Women's Experiences of Continuous Fetal Monitoring – A Mixed-Methods Systematic Review

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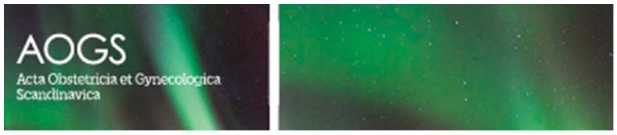

Women's Experiences of Continuous Fetal Monitoring – A Mixed-Methods Systematic Review

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Women's experiences of continuous fetal monitoring – a mixed-methods systematic review

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There are no conflicts of interest associated with any of the authors involved in this work.

Abstract

Introduction: Antepartum stillbirth is often preceded by detectable signs of fetal compromise, including changes in fetal heart rate and movement. It is hypothesised that continuous fetal monitoring could detect these signs more accurately and objectively than current forms of fetal monitoring and allow for timely intervention. This systematic review aimed to explore available evidence on women's experiences of continuous fetal monitoring to investigate its acceptability prior to clinical implementation and to inform clinical studies. *Material and methods:* Systematic searching of four electronic databases (Embase, PsycINFO, MEDLINE and CINAHL), using key terms defined by initial scoping searches, identified a total of 35 studies. Following title and abstract screening by two independent researchers five studies met the inclusion criteria. Studies were not excluded based on language, methodology or quality assessment. An integrative methodology was used to synthesise qualitative and quantitative data together. *Results:* Forms of continuous fetal monitoring used included Monica AN24 monitors (n=4) and phonocardiography (n=1). Four main themes were identified: practical limitations of the device, negative emotions, positive perceptions and device implementation. Continuous fetal monitoring was reported to have high levels of participant satisfaction and was preferred by women to intermittent cardiotocography. *Conclusion:* This review suggests that continuous fetal monitoring is accepted by women. However, it has also highlighted both the paucity and heterogeneity of current studies and suggests further research should be conducted into women's experiences of continuous fetal monitoring before such devices can be used clinically.

Keywords

Continuous fetal monitoring; pregnancy; patient experience; maternal anxiety; cardiotocography.

Abbreviations

CFM continuous fetal monitoring;

CTG cardiotocography;

HIC high income countries;

Key Message

Continuous fetal monitoring is associated with high levels of participant satisfaction and is preferable to intermittent CTG monitoring

Introduction

Late stillbirth is defined by the WHO as a fetus which has died before birth and after the 28th week of gestation (1). In 2014, the incidence of stillbirth in high income countries (HICs) varied from 1.3 to 8.8 per 1,000 total births; the annual rate reduction from 2000-2015 varies from +0.5% to -6.8% (2). The variation in stillbirth rates and annual rate reductions which have been achieved by some HICs indicates that there remains room for improvement in stillbirth rates in some HICs (2). If HICs reduced stillbirth rates to 2.0 per 1,000 births, over 20,000 stillbirths could be avoided. Data from the UK in 2014 found that one third of reviewed stillbirths occurred in normally-formed, term, singleton babies (3). Given their gestational age, these babies would be expected to have a low risk of neonatal mortality and morbidity and therefore represent a missed opportunity to prevent fetal death if fetal compromise could be reliably detected.

Antepartum fetal monitoring aims to reduce perinatal mortality rates by detecting signs of fetal compromise which occur in response to the sub-optimal intrauterine environment and often precede stillbirth, such as changes in fetal heart rate or fetal movements (4). However, current forms of fetal monitoring do not significantly reduce perinatal mortality rate, especially in women who have a low risk of complications as they have poor predictive value. Hence, confirmatory testing is often required, resulting in additional testing requiring increased resources (5). Additionally, current fetal monitoring methods do not provide a longitudinal and objective view of fetal wellbeing and therefore may not be able to detect intermittent signs of fetal compromise (6).

Continuous fetal monitoring (CFM) describes technologies which can provide an objective view of fetal wellbeing and could reasonably be practically used over long periods of time without risk of injury to either the mother or fetus. Ultrasound-based technologies, such as cardiotocography (CTG) and Doppler velocimetry are not considered to have potential use in CFM due to the risk of ultrasonic heating of fetal tissue with prolonged use (7). Current forms of CFM can measure fetal heart rate or fetal movement to detect signs of fetal compromise before death and allow for timely delivery. Fetal electrocardiography has been subject to the most research and is most advanced in its development. One particular example of this technology is the Monica AN24 (Figure 1), which uses five adhesive trans-abdominal electrodes and an inbuilt accelerometer to non-invasively record maternal movement, uterine activity, maternal heart rate and fetal heart rate. This produces a fetal heart recording which can be interpreted by clinicians retrospectively, whereby data are

stored on the device and downloaded once the recording has finished, or in real-time which requires the use of an additional Bluetooth device (8).

