essential hypertension or pregnancy induced hypertension on treatment – see below)
	Hb >90g/L
	reassuring intermittent fetal heart auscultation or adequate recording of normal CTG
	one-to-one midwifery care
	Access to telemetry for continuous electronic fetal monitoring if required
Women must not	have had recent opiate analgesia. Women must not re-enter the water for a minimum of 2 hours after opiates and until they are no longer drowsy.
	be on a continuous intravenous infusion of any type
	have a history of shoulder dystocia or PPH >1000ml
	have any new intrapartum risk factors including APH

INCLUSION CRITERIA THESE WOMEN CAN LABOUR AND GIVE BIRTH IN THE POOL		
		Additional notes
Telemetry not necessarily required	BMI <40	
	Group B Strep	Provided there is no evidence of infection N.B. IV antibiotics must be given out of the pool
	Non-significant meconium stained liquor	Remain vigilant to ensure meconium is not becoming significant. If there is any suspicion this is the case the woman must be asked to leave the pool for further assessment and observation of meconium.
	Prolonged SROM	Provided there is no evidence of infection
	Spontaneous labour following Prostin, Propess, cervical ripening balloon or ARM	
	Women on LMWH	Unless <12hrs post treatment dose
Telemetry CTG monitoring required	Antiphospholipid syndrome	
	Obstetric cholestasis	
	VBAC	One previous LSCS only
	Well controlled essential hypertension / pregnancy induced hypertension with a BP<150/100	
	Reduced fetal movements	
	Renal disease provided BP well controlled (BP<140/90)	
	SGA with normal/abnormal liquor & normal Dopplers	
	Thrombocytopaenia	Unless Platelet count is <80
	Thyroid disease (where CTG is indicated)	
	Well-controlled diabetes i.e. GDM or type 2 diabetes controlled with diet or metformin and with normal CBGs.	Women must not be at significant risk of hypoglycaemia or using a sliding scale

If women with other risk factors, outside of the prerequisite and inclusion criteria, wish to use the birthing pool this should be discussed with the consultant on-call regarding the suitability of labouring and delivering in water

13. Participant information sheet for interviews with women



NHS Manchester University NHS Foundation Trust

NHS Lancashire Teaching Hospitals NHS Foundation Trust

NHS National Institute for Health Research

MANCHESTER 1824

Participant Information Sheet Interviews (women): Version 2.0, 07/01/2018

Using telemetry to monitor the fetal heart in labour: A mixed methods study

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for taking the time to read this.

What are we trying to find out?

Continuous monitoring of a baby's heart during labour is recommended in certain situations by your doctor of midwife. Traditional fetal monitoring involves two circular discs placed on the abdomen (one for the heart beat and one for the contractions). The discs are held in place with stretchy straps and they are connected via leads to a larger machine which records and prints the information. Movement of the woman can be restricted by the leads and many women tend to remain on or near the bed. Monitoring by telemetry also uses two discs placed on the abdomen but there are no wires and the information is sent to the larger machine wirelessly. The woman can mobilise freely if she wishes and may be able to labour and give birth in a birthing pool. The purpose of this study is to understand more about telemetry monitoring and the experiences women have using it.

Why have I been invited?

We are giving this letter to women attending the hospital that may need to have continuous monitoring during labour and who may be able to use telemetry. Not all women who have continuous monitoring during labour may be able to use telemetry due to its availability. You may also have been given this letter as you have already had your baby and you used telemetry during your labour.

Who will conduct the research?

Kylie Watson, midwife and PhD student from the Division of Nursing, Midwifery and Social Work at the University Of Manchester, UK will be conducting the research. Kylie is supervised by Professor Dame Tina Lavender and Dr Tracey Mills from the Division of Nursing, Midwifery and Social Work at the University Of Manchester, UK. The study is funded by the National Institute for Health and Research (NIHR).

Do I have to take part?

