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Australian women's experiences of wearing a non-invasive fetal electrocardiography (NIFECG) device during labour

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ABSTRACT

Background: Continuous electronic fetal monitoring devices can restrict women's freedom of movement and choice of positioning during labour and birth. Despite the use of continuous electronic fetal monitoring for the past 50 years, little attention has been paid to women's experiences of wearing different fetal monitoring devices in labour.

Aim: To explore women's views and experiences of wearing a beltless continuous electronic fetal monitoring device, the non-invasive fetal electrocardiogram during labour.

Methods: A qualitative descriptive approach was taken. Recruitment was via a larger clinical feasibility study. Some women who consented to take part in the clinical feasibility study also consented to being interviewed during the postnatal period. Transcripts were thematically analysed.

Findings: Women reported improved comfort when wearing the non-invasive fetal electrocardiogram device. They appreciated how it enabled freedom of movement and an ability to actively participate in labour. They compared their experience with previous use of cardiotocography which they felt compromised their bodily autonomy. All forms of continuous electronic fetal monitoring experienced by women resulted in the unwelcome experience of 'Poking and prodding' by the midwife.

Discussion: Continuous electronic fetal monitoring can negatively impact women's labour and birth experience, particularly when the measurement of fetal wellbeing is prioritised.

Conclusion: The way in which continuous electronic fetal monitoring technology is designed and used is an important component of optimising physiological processes and positive experiences for women during labour and birth for women with complex pregnancies. Non-invasive fetal electrocardiograpy is a promising additional option for women.

Statement of significance

Problem or issue

Continuous electronic fetal monitoring devices have the capacity to restrict women's freedom of movement and positioning during labour and birth.

What is already known

The birth environment profoundly impacts women's experience of labour and birth. For a positive experience, women need a birth environment that supports their innate physiological processes, rather than an environment designed to facilitate clinicians' performing interventions and risk assessment tasks.

What this paper adds

This is the first paper exploring women's experiences of wearing the beltless NIFECG device during labour. Women found the NIFECG comfortable to wear and, when comparing their previous experiences of wearing a CTG, felt a greater sense of control and bodily autonomy.

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Introduction

The form of technology employed to monitor the wellbeing of a woman's fetus during labour can significantly impact her birth experience. Currently, a variety of methods are used in clinical practice to monitor the fetal heart rate (FHR) including intermittent auscultation (IA) using a Pinard fetoscope or handheld Doppler, and technologies such as cardiotocography (CTG) that enable the fetal heart and uterine activity to be measured continuously. Since the introduction of wired CTG in the 1960s, continuous measurement of the fetal heart rate has commonly been performed with equipment that requires the labouring woman to wear two elastic belts around her abdomen and to be connected to a machine by wiring. This technology restricts women's mobility during labour and limits their choice of position whilst giving birth. In addition, CTG has been shown to increase the rate of caesarean section without improving outcomes for babies, apart from a slight reduction in neonatal seizures [1]. Despite this evidence, CTG continues to be recommended for women experiencing complexities and/or risk factors in pregnancy and labour [2,3].

The CTG routinely used in most high income countries monitors the FHR pattern via ultrasound and uterine contractions via tocograph. In Australia and New Zealand, the predominant type of CTG monitoring is wired, with some facilities offering a wireless version, also known as telemetry [4,5]. Wired CTG machines require the woman to be 'tethered' to the monitor via electronic leads that transfer the FHR pattern to the machine. Telemetry transmits the FHR pattern wirelessly, enabling the woman to mobilise if she chooses. In the event of poor connectivity, a fetal scalp electrode (FSE) can be used as an alternative method to monitor the FHR via electrocardiograph (ECG). This is an invasive device, attached via an 'electrode' inserted into the fetal scalp. Application of FSE requires the amniotic sac to be ruptured artificially (if this has not already occurred spontaneously).