In a questionnaire study of 125 clinicians, 45% of respondents felt that CFM would be beneficial. The majority of respondents would use such a device in high-risk pregnancies such as in cases of fetal growth restriction, reduced fetal movements or previous stillbirth (9). Thus, CFM is proposed as an alternative method of fetal monitoring to current intermittent fetal monitoring for high-risk pregnancies performed in healthcare settings (6). However, the questionnaire study also found that 64.3% of clinicians expressed concern that, if implemented into routine clinical care, CFM could increase levels of maternal anxiety (9). Conversely, only 23.6% of clinicians felt that CFM would provide pregnant women with a sense of reassurance (9). This is important as anxiety in pregnancy has been associated with an increased risk of adverse outcome, including low birthweight (relative risk 1.79) and preterm labour (relative risk 1.50), and would likely act as a barrier to implementation (10). Despite these concerns the majority of surveyed clinicians believed CFM would be beneficial to obstetric practice (9). It is therefore necessary to assess the clinical benefit of CFM against the potential for negative psychological consequences.

Therefore, this systematic review was conducted which aimed to explore current knowledge about women's experiences of CFM and whether it has a positive or negative effect on anxiety.

Material and methods

This systematic review and meta-analysis used a mixed-methods synthesis to combine the paradigms of qualitative and quantitative research exploring a single research question, and thus understand a phenomenon in its entirety (11). A mixed-methods approach also permitted the scope of this review to be as wide as possible, which was important given the anticipated paucity of literature concerning women's experiences of CFM. The primary outcome was to report women's experiences of CFM.

A series of initial scoping searches were conducted by the primary researcher (A.C) prior to the main search. This found that no previous systematic review had explored women's views of CFM. Scoping searches served as an iterative process to identify relevant search terms for the review. For instance, some studies of CFM were set in the context of home induction of labour so ((induct* OR induce*) ADJ3 labour) was included in the search strategies.

Four electronic databases (MEDLINE, Embase, CINAHL and PsycINFO) were systematically searched to identify full-text studies which investigated women's views of CFM. An example search strategy is shown in Supporting Information Appendix S1. The Cochrane Database of Clinical Trials, Google Scholar, Web of Knowledge, the Royal College of Obstetricians and Gynecologists (RCOG) and the National Institute for Health and Care Excellence (NICE) were also searched for further studies. The review was registered in PROSPERO (CRD42016035715).

Key search terms (fetal monitoring AND monitoring AND satisfaction) were mapped to the thesaurus where possible. Synonyms of the key search terms were used to capture the maximal amount of relevant literature. To maximise the scope of the review, there were no limits applied to publication and non-English language papers were included. Following searches of the core databases, key studies were subject to footnote and citation chasing. The titles and abstracts were screened by two independent researchers (A.C & D.H) against the inclusion and exclusion criteria. Studies were included if they reported women's experiences of CFM at any point in their pregnancy using either quantitative or qualitative methodology to obtain data.

For the purpose of this review, fetal monitoring technologies considered to be continuous were those that are non-invasive and could feasibly and safely be used over a sustained period of time to obtain an objective view of fetal wellbeing. Examples of technology which fell under this definition include; phonocardiography, accelerometry, vectorcardiography and fetal electrocardiography. Ultrasound-based technologies, such as CTG and Doppler ultrasound, were excluded due to the risk of ultrasonic heating of fetal tissue with long-term use (7). Invasive technologies such as ST waveform analysis were also excluded.

Two researchers (A.C & D.H) independently assessed the quality of included studies using the EPPI Centre criteria, adapted by McDermott et al. (12). Using these criteria each study was graded from A-D based on the reliability and validity of the study (A – No or few flaws, B – Some flaws, C – Significant flaws which may affect the validity of the findings, D – Untrustworthy findings/conclusions). This quality assessment tool was chosen as it was deemed to be sufficiently flexible to accommodate the heterogeneity of study design of included studies and could be utilised for qualitative, quantitative and mixed-methods studies. No studies were excluded based on their quality assessment, but the quality assessment was considered during data analysis.

Data extraction was performed by A.C. All foreign language papers were translated into English using a hospital-approved translation service. Authors were contacted to provide additional study

information where necessary or answer queries regarding study design. An integrated methodology was used to extract and analyse data in this mixed-method synthesis, as demonstrated in Figure 2.

Qualitative and quantitative data were extracted separately. Qualitative data were extracted through iterative re-reading and inductive thematic analysis (13). Initially, data from each of the five studies was coded manually. Codes were then compared across studies to identify major themes and subthemes. Direct quotations were taken from studies to illustrate individual subthemes. Quantitative data were exported into a Microsoft Excel (Microsoft, Washington, USA) spreadsheet. Weighted mean averages were calculated using the formula:

$$Weighted\ mean\ average = \frac{x_1w_1 + x_2w_2 + x_3w_3}{w_1 + w_2 + w_3}$$

Where x = satisfaction score and w = sample number.

To allow for comparison between studies all Likert-scale data were standardised to a 10-point scale. All data extraction and calculations were conducted by two authors (A.C and A.H). Graphs were constructed using GraphPad Prism 6.0 (GraphPad Software Inc., San Diego, USA). Qualitative and quantitative data were synthesised together to assess for agreement or disagreement.

Results

Thirty five studies were identified using the search strategy. Following review of titles and abstracts five studies were included in this review. A PRISMA flow diagram summarising the study selection process is shown in Figure 3. The summary characteristics of all studies included in this systematic review and their quality assessment grade can be found in Table 1.