No, you do not have to take part in the study if you do not want to. Taking part in the research is voluntary; this means it is completely up to you to decide whether or not to join the study. Your decision to participate in this study will not be connected to the care you are receiving now or in the future. If you decide to take part and sign the consent form but change your mind later, you are free to withdraw at any point during the study without giving a reason and without any consequence to your current or future treatment. If you withdraw from the study we will use any data collected up to that point unless you ask us not to. We cannot remove information after the results are sent for publication.

What will happen to me if I take part?

You will be asked to take part in one interview of approximately an hour to an hour and a half long; at a time and location convenient to you, this could be at your home or in the hospital or another location. You will be interviewed by the researcher, who is a midwife, to discuss your views and experiences of using telemetry during labour. There are no right or wrong answers, we just want to try and understand your experience. With your permission, the interviews will be audio recorded and we may use your word-for-word quotations in publications using a false name (pseudonym) to protect your identity.

What happens to the information we collect?

All information discussed at the interview will be kept strictly confidential, although in rare circumstances we might need to share information to protect you or others from significant harm, or if required by law or the order of a court. Any identifiable data such as name and address will be removed from study information to protect your identity before analysis. The audio recorded interviews will be transferred securely to an encrypted computer, and written down word for word using a University of Manchester approved professional transcriber, to allow analysis by the researcher and research team. Following publication of the results, tape recordings will be destroyed. Research documents will be stored securely, in a locked cabinet, at the University of Manchester. Computer records will be password protected and transferred for storage to an encrypted server at the University of Manchester. Data from the study will be kept for a minimum of 5 years after the date of any publication which is based upon it, to follow recommended good practice guidelines for research. Individuals from the University of Manchester, NHS Trust or regulatory authorities may need to look at the data collected for this study to make sure the project is being carried out as planned. This may involve looking at identifiable data but all individuals involved in auditing and monitoring the study, will have a strict duty of confidentiality to you as a research participant.

What are the benefits and risks of taking part?

There is no direct benefit intended to you of taking part in this research. However, many women taking part in similar studies have told researchers they valued the opportunity to talk to a researcher about their experiences. We hope to use the findings to improve the care of women who need continuous monitoring of their babies heart beats during labour.

It is not thought that there are any risks to taking part in the study. It is possible that discussing your labour and birth may raise issues or concerns for you. The researcher is an experienced midwife and very used to discussing labour and birth with women. You could also speak to your own midwife or doctor. There will also be the opportunity for you to speak to somebody else if you feel upset in any way talking about your experiences.

Will I be paid for participating in the research?

No, there is no payment for taking part in the research.

What is the duration of the research?

The interview would normally be expected to take not more than one and a half hours. This study is part of a PhD study that will last for three years and finish in 2019.

What will happen to the findings of the research?

So that others can learn from our study, we will write articles for midwifery and medical journals and present findings at national and international research conferences. We will be careful to ensure that it is not possible to identify you in any reports, papers or presentations. If you take part, we will send you a summary of the results when we have completed the research.

Who has reviewed the study project?

All research which involves NHS patients has to be reviewed by the National Health Service Research Ethics Committee (REC). This study has been reviewed by North West Haydock Research Ethics Committee.

What if something goes wrong or I want to make a complaint?

If you have a minor complaint then you need to contact the researcher in the first instance. Please contact **KYLIE WATSON; e-mail kylie.watson@postgrad.manchester.ac.uk or on mobile phone** 07487257589. You may also contact another member of the research team (Prof. Dame Tina Lavender or Dr Tracey Mills) or contact the University Research Office (0161 275 7583). You may also speak to your midwife or doctor.

Any complaint you make will be taken very seriously.

Formal Complaints

If you wish to make a formal complaint or if you are not satisfied with the response you have gained from the researchers in the first instance, please contact the **Research Governance and Integrity Manager, Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PL, by emailing:** research.complaints@manchester.ac.uk or by telephoning 0161 275 2674 or 275 2046.

What Do I Do Now?

If you have any queries about the study please contact the researcher Kylie Watson - 07487257589 or kylie.watson@postgrad.manchester.ac.uk. If you would like to take part in the study and be interviewed about your experiences with telemetry then please get in touch with Kylie. You may be approached by the researcher to ask if you would like to take part in the study.