In 2018, a new continuous electronic fetal monitoring (CEFM) device known as the non-invasive fetal ECG (NIFECG) entered the healthcare market in Australia. The NIFECG monitors the maternal and fetal heart rate by ECG and measures contractions via electromyography. The NIFECG device is external, beltless and wireless, enabling the woman to have freedom of movement and positioning. The wearable component of the technology consists of adhesive patches containing five electrodes which can be applied to the woman's abdomen in labour and a battery charged electronic pod. The pod transmits fetal heart rate, maternal heart rate and uterine contraction data to the CTG machine which is then interpreted by care providers in the same manner as a CTG trace. There is robust evidence supporting the reliability and efficacy of NIFECG, demonstrating that it is superior to the CTG in transmitting data about the fetal heart rate [6,7] and uterine activity [8] under trial conditions.

By enabling freedom of movement in labour, the NIFECG contrasts with CEFM devices that are currently in common use such as the CTG, which is known to restrict women's movement and positioning, reduce their sense of choice and control [10] and lead to a cascade of interventions including increased rates of caesarean section and instrumental births, without improving neonatal mortality rates [1]. The concept of a cascade of interventions in labour and birth is commonly used to describe the process of one intervention disturbing the normal physiological process, leading to the need for yet more interventions to keep labour progressing [9]. As yet, there is no evidence to demonstrate the impact of NIFECG use on intervention rates and perinatal outcomes, compared with CTG, however research investigating this is currently underway (Australian New Zealand Clinical Trials Registry Number ACTRN12622000251729p).

Whilst there is robust evidence available regarding a range of devices with which fetal wellbeing may be monitored effectively [6–8,11], there is a paucity of recent research exploring women's experiences of using such devices in labour. A systematic review by Smith et al. [12] included ten papers published between 1976 and 2008 that described women's views of fetal monitoring during labour, with eight of the ten papers being published in the 1970 s and 1980 s. The review showed that some women felt increased anxiety when continuously exposed to fetal heart sounds in labour, whilst others found this reassuring. Restriction of mobility was a key concern for women, as well as a lack of information and choice regarding monitoring methods. This review also highlighted the need for additional contemporary research into women's views and experiences of FHR monitoring in labour [12].

A more recent study by Watson et al. [13] explored women's experiences of using telemetry during labour in the United Kingdom, finding that women had increased feelings of autonomy, dignity and control when they were able to mobilise in labour. Telemetry was found to increase women's mobility in labour and lead to more upright birth positions, contributing to humanising care in labour [13]. Our study sought to understand women's experiences of another CEFM device, the NIFECG.

The data used for this qualitative study is derived from a larger clinical feasibility study trialling the NIFECG device [14]. This paper describes women's views and experiences of using NIFECG in labour. Other papers arising from this study have described the impact of fetal monitoring technology on midwives' practice [15] and the feasibility of implementing the NIFECG device in Australian maternity care settings [14].

Methods

A qualitative descriptive methodology was employed to understand women's views and experiences of being monitored continuously with NIFECG in labour. Qualitative descriptive research lies within the naturalistic approach, which enables researchers to create an understanding of a phenomenon through accessing the meaning participants ascribe to them [16]. In the context of health care research, this approach intends to learn from the participants and their descriptions, and then use this knowledge to influence interventions [17]. This approach was, therefore, well suited to the aims of our research seeking to highlight women's perspectives on a new form of continuous electronic fetal monitoring technology, the NIFECG.

Data collection

Women who consented to take part in the above-mentioned clinical feasibility study were asked if they would also be willing to be contacted for an interview during the postnatal period, when their baby was approximately 6 weeks old. The women who consented to an interview were contacted by the first author who conducted all interviews.

Ethical considerations

Ethical clearance was sought via the Research Ethics and Governance Information System (REGIS) and was granted by the South Eastern Sydney LHD HREC on 8/5/2019. Site specific approval was also granted from the Royal Hospital for Women (reference number 2019/STE00589) and ratified by the University of Technology Sydney ethics committee (approval no. ETH19–3744).