All studies included in this review were full text articles published in peer-reviewed medical journals. The publication date of included studies ranged from 2008 to 2013. Studies originated from Germany (15), Italy (16), France (17) and the UK (8, 18). Sample sizes ranged from 6 to 70 women, the total number of women included in this review was 105, accounting for the overlap in participants used by Rauf et al. and O'Brien et al. (8, 18). The gestational age range of participants was 32-42 weeks' gestation. Two studies included only women with low-risk pregnancies (8, 18) and three did not report the risk status of participants (15-17).

Four studies used the Monica AN24 (8, 15, 17, 18) and one used phonocardiography (16) to conduct CFM. No studies were found which examined at other forms of CFM, such as accelerometry. Fetal monitoring was conducted in real-time in the participants' own home in two studies (8, 18). In one study monitoring occurred in the participants home with retrospective analysis in the hospital (16). In a further two studies monitoring was conducted in a hospital setting with interpretation of recording occurring only after monitoring had finished (15,17). Monitoring of the period during induction of labour was assessed in three studies (8, 17, 18) whereas two studies concerned monitoring in the antepartum period (15, 16). The length of individual recordings varied from 20 minutes to 22 hours.

Methods of data collection included semi-structured diary (8), semi-structured interview (18) and questionnaire (15-17). Two studies compared women's views of CFM with CTG (15, 17). Women's experience of CFM was the sole focus of only one study (18), with the remainder being mixed-methods studies which also assessed other aspects of CFM recordings. No studies reported assessment of maternal anxiety using a validated maternal anxiety score, thus the secondary outcome measure of this synthesis could not be addressed. Regarding the primary outcome of maternal experience four main themes and 11 subthemes were identified (Figure 4).

Practical Limitations

Mobility

Some participants described feeling that their mobility was reduced by the monitoring device, particularly due to the presence of multiple cables with the Monica AN24, whilst others described a relative increase in their mobility compared to other forms of monitoring. *"I also felt mobile and non-restricted whilst I was wearing the device"* (8). The freedom to mobilise was particularly important in studies of induction of labour as women felt that they experienced less pain and gained a greater sense of control.

Disturbed sleep

The issue of disturbed sleep was noted in two of the five studies (15, 17). One study reported this was due to an electrode repeatedly disconnecting (17) and in the other one participant requested not to receive overnight recordings, but no reason was given for this (15). None of the studies using real-time monitoring at home reported issues with sleep disturbance (8, 18). It is probable that this was not due to the device itself but rather the location of monitoring as had these women received standard induction of labour they would have had to be in hospital.

Positive Perceptions

Preference for CFM

In both comparative studies CFM was preferred by the majority of women when compared to CTG, as shown in Figure 5A. In both studies comparing CTG with CFM, women who preferred CTG stated that they found the audible fetal heart sounds reassuring (15, 17). The inability to hear fetal heart sounds whilst undergoing CFM was not mentioned by any of the other studies.

Satisfaction

All studies reported high levels of satisfaction during CFM. Scores from papers reporting Likert scales for satisfaction have been standardised and are shown in Figure 5B. The weighted mean average for satisfaction scores was 8.4/10.

Romano et al. found that quality of life was considered improved with phonocardiography and that satisfaction did not vary with the amount of time that the device was used for, although this study had the shortest period of use (16). Particular aspects of the experience which were identified to contribute to the high level of satisfaction were the freedom to mobilise, be comfortable and, for those receiving real-time monitoring, the ability to be at home.

Comfort

Both phonocardiography and the Monica AN24 were considered comfortable by participants in all studies. One study measured comfort quantitatively. Using a four-point Likert scale, with one being very uncomfortable and four being very comfortable, a mean score of 3.3 (Standard Deviation (SD) ± 0.6) was calculated (8). When the Monica AN24 was used during induction of labour some women experienced discomfort during uterine activity.

Reassurance

For studies using devices that allowed real-time transfer of recordings, women described knowing that someone was watching their baby's wellbeing as reassuring. *"I found in the hospital you get monitored so many times throughout the day, whereas this I felt like I was being monitored constantly"* (18).

Device Implementation

Home monitoring

High levels of participant satisfaction were found when CFM was used remotely to generate real-time recordings whilst participants were at home. Monitoring at home allowed women a greater

degree of privacy, comfort and better access to support from friends and family. *"I could watch the telly, I could you know, do washing or ironing and do whatever I wanted really...I could just rest and take it easy...all in all it was a lot more comfortable being at home"* (18). Women also liked being in a less clinical environment and felt that it allowed them to relax more than if they were in hospital.

Perceived relief on staff workload

Women who were monitored remotely felt as though they were reducing staff workload and hospital resources.