The other research team members are Prof. Dame Tina Lavender and Dr Tracey Mills at The University of Manchester, UK. (Division of Nursing, Midwifery & Social Work, Jean McFarlane Building, University of Manchester, Oxford Road, M13 9PL, Manchester, 0161 3060260).

Please free to discuss this information with others, who may be your family members or midwife. You can also contact the research team to answer further questions through the contacts provided above.

Thank you for taking your time to read this information sheet.

14. Consent to Contact form

NHS Manchester University NHS Foundation Trust

NHS Lancashire Teaching Hospitals NHS Foundation Trust

NHS National Institute for Health Research

MANCHESTER 1824

Study Title: Using Telemetry to Monitor the Fetal Heart in Labour
Chief Investigator: Kylie Watson

We are conducting a study looking at different ways of monitoring babies' heart beats during labour. One of these types of monitoring is called **telemetry. Telemetry allows information about the baby's heart beat to be recorded without any wires connecting to a larger machine. Conventional monitoring has wires which may restrict movement. Women whose babies need to be monitored continuously and use telemetry can move around in labour and some can go into a birthing pool to labour and give birth. Telemetry may be available for some women on the labour ward/delivery unit.**

We would like to interview women about their experiences of using telemetry. We would also like to interview some birth partners about their experiences of supporting women using telemetry.

If you are interested in taking part in this study and are happy for the researcher to contact you, please give your details below. You should only provide the information if you are happy to be contacted in that way. For example, if you do not want to be contacted by phone then do not provide a phone number.

Please note the following points in relation to the processing of your data:

- Data will be held securely by the research team on behalf of the University of Manchester according to the University's data protection and information security policies.

  Access to the data will be restricted to the research team for the sole purpose of contacting you about this study.
- Your data will not be shared with any third party without your written permission.
- The details collected will only be stored for as long as required to find out if you wish to take part in the study. Once no longer needed, that data will be destroyed securely
- If you decide to change your mind about being contacted about the study or would like your details to be destroyed you can contact Kylie Watson (07487257589).

Once you have completed your details, please ensure that you have added your signature handed the form to your midwife. Please keep this part of the form

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I am happy to be contacted by the researcher **in person on the postnatal ward** to discuss taking part in an interview for the study. I am happy to provide my personal details so that I can be contacted about this study.

Name (woman)	
Signature	
Name (birth partner). **Please get your birth partner to fill this part if he/she would like to discuss being interviewed for the study**	
Signature (birth partner)	
Today's date	

Contact by phone	Preferred contact number	
	When would you prefer to be contacted? (please circle)	Morning/ Afternoon/ Evening/ Don't Mind
Contact by email	Email address	

15. Participant information sheet for midwives



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Participant Information Sheet Interviews (midwives): Version 3.0,

15/01/2018

Using telemetry to monitor the fetal heart in labour: A mixed methods study

You are being invited to take part in a research study. Before you decide, it is important for you to understand why the research is being done and what it will involve. Please take time to read the following information carefully and discuss it with others if you wish. Please ask if there is anything that is not clear or if you would like more information. Take time to decide whether or not you wish to take part. Thank you for taking the time to read this.

What are we trying to find out?

There is very little contemporary good quality evidence that demonstrates whether telemetry has any effect on mobility, labour outcomes, or control and satisfaction in labour. There is no qualitative evidence on the experiences of women and health professionals using telemetry. The purpose of this study is to understand more about telemetry monitoring, including possible impact on outcomes, and the experiences women, their birth partners, and midwives have using it.

Why have I been invited?

You have been given this information sheet as you are a midwife working on the abour ward who cares for women in labour using telemetry.

Who will conduct the research?

Kylie Watson, midwife and PhD student from the Division of Nursing, Midwifery and Social Work at the University Of Manchester, UK will be conducting the research Kylie is supervised by Professor Dame Tina Lavender and Dr Tracey Mills from the Division of Nursing, Midwifery and Social Work at the University Of Manchester, UK. The study is funded by the National Institute for Health and Research (NIHR).

Do I have to take part?