All participants were assured that their data would be anonymised and that any identifying details would be deleted. Following completion of interviews, audio files were professionally transcribed and then re-identified with each participant being given a pseudonym. A distress protocol was in-place to ensure the psychological safety of the participants. Transcripts are stored in a secure cloud-based storage system at the University of Technology Sydney. After 15 years, data will be destroyed, in accordance with the Australian Code for the Responsible Conduct of Research [18].

Analysis

Reflexive thematic analysis was conducted, using the method of Braun and Clarke [19]. This method facilitates the identification and analysis of patterns or themes in a given data set. The first author (RC) led the qualitative data collection and analysis. All 15 transcripts were coded to identify patterns in the data and develop initial codes using NVivo software [20] to sort and store the data. Codes were derived directly from the data and the research team then met to discuss and develop the data into agreed codes and early themes. RC and the Chief Investigator of the larger study (DF) met several times to discuss identified themes throughout the analysis process.

As per Braun and Clarke [19], codes represented the researchers' interpretations of patterns of meaning across the dataset. We employed a constructionist epistemology using a critical perspective that enabled interpretation of meaning further to those explicitly communicated by participants and allowing for examination of how the wider social context may facilitate or dispute these systems of meaning [21].

Reflexivity

By its very nature, qualitative research is subjective, recognising that each person has their own perspective and that each perspective counts [16]. Further to this, qualitative research seeks to recognise the subjectivity of the experience of not only the participant but also the researcher, seeing the researcher as an active participant in the co-creation of data. As such, clear description of the context and intersecting relationships between the participant and researcher is thought to enhance the credibility of qualitative research findings [22].

In this study, reflexivity was a continual and ongoing process. Each of the three authors of this study are registered midwives and have significant research backgrounds related to maternity care. We have also each been consumers of maternity care as mothers ourselves, therefore possessing both insider and outsider knowledge of childbirth. In order to remain sensitive to whatever the data presented, we employed a number of reflexive techniques including memo writing, continual conversation amongst co-authors regarding the development of findings, and a general awareness and willingness to challenge our own personal biases about women's experiences of fetal monitoring technology. All authors share a belief that women have a fundamental right to bodily autonomy and are strong advocates for optimising physiological processes and positive experiences for women in labour and birth.

Findings

Fifteen women were interviewed within 12 weeks of giving birth. Interviews were audio-recorded and then transcribed verbatim by a professional transcription service. As per Fawcett and Garity [23] an adequate sample size is one that sufficiently answers the research question, the goal being to obtain cases deemed rich in information. This study employed a reflexive thematic analysis approach [24]. We acknowledge that themes are not entities that exist in isolation from one another but are chapters in a broader story [24]. As such we made an interpretative judgement related to the purpose and goals of the analysis and decided that after 15 interviews, enough information had been gained to understand the phenomenon in question.

The majority of participants interviewed after using NIFECG were multiparous women (n = 9), many of whom had experienced CTG in prior labours. Others had experienced CTG monitoring antenatally in a day-stay service or following admission to the antenatal ward. As such, women tended to reflect on their experience of using the new NIFECG device, whilst comparing this with previous antenatal or intrapartum experiences where wired or wireless CTG monitoring was used. Our findings, therefore, include women's views and experiences of using various forms of fetal monitoring technology. More than half of the women interviewed had their labour induced, with parity ranging from 38 to 41 weeks' gestation.

The following themes were identified in the data: '*Comfort is 10 out of 10!', 'Actively participating in my labour', 'Compromising bodily autonomy with restrictive devices'* and *'Poking and prodding'*.

Comfort is 10 out of 10!