Communication with the hospital

One of the main themes to come from the work of O'Brien et al. was the *"virtual presence required for remote reassurance"* (18). It was found that women who received regular contact from the hospital were more satisfied with their experience of CFM. Those that did not receive regular contact reported feeling anxious or worried. *"I think it would've been nice just to know that when the handover happened...you know, that you were still being monitored, and maybe just have a little bit more communication from the hospital."*

Need for confidence in staff

The need for women to have confidence and trust in the staff responsible for interpreting recordings was highlighted by Rauf et al. and O'Brien et al. *"If you're confident in the staff who are, kind of, responsible for you when you are going home, then it's easier to go home"* (8, 18).

Negative Emotions

Some women reported feeling anxious whilst undergoing CFM. The semi-structured diaries contained 34 comments regarding women's worries (8). Again, worry and anxiety was found to be increased in women who did not receive regular communication from the hospital as they feared that their baby was not being properly monitored, *"Am I being monitored?"* (8). A degree of anxiety was also noted towards the beginning of monitoring with the Monica AN24 as some women were concerned about displacing electrodes.

However, when assessing how well participants coped with the experience of CFM Rauf et al. found a mean coping score of 3.5 (SD ± 0.6), using a four-point Likert scale, with four indicating that the women coped very well (8). Those who coped less well had experienced issues with device error or a lack of hospital contact.

Furthermore, O'Brien et al. noted a greater need for communication amongst primiparous women when compared to multiparous women whilst being monitored remotely (18). The different needs for women who had not experienced pregnancy before was not explored in any of the other included studies.

Discussion

This mixed-methods systematic review included five studies that explored women's experiences of CFM in 105 participants. Synthesis of qualitative and quantitative data has shown that CFM is associated with high levels of participant satisfaction and is preferable to standard CTG monitoring. CFM allows women greater freedom to mobilise and, if used in combination with wireless technology, the ability to be monitored away from hospital both of which were perceived favourably. However, CFM may be associated with some degree of anxiety, although this appears to be related to the implementation strategy used and the degree of communication with clinicians.

As both English and non-English language papers were included in this review it was possible to take account of an additional three studies and a total of four countries. This systematic and mixed methods approach allowed for increased scope of the review and eliminated the risk of language bias.

This review is limited by the low number of included studies and consequently, the number of participants. Although the included studies were generally of good quality, there were high levels of heterogeneity (summarised in Table 1) in terms of their methodology, the duration of monitoring, the context in which the research was conducted and the country in which the research was undertaken all of which may have affected the results. For example, two included studies used CFM during home induction of labour; these were the only studies to use CFM to provide real-time and remote fetal monitoring (8, 18). Hence, these studies addressed similar, but not identical issues to the other studies. It is likely that the experiences and concerns of women receiving real-time monitoring at home are different to those of women being monitored in hospital with standard CTG monitoring. Therefore, the high satisfaction levels found in studies providing monitoring at home may be related to the location of monitoring rather than to the device itself or the concept of CFM. Furthermore, it would also be expected that issues surrounding antepartum monitoring are different to monitoring during induction of labour.

There was also a high degree of heterogeneity in the parameters used to assess the experiences of participants following CFM. For instance, though both Rauf et al. and Reinhard et al. utilised questionnaires, "*coping*" and "*wellbeing*" were assessed respectively and it cannot be assumed that these parameters are comparable (8, 15). Only one of the included studies was wholly qualitative in nature (18). Importantly, the small number of studies of the experiences of women using CFM limits the generalisability of findings.

Issues with the design of the monitoring devices were raised in all studies. Practical limitations of the device predominantly focussed on the number of cables though manufacturers of CFM devices appear to be responding to these concerns as the most recent model of the Monica AN24, the Monica Novii, has a cable-free design (19).

Though some women stated that being able to hear fetal heart sounds would provide reassurance, this appears to be a matter of individual preference and may serve to increase anxiety in others. A similar level of reassurance may be gained from receiving regular contact from clinicians during CFM.

Brown et al. found that 64.3% of clinicians expressed concern that CFM could increase women's levels of anxiety (9). This systematic review shows that these concerns may be overstated as none of the included studies found maternal anxiety to be a significant issue. However, no studies to date have conducted a formal assessment of anxiety. Hence, future studies exploring the experiences of women undergoing CFM should use validated assessment tools for maternal anxiety. However, a systematic review of anxiety scores in pregnancy has shown that none of the available measures are wholly reliable (20). Therefore, it may be necessary to use a combination of different measures.

The means by which CFM is implemented appears to play an important role in women's experiences. Contact with clinicians during monitoring provides reassurance and may reduce anxiety. In the case of overnight monitoring which is associated with higher levels of recording quality due to reduced maternal artefacts, regular contact could conflict with previously noted issues of disturbed sleep (21). This highlights the need for effective communication to ascertain individual women's preferences and the trade-off between these preferences and obtaining high quality recordings of fetal wellbeing.

In order for implementation of CFM to be successful it must be acceptable to clinicians as well as women. Clinicians' concerns must be understood and addressed so that they feel comfortable and

confident using the technology. Implementation also needs to account for adequate training of staff to reduce inter-observer variability when interpreting recordings. There is very little literature concerning clinicians' views of fetal monitoring and only one study has explored views of CFM specifically (9). Future studies should address health care professionals' as well as mothers' experiences of CFM.

