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Review article

Intrapartum cardiotocograph monitoring and perinatal outcomes for women at risk: Literature review

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ABSTRACT

Problem: Caesarean section rates have risen in high-income countries. One of the potential drivers for this is the widespread use of CTG monitoring.

Background: Intrapartum cardiotocograph monitoring is considered to be indicated for women at risk for poor perinatal outcome.

Aim: This systematic literature review with meta-analysis examined randomised controlled trials and non-experimental research to determine whether cardiotocograph monitoring rather than intermittent auscultation during labour was associated with changes in perinatal mortality or cerebral palsy rates for high-risk women.

Methods: A systematic search for research published up to 2019 was conducted using PubMed, CINAHL, Cochrane, and Web of Science databases. Non-experimental and randomised controlled trial research in populations of women at risk which compared intrapartum cardiotocography with intermittent auscultation and reported on stillbirth, neonatal mortality, perinatal mortality and/or cerebral palsy were included. Relative risks were calculated from extracted data, and meta-analysis of randomised controlled trials was undertaken.

Findings: Nine randomised controlled trials and 26 non-experimental studies were included. Meta-analysis of pooled data from RCTs in mixed- and high-risk populations found no statistically significant differences in perinatal mortality rates. The majority of non-experimental research was at critical risk of bias and should not be relied on to inform practice. Cardiotocograph monitoring during preterm labour was associated with a higher incidence of cerebral palsy.

Discussion: Research evidence failed to demonstrate perinatal benefits from intrapartum cardiotocograph monitoring for women at risk for poor perinatal outcome.

Conclusion: There is an urgent need for well-designed research to consider whether intrapartum cardiotocograph monitoring provides benefits.

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Statement of significance

Problem

The use of intrapartum CTG monitoring is widespread, particularly for women considered to be at risk for poor

perinatal outcome. The use of intrapartum CTG monitoring increases the risk of surgical birth.

What is already known

Intrapartum CTG monitoring does not prevent perinatal death or cerebral palsy in infants born to low risk women.

What this paper adds

Current research evidence does not demonstrate improvements in perinatal outcome for infants born to women at risk of poor perinatal outcome when intrapartum CTG monitoring is used.

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Introduction

Intrapartum cardiotocograph (CTG) monitoring was introduced in the 1970s.¹ The CTG records and displays the fetal heart rate and uterine tone over time making it possible to examine relationships between heart rate and uterine activity. Fetal heart rate patterns are considered to provide physiological information regarding oxygenation of the fetus.² During labour a reduction in placental blood flow occurs during uterine contractions.³ This reduction may place the fetus at risk for low oxygenation.⁴ Hypoxia is presumed to be responsible for a proportion of perinatal deaths and cases of cerebral palsy (CP).^{5,6}

CTG monitoring was introduced as a screening tool in order to detect fetal hypoxia so that corrective action could be taken.⁷ The goals of intrapartum CTG monitoring include reducing perinatal mortality and CP. CTG monitoring confers no benefits over intermittent auscultation (IA) for women considered to be at low risk for poor perinatal outcome.⁸ Most professional guidelines regarding intrapartum fetal monitoring therefore consider that IA is appropriate for women at low risk. Continuous intrapartum CTG monitoring for women at risk is universally recommended within professional guidelines.^{9–13} Caesarean section rates have increased over the past two decades,¹⁴ with clear evidence that use of CTG monitoring contributes to increases in the use of caesarean section.¹⁵ Rates of maternal mortality and significant maternal morbidity appear to be increasing in some high income countries¹⁶ and are associated with rising caesarean section rates.^{17,18}

The Royal Australian and New Zealand College of Obstetricians and Gynaecologists Intrapartum Fetal Surveillance guideline acknowledge that evidence from randomised controlled trials (RCTs) do not demonstrate a perinatal benefit from intrapartum CTG monitoring for infants born to women with risk factors but suggests that non-experimental evidence supports this practice and therefore justifies the guideline's recommendations for CTG use.⁹ No systematic review of non-experimental research regarding intrapartum CTG use in high risk women has previously been undertaken. The Cochrane review of RCTs investigating intrapartum CTG monitoring included subgroup analyses for high and mixed risk populations of women, but this information was not foregrounded within the review making it easy to overlook.

Given that CTG monitoring is associated with surgical risks for women, it is important to revisit the evidence regarding intrapartum CTG monitoring to ensure that current efforts to reduce perinatal hypoxic injury and death are effective and balance this risk. The research question underpinning this systematic literature review and meta-analysis was: does continuous intrapartum CTG monitoring modify the risk for fetal or neonatal mortality, or cerebral palsy, for infants born to women who are considered to be at increased risk of experiencing perinatal mortality or CP? In order to address this question evidence from both RCTs and non-experimental research was examined.