No, you do not have to take part in the study if you do not want to. Taking part in the research is voluntary; this means it is completely up to you to decide whether or not to join the study. If you decide to take part and sign the consent form but change your mind later, you are free to withdraw at any point during the study without giving a reason. If you withdraw from the study we will use any data collected up to that point unless you ask us not to. We cannot remove information after the results are sent for publication.

What will happen to me if I take part?

You will be asked to take part in one interview of approximately an hour to an hour and a half long; at a time and location convenient to you, normally within the hospital. You will be interviewed by the researcher, who is a midwife, to discuss your views and experiences of caring for women using telemetry during labour. There are no right or wrong answers, we just want to try and understand your experience. With your permission, the interviews will be audio recorded and we may use your word-for-word quotations in publications using a false name (pseudonym) to protect your identity.

What happens to the information we collect?

All information discussed at the interview will be kept strictly confidential, although in rare circumstances we might need to share information to protect others from significant harm, or if required by law or the order of a court. Any identifiable data such as name and address will be removed from study information to protect your identity before analysis. The audio recorded interviews will be transferred securely to an encrypted computer, and written down word for word using a University of Manchester approved professional transcriber, to allow analysis by the researcher and research team. Following publication of the results, tape recordings will be destroyed. Research documents will be stored securely, in a locked cabinet, at the University of Manchester. Computer records will be password protected and transferred for storage to an encrypted server at the University of Manchester. Data from the study will be kept for a minimum of 5 years after the date of any publication which is based upon it, to follow recommended good practice guidelines for research. Individuals from the University of Manchester, NHS Trust or regulatory authorities may need to look at the data collected for this study to make sure the project is being carried out as planned. This may involve looking at identifiable data but all individuals involved in auditing and monitoring the study, will have a strict duty of confidentiality to you as a research participant.

What are the benefits and risks of taking part?

There is no direct benefit intended to you of taking part in this research. However, some midwives value the opportunity to talk to a researcher about their experiences. We hope to use the findings to improve the care of women who need continuous monitoring of their babies heart beats during labour.

It is not thought that there are any risks to taking part in the study. There will also be the opportunity for you to speak to somebody else if you feel upset in any way talking about your experiences.



Will I be paid for participating in the research?

No, there is no payment for taking part in the research.

What is the duration of the research?

The interview would normally be expected to take not more than one and a half hours. This study is part of a PhD study that will last for three years and finish in 2019.

What will happen to the findings of the research?

So that others can learn from our study, we will write articles for midwifery and medical journals and present findings at national and international research conferences. We will be careful to ensure that it is not possible to identify you in any reports, papers or presentations. If you take part, we will send you a summary of the results when we have completed the research.

Who has reviewed the study project?

All research which involves NHS patients has to be reviewed by the National Health Service Research Ethics Committee (REC). This study has been reviewed by North West – Haydock Research Ethics Committee (17/NW/0699).

What if something goes wrong or I want to make a complaint?

If you have a minor complaint then you need to contact the researcher in the first instance. Please contact KYLIE WATSON; e-mail **kylie.watson@postgrad.manchester.ac.uk** or on mobile phone 07487257589. You may also contact another member of the research team (Prof. Dame Tina Lavender or Dr Tracey Mills) or contact the University Research Office (0161 275 7583).

Any complaint you make will be taken very seriously.

Formal Complaints

If you wish to make a formal complaint or if you are not satisfied with the response you have gained from the researchers in the first instance, please contact the Research Governance and Integrity Manager, Research Office, Christie Building, University of Manchester, Oxford Road, Manchester, M13 9PL, by emailing: research.complaints@manchester.ac.uk or by telephoning 0161 275 2674 or 275 2046.

What Do I Do Now?

If you have any queries about the study please contact the researcher Kylie Watson - 07487257589 or kylie.watson@postgrad.manchester.ac.uk. If you would like to take part in the study and be interviewed about your experiences with telemetry then please get in touch with Kylie. You may be approached by the researcher to ask if you would like to take part in the study.