CFM could be used adjunctively to or in place of intermittent CTG monitoring to detect signs of fetal compromise, but further research is needed to ascertain the feasibility of CFM within a real-world setting and to explore the factors that contribute to the acceptability of fetal monitoring devices.

In conclusion, recently devised CFM technology could benefit obstetric practice and help to reduce perinatal morbidity and mortality. Though these devices may have the ability to improve pregnancy outcome, they may also significantly impact women's experience of pregnancy, particularly if the device must be worn over a sustained period of time. This systematic review explored women's experiences of CFM and, whilst high levels of patient satisfaction were found, the paucity and heterogeneity of the available literature leaves the findings of this systematic review inconclusive. Consequently, further studies of CFM are required before firm conclusions can be drawn about its effects on women's experiences. Future studies should consider potential sources of heterogeneity identified in this review, including the setting of monitoring (home vs. hospital), timing of monitoring (real-time vs. retrospective analysis), context of monitoring (antenatal vs. induction of labour) and the risk status of participants as these factors may all impact upon women's experience of CFM. A greater number of studies would allow more detailed exploration of the origins of study heterogeneity.

Ultimately studies are needed to assess the efficacy of CFM in comparison to current methods of fetal monitoring before CFM can be incorporated into clinical practice. This review suggests that CFM does not have a deleterious effect on maternal experience, so this should not be a barrier to such studies. However, the paucity of evidence identified in this review indicates that such studies should continue to assess how clinicians and women view this technology and how the technology could best be employed. Thus, it is imperative that studies of the clinical effectiveness of CFM robustly explore the impact on maternal experience especially during the antenatal period (22).

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Supporting Information legend

Appendix S1. Example search strategy for Medline database.

Legends

Table 1 - Summary characteristics of included studies.

Figure 1: An example of a device for continuous fetal monitoring (MONICA AN24) showing adhesive electrodes applied to the maternal abdomen connected by wires to a storage device which produces a recording of the fetal heart rate trace and uterine activity. Photograph used with permission of Monica Healthcare Limited.

Figure 2: Diagram demonstrating the integrative approach to mixed-method systematic review. Adapted from Pearson A, White H, Bath-Hextall F, Salmond S, Apostolo J, Kirkpatrick P. A mixed-methods approach to systematic reviews. Int J Evid Based Healthc. 2015;13,121-131.

Figure 3: PRISMA flow diagram of study selection. CFM, continuous fetal monitoring. Adapted from Moher D, Shamseer L, Clarke M, Ghersi D, Liberati A, Petticrew M, et al. Preferred reporting items for systematic review and meta-analysis protocols (PRISMA-P) 2015 statement. Syst Rev. 2015;4:1.

Figure 4: Thematic diagram of the main themes and subthemes identified by the systematic review. Main themes are represented by ellipses and subthemes by squares. CFM, continuous fetal monitoring.

Figure 5: A) Proportions of preferences for continuous fetal monitoring versus CTG (15, 17) and B) Satisfaction scores standardised to a 10-point Likert scale, with 10 being completely satisfied

and 0 being completely unsatisfied. Error bars are provided where possible from the published data [Data extracted from References (8),(15) and (17)].

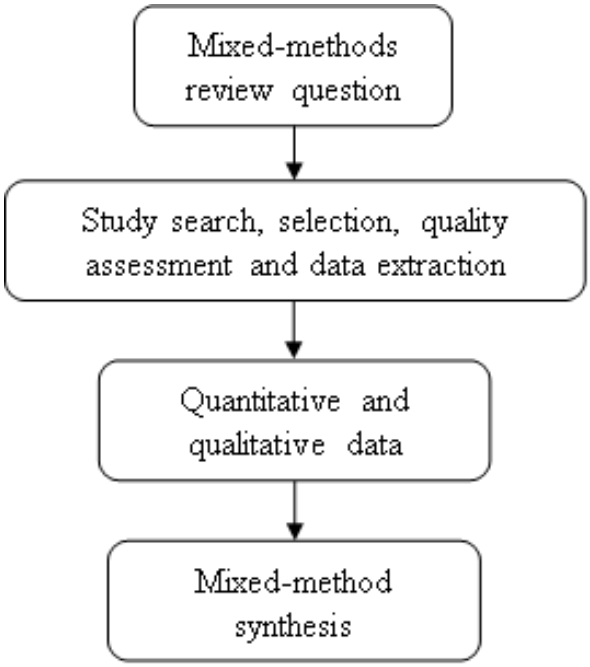
Table 1 - Summary characteristics of included studies.