Women found the beltless NIFECG device very comfortable: "*Its comfort is honestly, a 10 out of 10!" (Sascha)*. Many commented that it was lightweight and easy to apply. Once they got used to it, they would almost forget it was there, enabling them to focus on managing the pain of labour, as these women described:

> *You don't really notice it's there… It's just one less thing that you really had to think about (Kara).*

> *What I really loved about it was you didn't have this heavy weight strapped around you, because you're already quite big by then. Any less weight, the better. I just couldn't believe how small it was when they stuck it on. I was really impressed by that (Alicia).*

Women who had previously experienced wearing the CTG were especially positive about the NIFECG, describing the discomfort they had endured in previous labours. Their experience of discomfort with the CTG was primarily caused by the two tight elastic belts wrapped around their abdomen, commenting "*Having the straps on you, that makes you feel uncomfortable" (Sascha).* Similarly, another woman stated she found it *"…uncomfortable having the heavy elastic wrapped around me" (Natasha)*. Women felt they had no choice but to tolerate the discomfort of wearing a CTG device in order to monitor the wellbeing of their fetus:

> *[CTG] was restrictive…[but] I didn't have anything to compare it to, so I just thought that, well that's how you monitor someone and I needed to be monitored (Alicia).*

In comparison, women felt the NIFECG device was a superior method of fetal monitoring due to the absence of elastic straps and wires connecting to the machine:

> *Look, I just thought it was fantastic. Once it was all on and configured and all that kind of thing, it was all pretty straightforward. And I loved being able to watch it on the monitor… it was fairly painless, the way that it was sort of attached and it didn't have all the cords coming off it, so it was less cumbersome (Carol).*

Without the need for elastic belts, women were able to wear their regular clothes over the top of the NIFECG device. This not only made them feel more comfortable, it also served to reduce the sense of their labour being a medicalised event:

> *I did feel more in control and a little bit more empowered to have… a little less medicalised birth. To not feel so much like a patient in a bed (Narelle).*

The improved comfort of NIFECG was highly regarded by women participants, who were excited about the potential for this new technology to better cater for the needs of women who may consent to CEFM in labour.

Actively participating in my labour

In comparison to previous experiences with the CTG, women felt a greater sense of control when using the beltless NIFECG device. Feeling unrestricted, without being tethered to the machine by wires, gave them a sense of physical freedom which had a positive psychological impact, as these women explained:

> *It definitely helps mentally and also physically, because I actually like to labour on the ground on all fours or moving round. [With NIFECG] I didn't have that limitation… it meant that I could just focus on the task at hand (Alicia).*

Just having the knowledge that if I needed to I could get up and move – that was quite comforting (Melanie).

When using the NIFECG, women felt able to maintain their mental focus during labour without being distracted by the device. When they were able to mobilise, not only did women experience the benefits of pain management, they also felt they were participating more actively in their labour:

I felt in total control of what was going on. It felt like I was able to actually be actively participating in progressing with it [labour], rather than just laying there doing what I'm told (Melanie).

For me, actively moving made a really big difference to my pain management and my mental state. If you were having an epidural then you probably wouldn't care. But for me, for someone who wanted to have a really non-medicated birth, I wanted to be able to move (Katherine).

Women reflected upon their previous experiences of continuous monitoring in labour using a wired CTG. They described feeling 'locked into the machine' and 'strapped to the bed'. This had both physical and psychological impacts on women:

Because I was locked into the machine, I wasn't able to move around or go to the bathroom or go from one room to the other (Alicia).

That mental thing of knowing you can't move when you are strapped onto it [CTG] was really quite tricky… Having that feeling of just having to lay there because I'm strapped to the bed, I felt really fidgety (Melanie).

Lacking the freedom to move during previous experiences with the CTG had increased women's feelings of stress and anxiety:

I was getting anxious that I wanted to get up. But it was just too difficult with the belt on. So, I was feeling a bit anxious about having that feeling again… that was totally, totally alleviated with the beltless [NIFECG] system (Melanie).

