Impact of maternal and fetal characteristics on effectiveness of ambulatory non-invasive fetal electrocardiography

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Objective:

- To establish the feasibility of non-invasive fetal electrocardiography (NIFECG) monitoring using a novel, wireless ambulatory monitor. We also aimed to investigate the impact of maternal and fetal characteristics on its signal quality in comparison to conventional computerised cardiotocography (cCTG).

Design:

- A prospective observational study.

Figure 1. The novel wireless NIFECG device applied on the maternal abdomen

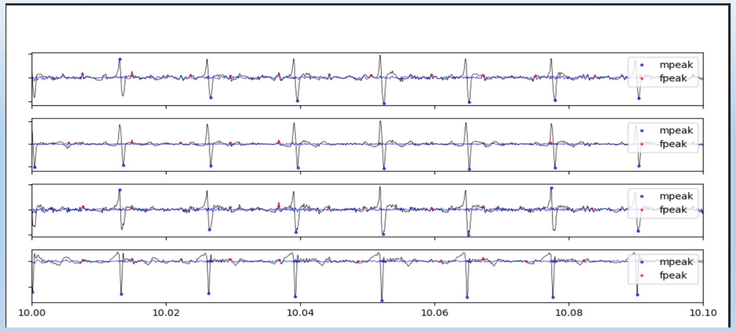

Figure 2. Raw NIFECG signals, combining both fetal and maternal QRS complexes. Maternal (mpeak) and fetal (fpeak) R waves are marked by the blue and red dots respectively.

Methods:

- Women with a singleton pregnancy over 28+0 weeks' gestation undergoing cCTG assessment for any clinical indication were eligible.
- Concurrent monitoring with a novel wireless ambulatory NIFECG device was performed with the cCTG for up to 60 minutes.
- Signal loss was reported as a percentage of the trace duration where FHR signals were not captured. Traces were deemed clinically interpretable if they fulfilled the signal acceptance criteria of <50% signal loss.
- Multiple regression analyses were performed to examine the correlation between maternal and fetal characteristics and signal loss.

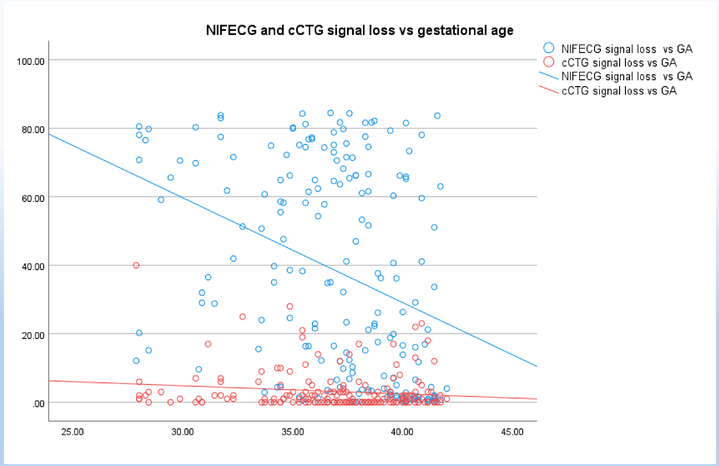

Figure 3. Signal loss (y axis) against gestational age (GA, x axis) in NIFECG (blue circles) and cCTG (red circles). Regression lines for the 2 cohorts shows a significant negative correlation between GA and signal loss in the NIFECG (blue line), with a less pronounced effect on signal loss in cCTG (red line)

Results:

- Concurrent NIFECG and cCTG traces were collected from 186 women.
- 56% of NIFECG and 100% of cCTG traces were clinically interpretable.
- 55% of signal loss from NIFECG was secondary to electrical interference, 28% from loss of R waves, and 17% from both.
- Multiple regression analyses demonstrated that increasing gestation was significantly correlated with reduced signal loss for both NIFECG ($p<0.001$) and cCTG ($p=0.045$). Increased signal loss in women of Black ethnicity ($p=0.029$) was seen in NIFECG, whilst increased signal loss in women with increased maternal weight ($p=0.018$) and fetal movement ($p=0.003$) were evident only with cCTG.

Conclusions:

- NIFECG showed higher rates of signal loss than cCTG, but it appears to be less hindered by characteristics such as maternal weight and excessive fetal movements.
- Signal loss secondary to electrical interference contributes to a large proportion of clinically uninterpretable traces, possibly specific to the hospital environment, therefore further research using the NIFECG monitor in the home setting is required to establish feasibility.

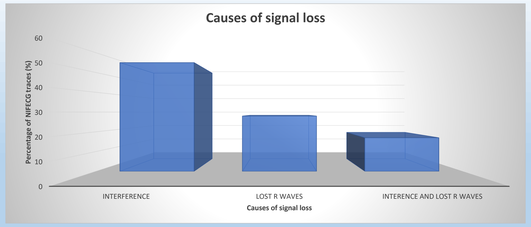

Figure 4. Factors causing signal loss. The majority of traces were affected by electrical interference, whilst others were clinically uninterpretable due to loss of fetal R waves.

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