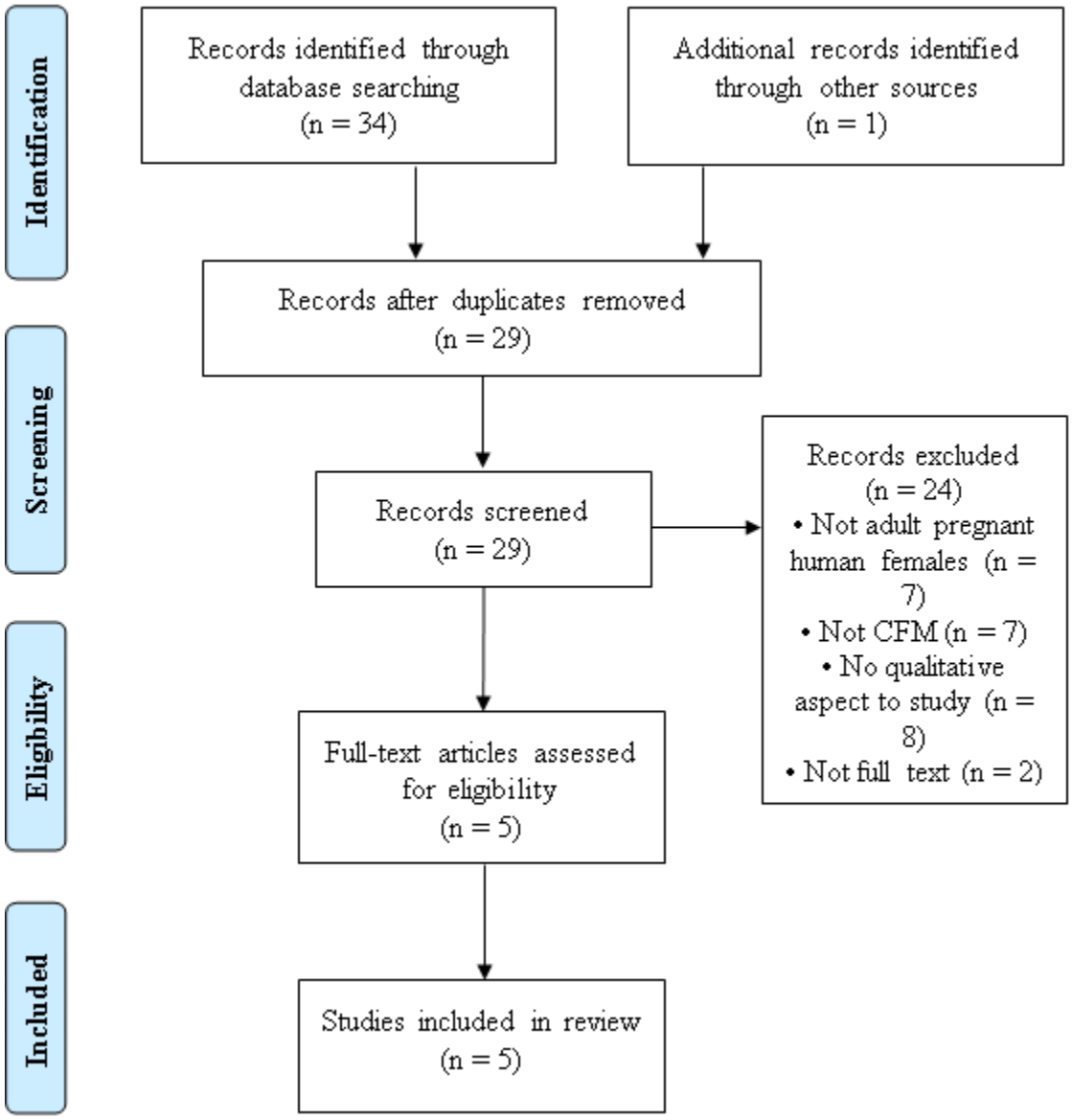
Authors	Sample Characteristics	Location of monitoring	Country of study	Timing of Monitoring	Data Collection	Key Findings	Quality Assessment
Reinhard et al. 2008 (15)	Ten pregnant women >32 weeks' gestation, received overnight monitoring with Monica AN24. All women had a previous hospital admission during pregnancy.	During inpatient admission.	Germany	Retrospective	Satisfaction and preference questionnaires.	All participants were outwardly happy with Monica AN24. Overall participants were satisfied with Monica AN24 and 80% preferred Monica AN24 to CTG. 20% of participants preferred CTG due to reduced mobility and lack of audible fetal heart sounds with Monica AN24.	B
Romano et al. 2010 (16)	Six pregnant women at 39-42 weeks' gestation received 20 minute phonocardiography recordings twice a week	Antenatal monitoring at home	Italy	Retrospective	Satisfaction questionnaire on a Likert scale of 1-4 completed before and after recordings.	Participants reported high levels of satisfaction and improved quality of life with phonocardiography. Satisfaction did not vary between participants who used the monitor for short or long periods of time.	B
Rauf et al.	Seventy low-risk women were monitored with	At home during	UK	Real-time	Semi-structured diaries assessed	Women predominantly coped well or very well and were	A