The desire for freedom of movement in labour was strong. Almost all women interviewed mentioned the importance of being free to move around the room, remaining upright and active in labour. For many women, mobility was a key strategy they employed to manage the pain of labour:

I personally wanted a labour without too much medical assistance… One of my main things is I wanted to be able to move around. I wasn't having an epidural or anything. I didn't want to have to be stuck on a bed. I'm an active person anyway, so for me being able to move around was important (Katherine).

Women enjoyed how the beltless NIFECG device allowed them to adopt numerous positions that included being on all fours, walking, standing, dancing, using the shower, sitting on a birth ball, as well as lying supine and left lateral in bed. They noticed that with no cords, the device was less cumbersome, which meant they were able to move about the room and choose their position freely.

One drawback women identified was that the NIFECG was not compatible with water immersion, meaning that access to waterbirth was inhibited:

The only downside is if everything was going really well, I would've wanted to be in a bath, but that wasn't an option [with NIFECG]. [Nevertheless] I was 100% happier wearing [the NIFECG] (Natasha).

Beyond this drawback, women indicated a strong preference for fetal monitoring with the NIFECG as opposed to either wired or wireless CTG, as they felt it enabled them markedly greater freedom of movement which had positive physical and psychological impacts.

Compromising bodily autonomy with restrictive devices

Many of the women using CEFM were doing so because their pregnancy had been identified as high risk. Being labelled as high risk and experiencing the need for medical intervention, women sometimes felt their choices for labour and birth were diminished. In such circumstances, the capacity for women to move freely and fulfil bodily needs when using the beltless device lead to a greater sense of choice and control:

I think in a high risk pregnancy particularly… you feel very, very micromanaged and it's quite medicalised and so just having something to be able to have control over or a little bit of freedom to be able to make a choice [of position] during the labour process, it was quite nice (Melanie).

Conversely, CTG devices compromised women's bodily autonomy in labour. Wired CTG had the most significant negative impact, as women were literally tethered to the machine, unable to move more than 1.5 m away from the CTG base station. This meant they were unable to move about the room freely and needed to ask for help or permission to perform fundamental bodily functions such as accessing the toilet to void, open their bowels or vomit. One woman described how restricted she felt by the wired CTG and how she didn't want to 'hassle' the midwives to assist her to access the bathroom:

You have that feeling where you have to go to the toilet quite a lot. And of course, feeling like you're wanting to vomit. But… I felt restricted in being able to ask. I felt like it was too much of an effort to ask everyone, and for the midwives to come back in and unhook me and take me over there. I kind of felt like it was too much of a hassle. So, you kind of just had to put up with it (Melanie).

Women described how much better their experience was with the NIFECG as it enabled them to access the bathroom without needing to ask for permission or assistance:

For me, being able to get up and go to the toilet and things like that…[the NIFECG] was really good in that respect (Katherine).

A few times I had to get up and go to the bathroom and it was just easier that I only had to worry about the drip (Rose).

It was nice to be able to get up and move around, use the ball, spin. I could use the bathroom without having to worry about too much (Kara).

Another woman who experienced nausea and vomiting throughout labour noted the improved experience when using the beltless NIFECG device as she was readily able to access the bathroom to vomit:

Yeah, it was really fantastic. With my first pregnancy, I was hooked up to the belt and couldn't move at all. And so, I was really feeling anxious about not being able to move with my second birth. So, just being able to get up. And I vomited during both births. So, being able to actually get up and vomit was good rather than just laying back (Melanie).

The process of labour commonly results in women needing to frequently access the bathroom. Restricting women's capacity to access this impinges on their sense of dignity and results in a loss of bodily autonomy. The notion of a woman seeking permission to use the bathroom is infantilising and should not be considered acceptable practice.

Poking and prodding

When women were being monitored with CEFM, they were often disrupted by the midwife needing to adjust or reposition the wearable device, in order to maintain a good trace of the fetal heart. Women who had used CTG before recalled this occurring frequently:

[Midwives] were always fiddling with the discs [CTG transducers] trying to get it in the right place… (Natasha).