The other research team members are Prof. Dame Tina Lavender and Dr Tracey Mills at The University of Manchester, UK. (Division of Nursing, Midwifery & Social Work, Jean McFarlane Building, University of Manchester, Oxford Road, M13 9PL, Manchester,0161 3000200).

Please free to discuss this information with others. You can also contact the research team to answer further questions through the contacts provided above.

Thank you for taking your time to read this information sheet.

16. Consent form – interviews with women

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CONSENT FORM INTERVIEWS

Using telemetry to monitor the fetal heart in labour: A mixed methods study

Chief Investigator: Kylie Watson

Participant Identification number ☐

Please initial box

1) I confirm that I have read and understand the Participant Information Sheet Version _____dated _____for the above study and have had the opportunity to consider the information. ☐

2) I confirm that I have had the opportunity to ask questions about the study and that these questions have been answered satisfactorily ☐

3) I understand that my participation is completely voluntary and that I am free to withdraw at any time, without giving a reason. We will use any data collected up to this point unless you ask us not to. ☐

4) I understand that the data collected may be published as part of a research project. My identity will not be revealed in any publication. ☐

5) I understand that data collected during the study may be looked at by responsible individuals from the University of Manchester, from regulatory authorities or from the NHS Trust, where it is relevant to my taking part in the research. I give permission for these individuals to have access to this data. ☐

6) I am aware that the interview will be audio recorded. I agree for the interview to be audio recorded and written out in full (transcribed) by the research team or one of the University's approved transcription service providers. Audio recordings will be stored in a secure location and destroyed by the researchers once the study has been written up. I understand that anonymised direct quotes from the interview may be used. ☐

7) I agree to take part in the above study. ☐

_____	_____	_____
Name of participant	Date	Signature
_____	_____	_____
Name of researcher	Date	Signature

When completed: 1 copy for Participant, 1 copy for Researcher site file, 1 (original) to be kept in medical notes.

17. Topic guide for interviews with women

Using telemetry to monitor the fetal heart in labour: A mixed methods study

Topic Guide (women and birth partners)

1. **Introduction, setting ground rules:**

Introduce self, thank participant for taking part and confirm agrees to interview taking place. Ensure environment is comfortable. Discuss the following issues:

- Review the nature and purpose of the research.
- No right or wrong answers, aim to understand experiences.
- Confidentiality, use of data.
- Explain the use of data recorder, transcription, use of pseudonym (invite to choose), use of verbatim quotes, will be taking field notes.
- Researcher aware that discussion might bring up difficult memories, explain can decline to answer any question or prompt; can ask to stop at any time if feels need to.
- Expected duration of interview.
- Check consent form signed.
- Ask if any questions.

Check recorder working

Introduce and switch on tape recorder

2. **Broad opening questions**

Could you describe to me your understanding of how your baby could be monitored during labour?

- Discussion with others (health professionals/friends/family)
- Previous experiences
- Any preferences? Reasons for this?

Allow participant to describe experiences uninterrupted. Use open prompts – can you tell me more about xxxx? What makes you say xxxx? How did that make you feel?

Could you describe how your baby was monitored during your labour?

- Remember any discussions? Options?
- How did you feel?
- Related to other experiences?

  Other aspects – mobility, birth partner support, technology

3. **Close of interview**

Fill in data collection sheet with woman about ethnicity, age, parity, birth outcomes.

At the close of the interview briefly summarise the main points to confirm interpretation with the participant. Ask if they wish to expand any responses or add anything else to the discussion. Thank the participants for their time.

Ask how they feel after talking about these experiences, do they want you to contact anyone? Family, friend, health worker?

Ensure participant has contact details for the local research team should they wish to discuss any aspect of the study.

Complete reflexive diary/field notes.