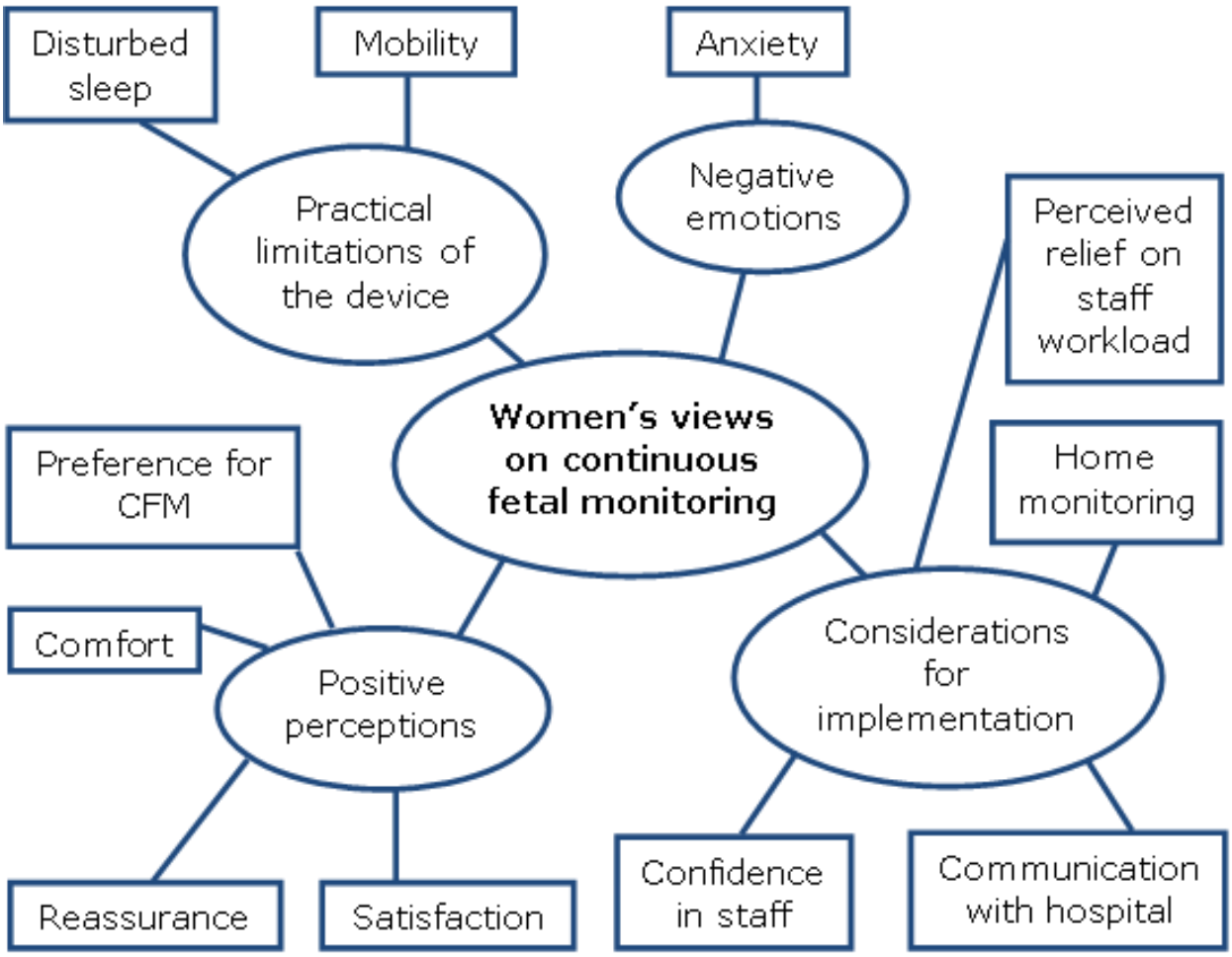
2011 (8)	Monica AN24	induction of labour.			coping, comfort, satisfaction and location preference on a 4-point Likert scale with free text space for comments.	overall satisfied or very satisfied. Satisfaction was influenced by the level of contact with hospital. Women mostly preferred being at home to in hospital and were generally comfortable.	
Philippe et al. 2011 (17)	Nineteen pregnant women 34-42 weeks' gestation received recordings with Monica AN24 and CTG.	In hospital during induction of labour	France	Retrospective	Satisfaction questionnaire.	Women generally preferred Monica AN24 over CTG and all would recommend Monica AN24 to a friend. Some participants reported discomfort, reduced mobility and disturbed sleep.	B
O'Brien et al. 2013 (18)	Fifteen low-risk pregnant women were monitored with Monica AN24.	At home during induction of labour.	UK	Real-time	Individual semi-structured interviews. Transcripts were subject to thematic coding and analysis.	Three main themes were identified: need for women to labour in their comfort zone, desire to achieve the next best thing to a normal labour and importance of a virtual presence to offer remote reassurance.	A

Figure 1: An example of a device for continuous fetal monitoring (MONICA AN24) showing adhesive electrodes applied to the maternal abdomen connected by wires to a storage device which produces a recording of the fetal heart rate trace and uterine activity. Photograph used with permission of Monica Healthcare Limited.