I remember having to adjust [the CTG] constantly. It would always sort of dislodge or disconnect from the monitoring. They would have to sort of constantly play around with it and try to adjust it to get it back into position (Nerida).

When it was working well, the NIFECG device did not need adjustment. However, at times, disruption also occurred when the NIFECG was not working correctly and required troubleshooting by the midwife:

I love the idea of it [NIFECG]… but it just wasn't effective on me. It just wasn't working and we reapplied it. They went through the instructions around cleaning surface and all that stuff, but it just wasn't working. Unfortunately I had to revert back to the [CTG] thing (Nerida).

Such fiddling with the monitoring device was disruptive to the woman and tended to impact her choice of position and access to comfort measures, as these women described:

The only thing that I… could comment on in the negative respect is that when I went to the toilet, I found that [the NIFECG] had slipped. That happened a couple of times. You had to lay back down again and have it configured again, that did happen maybe twice, but it wasn't such a big deal (Carol).

I did just find a couple of issues… the top sticker kept coming off. It wasn't fully removing itself [but] it wasn't picking up what it needed to pick up all the time… There was a lot of my midwife running in, trying to re-stick it and try to leave me in peace and then running back in, trying to re-stick it, leaving me in peace (Natasha).

Natasha went on to describe how the focus on fetal monitoring technology disrupted her focus in labour and added an element of stress for everyone in the birth environment:

There were a lot of people poking and prodding and trying to adjust [the NIFECG] during contractions, when I was mentally trying very hard to focus on breathing. I felt like there were stressors around me and I was picking up on midwives being a bit anxious… Having someone fiddling with me and talking to me and saying, "I'll just get you to move this way and just get you to move that way," was pulling me out of where I mentally needed to be (Natasha).

At times, the midwife's need to obtain accurate fetal heart rate and contraction data was at odds with the woman's need for an undisturbed birth environment. Optimal birth environments need to be supportive of physiological processes *as well as* facilitating successful fetal monitoring.

The four themes, '*Comfort is 10 out of 10!*', '*Actively participating in my labour*', '*Compromising bodily autonomy with restrictive devices*' and '*Poking and prodding*'. illustrate women's perspectives on the impact of NIFECG upon their labour and birth processes. Several participants compared their experience of NIFECG with past experiences of wearing a CTG, and these comparisons were added to enrich the data.

Discussion

Our findings demonstrate that CEFM can significantly impact women's labour and birth, dehumanising their experience while prioritising measurement of fetal wellbeing. The responsible design of technology encompasses the needs of the woman, the fetus and the caregiving responsibilities of the clinician. The CTG was designed in the 1960 s without concern for the woman's comfort, needs or neurohormonal processes of labour and birth. Yet the technology persists today and newer technologies that are more woman-centred, such as telemetry, have been slow to be adopted into mainstream practice [5].

The restriction of women's bodily autonomy whilst receiving health care is a violation of their human rights [33]. Freedom of movement is important physiologically because of the anatomical mechanisms and neurohormonal processes that are disturbed when women are stressed, uncomfortable or unable to move freely [25-34]. Stress and discomfort result in reduced production of endogenous oxytocin which is a primary cause of delayed progress in labour [30] and lack of upright positioning and mobility restricts women's capacity to change the shape and size of their pelvic inlet and outlet through which the baby must pass in order to be born [35,36]. Our findings show that women value freedom of movement in labour and use mobility as a key strategy for managing labour pain. Participants clearly indicated that when they could move freely this had significant positive physical and psychological effects.