18. Topic guide for interview with midwives and student midwives



Using telemetry to monitor the fetal heart in labour: A mixed methods study

Topic Guide (midwives/student midwives)

1. **Introduction, setting ground rules:**

ntroduce self, thank participant for taking part and confirm agrees to interview taking place. Ensure environment is comfortable. Discuss the fo lowing issues:

- Review the nature and purpose of the research.
- No right or wrong answers, aim to understand experiences.
- Confidentiality, use of data.
- Explain the use of data recorder, transcription, use of pseudonym (invite to choose), use of verbatim quotes, will be taking field notes
- Researcher aware that discussion might bring up difficult memories, explain can decline to answer any question or prompt; can ask to stop at any time if feels need to.
- Expected duration of interview.
- Check consent form signed.
- Ask if any questions.

Check recorder working

ntroduce and switch on tape recorder

2. **Broad opening questions**

Could you describe to me your thoughts on monitoring the fetal heart during labour?

- Experiences of different types of monitoring
- Women's expectations and knowledge
- Discussions with colleagues
- Culture of fetal monitoring within maternity unit
- Technology/central monitoring
- Monitoring and practice

Allow participant to describe experiences uninterrupted. Use open prompts – can you tell me more about xxxx? What makes you say xxxx? How did that make you feel?

Could you describe any experiences of using telemetry to monitor the fetal heart in labour?

- Remember any discussions with women/birth partner/colleagues?
- Any perceived problems?
  Any perceived advantages – mobility/partner support?

3. Close of interview

Fill in data collection sheet with woman about ethnicity, age, parity, birth outcomes.

At the close of the interview briefly summarise the main points to confirm interpretation with the participant. Ask if they wish to expand any responses or add anything else to the discussion. Thank the participants for their time.

Ask how they feel after talking about these experiences, do they want you to contact anyone? Family, friend, colleague?

Ensure participant has contact details for the local research team should they wish to discuss any aspect of the study.

Complete reflexive diary/field notes.

19. Questionnaire

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Using telemetry to monitor the fetal heart in labour: A mixed methods study

Cohort Postnatal Questionnaire

Participant Study Identification number ☐

Thank you for taking the time to fill out this questionnaire. It should take you no more than 10 - 15 minutes to complete. If you have any questions about the questionnaire please contact the researcher or your midwife.

Perceived Control in Childbirth Scale

Instructions: Each item below is a statement with which you may agree or disagree. Please respond to these items as they relate to your most recent experience of childbirth. For each item indicate the number, which represents how much you agree with it using the scale below. Please make sure that you mark ONLY ONE number per item. This is a measure of your personal experience; there are no right or wrong answers.

- 6 – Strongly agree
- 5 – Moderately agree
- 4 – Slightly agree
- 3 – Slightly disagree
- 2 – Moderately disagree
- 1 – Strongly disagree

1. I was able to participate in making decisions about how to manage my labour and birth ☐

2. I was given choices before procedures were decided upon. ☐

3. I did not feel that I was in control of my birth environment. ☐

During my labour and birth, when I was told about the procedures I felt……..

4. That I could not question my health professional's (midwife or doctor) decisions. ☐

5. That I did not have much influence over what procedures were done. ☐

6. That I was in control of the situation. ☐

7. That I could get all my questions answered. ☐

8. That what I said or did made no difference in what occurred. ☐

From the time I arrived at the hospital or birth centre, I felt.....

9. At a loss to know what I would be experiencing. ☐

10. If wanted to, I could change the procedures I was receiving. ☐

11. knew what the purpose and effects of the procedures were. ☐

12. If I asked my midwife or doctor to do something differently during labour and delivery they usually did. ☐

Satisfaction with Childbirth Scale

Instructions: Each item below is a statement with which you may agree or disagree. Please respond to these items as they relate to your most recent experience of childbirth. For each item indicate the number, which represents how much you agree with it using the scale below. Please make sure that you mark ONLY ONE number per item. This is a measure of your personal experience; there are no right or wrong answers.

- 7 – Strongly agree
- 6 – Moderately agree
- 5– Slightly agree
- 4 – Neither agree nor disagree
- 3 – Slightly disagree
- 2 – Moderately disagree
- 1 – Strongly disagree

1. In most ways, my childbirth experience was close to my ideal. ☐

2. My baby's birth did not go the way I wanted it to go. ☐

3. The conditions of my childbirth experience were excellent. ☐

4. If could do it over, would change some things about my childbirth experience. ☐

5. I am satisfied with the experience of my baby's birth. ☐

6. I got what wanted out of my childbirth experience. ☐

7. If could do it over, would change almost nothing about my childbirth experience. ☐

Thank you again for completing this questionnaire. Please hand the form to your midwife or the researcher.