438x292mm (300 x 300 DPI)


Mixed-methods review question
Study search, selection, quality assessment and data extraction
Quantitative and qualitative data
Mixed-method synthesis


Identification
Screening
Eligibility
Included
Records identified through database searching (n = 34)
Additional records identified through other sources (n = 1)
Records after duplicates removed (n = 29)
Records screened (n = 29)
Records excluded (n = 24)
• Not adult pregnant human females (n = 7)
• Not CFM (n = 7)
• No qualitative aspect to study (n = 8)
• Not full text (n = 2)
Full-text articles assessed for eligibility (n = 5)
Studies included in review (n = 5)


Disturbed sleep
Mobility
Anxiety
Practical limitations of the device
Negative emotions
Perceived relief on staff workload
Women's views on continuous fetal monitoring
Preference for CFM
Home monitoring
Comfort
Positive perceptions
Considerations for implementation
Reassurance
Satisfaction
Confidence in staff
Communication with hospital

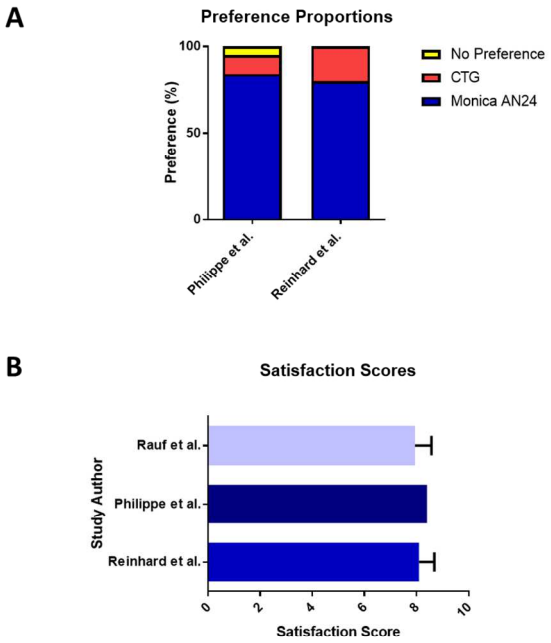


Figure 5: A) Proportions of preferences for CFM versus CTG (15, 17) and B) Satisfaction scores standardised to a 10-point Likert scale, with 10 being completely satisfied and 0 being completely unsatisfied. Error bars are provided where possible from the published data (8, 15, 17).

190x275mm (150 x 150 DPI)

Appendix S1.

1. Medline; exp FETUS/; 145072 results.
2. Medline; ((fetus OR foetus OR fetal OR foetal) ADJ3 monitor*).ti,ab; 348 results.
3. Medline; ((fetus OR foetus OR fetal OR foetal) ADJ3 movement*).ti,ab; 146 results.
4. Medline; ((fetus OR foetus OR fetal OR foetal) ADJ3 electrocardiogra*).ti,ab; 27 results.
5. Medline; ((fetus OR foetus OR fetal OR foetal) ADJ3 ecg).ti,ab; 12 results.
6. Medline; ((fetus OR foetus OR fetal OR foetal) ADJ3 "heart rate").ti,ab; 117 results.
7. Medline; electrocardiography.ti,ab; 11470 results.
8. Medline; exp ELECTROCARDIOGRAPHY/; 184388 results.
9. Medline; exp PHONOCARDIOGRAPHY/; 7602 results.
11. Medline; ((induce* OR induct*) ADJ3 labour).ti,ab; 7280 results.
12. Medline; 1 OR 2 OR 3 OR 4 OR 5 OR 6 OR 7 OR 8 OR 9 OR 11; 166882 results.
13. Medline; "long term".ti,ab; 583838 results.
14. Medline; continuous*.ti,ab; 353270 results.
15. Medline; continual*.ti,ab; 15889 results.
16. Medline; 13 OR 14 OR 15; 930835 results.
17. Medline; exp TELEMEDICINE/; 17880 results.
18. Medline; remote*.ti,ab; 51226 results.
19. Medline; wireless*.ti,ab; 7880 results.
21. Medline; transabdominal*.ti,ab; 6262 results.
22. Medline; exp MONITORING, AMBULATORY/; 22985 results.
23. Medline; wearable.ti,ab; 3155 results.
24. Medline; exp TELEMETRY/; 10145 results.
25. Medline; "long distance".ti,ab; 9420 results.
26. Medline; telehealth.ti,ab; 2025 results.
27. Medline; 17 OR 18 OR 19 OR 21 OR 22 OR 23 OR 24 OR 25 OR 26; 118647 results.
28. Medline; 12 AND 16 AND 27; 221 results.
29. Medline; exp CARDIOTOCOGRAPHY/; 1647 results.
30. Medline; ultrasound.ti,ab; 174896 results.
31. Medline; doppler.ti,ab; 86647 results.
32. Medline; ctg.ti,ab; 3082 results.
33. Medline; 29 OR 30 OR 31 OR 32; 246054 results.
34. Medline; 28 NOT 33; 199 results.
35. Medline; monica*.ti,ab; 1661 results.
36. Medline; 12 AND 35; 13 results.
37. Medline; 34 OR 36; 212 results.
38. Medline; exp PERSONAL SATISFACTION/; 12952 results.
39. Medline; acceptab*.ti,ab; 122767 results.
40. Medline; experience*.ti,ab; 772846 results.
41. Medline; satisf*.ti,ab; 239760 results.
42. Medline; 38 OR 39 OR 40 OR 41; 1086614 results.
43. Medline; 37 AND 42; 13 results.