International evidence shows that freedom of movement and positioning for women during labour and birth is not associated with any adverse effects for women or unborn babies and decreases the use of pharmacological pain management [12,26], reduces the likelihood of caesarean section [28] and increases the likelihood of a shorter duration of labour [29]. Psychological benefits for women include increased satisfaction with the birth experience [26] and a strengthened sense of choice and control [30]. In our study, women described how problematic it was to need to ask for help or permission to perform fundamental bodily functions such as accessing the toilet to void, open their bowels or vomit, restricting their bodily autonomy and infantilising them. Given the clear benefits of freedom of movement in labour, and the negative impacts described by women in our study, it is unacceptable to restrict women's mobility with fetal monitoring devices that do not allow them to move freely and instinctively in childbirth.

For over 50 years, the need to elicit continuous data from fetal monitoring technology has been prioritised over the basic human needs of labouring women, in its design and utilisation. As described in the findings, women with prior experiences of wearing a CTG found it very uncomfortable, in particular the tight elastic belts around their pregnant abdomen caused pain and discomfort. Further to this, CTG transducers were noted to frequently slip or become displaced, resulting in the need for the midwife to fiddle with and readjust them, thus disturbing the labouring woman. Our findings were aligned with those of Watson et al. [13], whose research demonstrated that women do not want to be 'strapped to the bed'. Wired forms of CEFM restrict women's bodily autonomy by tethering them to the bed. Our study expands upon the notion of wires being restrictive but also explores the influence of belts/straps on women's comfort and the advantages of a beltless device such as the NIFECG. Nevertheless, all forms of CEFM require adjustment at times which may be distracting and uncomfortable for women, disturbing the environment necessary for the facilitation of neurohormonal procceses during labour and birth.

Strengths and limitations

A limitation of this study is that it incorporated women from one study site in an urban area. Participants are of a high socio-economic status which may limit the diversity of demographic backgrounds of participants. Midwives at this particular hospital promoted the use of mobility in labour and encouraged the routine use of wireless CTG monitoring. In general, women were supported by midwives to mobilise, as a strategy to improve labour progress. This is the first time research has focused explicitly on women's experiences of using NIFECG in labour.

Further research is needed to investigate women's experiences of contemporary intrapartum CEFM in a larger and more diverse population.

Conclusion

Fetal monitoring technology that allows autonomy and freedom of movement is an imperative component of optimising physiological processes in labour and birth for women with complications and risk factors in labour. All stakeholders need to have the opportunity to be actively engaged in the development of new CEFM devices in order to influence the responsible design of technologies in maternity care. The restriction of women's bodily autonomy in labour is not acceptable and has the potential to adversely impact psychological and physiological processes in labour. The beltless NIFECG device has the potential to improve women's experiences of labour and affords them more autonomy and ability to make choices around movement, positioning and accessing the bathroom.

When undisturbed, women intuitively adopt positions in labour that facilitate physiological processes. All forms of CEFM interrupt this, even those that are wireless and beltless will sometimes require attention and adjustment by the midwife, to ensure optimal connectivity. It is evident that anatomical and neurohormonal processes are paramount when designing future continuous electronic fetal monitoring technologies.

Ethical statement

Ethical clearance was sought via the Research Ethics and Governance Information System (REGIS) and was granted on 8/5/2019. Site specific approval was also granted from South East Sydney Local Health District (approval no, **2019/ETH00630)** and ratified by the University of Technology Sydney ethics committee (approval no, **ETH19–3744).** Australian New Zealand Clinical Trials Registry number: ACTRN12619000293167p.

CRediT authorship contribution statement

Deborah Fox: Conceptualization, Funding acquisition, Project administration, Methodology, Investigation, Data curation, Writing – original draft, Writing – review & editing. **Rebecca Coddington:** Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing – original draft, Writing – review & editing. **Vanessa Scarf:** Conceptualization, Investigation, Writing – review & editing.

Declaration of interest

The Chief Investigator, Dr Deborah Fox, has received honoraria from Philips Healthcare for presenting lectures and workshops to midwives and obstetricians, in a consultant capacity, about mobility in labour. Neither Dr Fox, nor any other research team members have any financial interest in the NIFECG product, or in Philips Healthcare or any of its subsidiaries. No conflict of interest declared.

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