20. Data collection sheet – demographics and clinical outcomes

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Cohort Data Collection Sheet

Participant Study Number

		Demographic Details					
Age		Ethnicity (see code overleaf)		BMI		Site	
Parity prior to this labour and birth		Gestation at delivery					

Antenatal		
Did the woman have any underlying medical conditions? **Yes/No**	Details including any medications taken during pregnancy:	
Did the woman develop any complications or risk factors during the pregnancy? **Yes/No**	Details of risk factors:	
Was the woman admitted to hospital during the pregnancy? **Yes/No**	Details of admissions:	
Was the labour **spontaneous/induced or augmented?**	What was the reason for induction of labour? **Fetal/maternal/other**	Where did the woman plan to give birth? **OU/AMU/SMU/home**
Induction of labour details:		

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Labour and birth

Time of admission to induction of labour ward:	Time ready for transfer to delivery unit:	Time admitted to delivery unit:	Did the woman have an ARM? Yes/No	Time ARM performed:	Did the woman have syntocinon? Yes/No	Time syntocinon started:

Did the woman have SROM? Yes/No	Time of SROM:	

Did the woman transfer to the OU during her labour? Yes/No	Details of transfer:

What was the indication for continuous fetal heart rate monitoring:	What time did continuous fetal heart monitoring commence:

Did the woman use telemetry during the labour? Yes/No Was telemetry used for the whole labour? Yes/No Was a fetal scalp electrode used at any point in the labour? Yes/No	Time telemetry started: Time telemetry stopped:

Time first stage diagnosed:	Time second stage diagnosed:	Time active pushing commenced:	Time of birth:	Estimated blood loss (mls):



What type of birth did the woman have? **SVD/ventouse/ forceps/ emergency LSCS**	Where did the birth occur: **Labour room/theatre**	Type of pain relief: **None/water/gas and air/diamorphine/ pethidine/remifentanyl/ epidural/spinal/GA**	Did the woman have any fetal blood sampling: **Yes/No** Number:
What was the indication for Instrumental or LSCS?	What position was the woman in for the birth:	Time of third stage:	Type of third stage: **Active/ physiological/ MROP**

Did the woman have an episiotomy? **Yes/No**	Perineum details **Intact/1st degree/2nd degree/3rd degree/4th degree/episiotomy**	

Infant details			
Birth weight:	APGAR 1 minute:	APGAR 5 minutes:	APGAR 10 minutes:
Immediate Admission to NICU from delivery unit? Yes/No	Reason for admission to NICU:	Delayed cord clamping: **Yes/No**	
Skin-to-skin? **Yes/No**	Skin to skin details:	Sex of baby: **M/F**	
Did the woman intend to BF? **Yes/No**	Breastfeeding within first hour? **Yes/No**		

White	
English/Welsh/Scottish/Northern Irish/British	1
Irish	2
Gypsy or Irish Traveller	3
Any other white background	4
Mixed/multiple ethnic groups	
White and Black Caribbean	5
White and Black African	6
White and Asian	7
Any other mixed/multiple ethnic background	8
Asian/Asian British	
Indian	9
Pakistani	10
Bangladeshi	11
Chinese	12
Any other Asian background	13
Black/African/Caribbean/Black British	
African	14
Caribbean	15
Any other Black/African/Caribbean background	16
Other ethnic group	
Arab	17
Any other ethnic group	18

21. Mobility data collection sheet

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Using telemetry to monitor the fetal heart in labour: A mixed methods study

Mobility Data Collection Sheet

Participant Study Identification number ☐

Please use this sheet to collect data on positions the woman uses in labour. Use the diagrams and corresponding numbers on the next page to record the position the woman was *mostly in* over the preceding 15 minutes. Place the numbers in the boxes below. Please also note what position the woman was in when she gave birth. This form can be completed by the midwife, or her birth partner(s). Please leave the completed form in the notes. Thank you in advance for taking the time to complete this form.

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03	
04	
05	
06	
07	

What position was the woman in when she gave birth?

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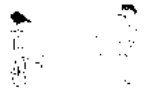
1. Walking 

2. Standing with support from birth partner/furniture/wall 

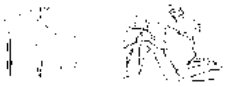
3. Sitting on a chair 

4. Sitting on a birthing ball 

5. Leaning over a birthing ball 

6. Sitting on a rocking chair 

7. On all fours 

8. On knees using bed or chair for support 

9. In a birthing pool 

10. Squatting 

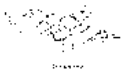
11. Birthing stool 

12. Lying semi-reclined 

13. Lying on side 

14. Semi-sitting in bed 

15. Resting legs on supports 

16. Legs in full lithotomy 

17. Other – please write details in box

22. Distress policy

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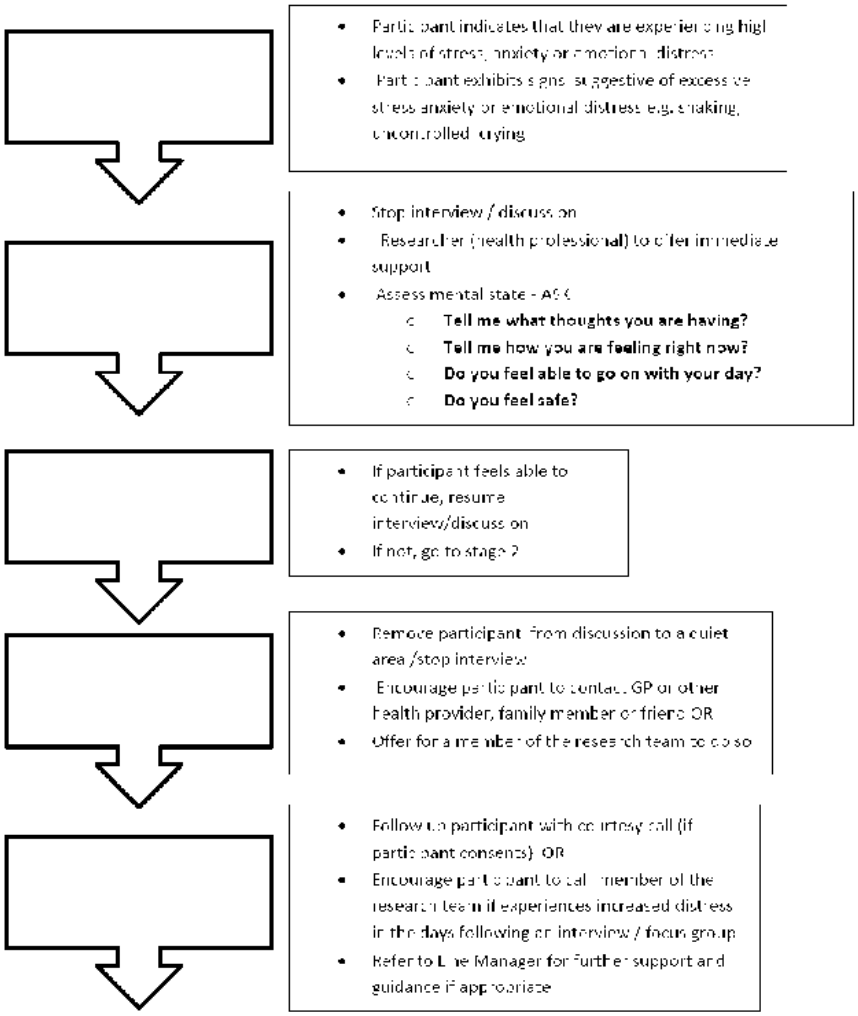
Using telemetry to monitor the fetal heart in labour: A mixed methods study

DISTRESS POLICY FOR INTERVIEWS



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