Methods

Literature search

This systematic literature review was registered prospectively with PROSPERO (CRD42018114637). The PubMed, Cumulative Index to Nursing and Allied Health Literature, Cochrane Library, and Web of Science databases were searched in November 2018 and updated in July 2019. The search string used was ("Cardiotocography" OR "Fetal Monitoring" OR "Monitoring, Physiologic") AND ("Labor, Obstetric" OR "Delivery, Obstetric"). The search was limited to English language publications, humans and no date limits were set.

The searches returned 1853 matches, spanning the years 1966–2019. Titles and abstracts of the papers were assessed against

inclusion and exclusion criteria (see Fig. 1). Included in the review were original research papers examining continuous intrapartum CTG monitoring which reported on at least one of the outcomes of interest: perinatal mortality, neonatal mortality, stillbirth, or CP. Reference lists were examined, along with those of the Cochrane review of intrapartum CTG monitoring⁸ and other systematic literature reviews^{19–22} and 40 additional papers were identified.

Full text copies of 74 papers were read and excluded if they reported data later included in a subsequent publication (when this occurred, the most complete data set was included), if the population was women at low risk, or when comparisons were not made between intrapartum CTG monitoring and IA. Many of the early papers referred to the comparison group as having "no monitoring" and it has been assumed that IA was in use for this group of women.

A total of 36 papers were excluded at the full text review. Fifteen provided no outcome data, and two examined populations of women at low risk. Six papers presented data published again later. Eight papers compared restricted CTG use with liberal CTG use. These were excluded as women at risk were likely to have been equally included in both cohorts. One RCT was excluded as intermittent electronic fetal heart monitoring without uterine tone monitoring was used rather than CTG monitoring. Also excluded were two papers reporting outcomes in a population of women exposed to CTG monitoring with no comparison group, and another published only as an abstract and lacking detail. A final unpublished RCT data set referred to in the Cochrane review was unable to be obtained.

Risk of bias assessment

The 38 included papers were assessed for risk of bias. The Risk of Bias in Nonrandomised Studies of Interventions (ROBINS-I) tool²³ was used to assess the non-experimental research. None of the papers provided information regarding the use of co-interventions which might have altered outcomes (such as fetal scalp blood sampling). This parameter was therefore disregarded. All the included RCTs had previously been assessed for risk of bias by the authors of the Cochrane review of intrapartum CTG monitoring,⁸ and these results were utilised.

Data extraction

Included papers were read and data on the total number of births and the number of stillbirths, neonatal deaths and/or perinatal deaths were extracted (when available) and summarised in tabular form. Definitions for stillbirth, neonatal and perinatal mortality were not always expressed, and when they were, these varied. No attempt has been made to correct for this. When information regarding both the intrapartum stillbirth rate and either the antenatal or total stillbirth rate was reported, only the intrapartum rate was extracted. When the neonatal mortality rate was corrected for lethal anomalies, this figure was used in preference to the raw data. When it was not otherwise specified, perinatal mortality was calculated as the sum of stillbirth and neonatal mortality rates.

Data analysis

Results from non-experimental and RCT research were analysed separately. Study designs and definitions used within the non-experimental research varied significantly, hence the outcome data were not summarised into a single figure. The majority of the non-experimental data did not report measures of statistical significance. Where sufficient data extracted from the papers enabled this, rates of stillbirth, neonatal mortality, perinatal

Fig. 1. PRISMA diagram.

mortality and cerebral palsy were calculated per 1000 births. Risk ratios (RR) and 95% confidence intervals (95% CI) were also retrospectively calculated from the raw data. When the data was insufficient to perform such calculations, the results presented by the original authors were used.

RCTs were grouped into high- and mixed-risk populations for meta-analysis. RRs and 95% CIs were calculated for each outcome. Meta-analysis of pooled data used the fixed effects Mantel–Haenszel test, as the I^2 test for heterogeneity was low. Review Manager software (v5.3.5) was used to perform all statistical calculations.

Findings

Non-experimental research

Twenty-seven non-experimental papers reported data between 1972 and 2018. Data from Fleet et al.²⁴ and Hopkins et al.²⁵ were merged, as the earlier paper provided data prior to and the latter provided data after CTG monitoring was introduced. Most research ($n = 16$) was undertaken in the United States of America (USA). The remainder was conducted in Canada ($n = 3$), Denmark ($n = 2$), the United Kingdom (UK) ($n = 1$), Africa ($n = 1$), Germany ($n = 1$), Israel ($n = 1$), Norway ($n = 1$), and Switzerland ($n = 1$).

Risk of bias assessment

The most common potential bias regarded recognising and controlling for confounding variables, which was a critical issue for

22 papers. One paper was assessed as being at serious risk in the category of classification of intervention.²⁶ Women in this research were retrospectively assigned to risk categories on the basis of their birth outcome. Only four papers had moderate risk of bias; a level considered compatible with providing sound evidence for practice.^{27–30}

Research approaches

Table 1 describes the approaches used and the findings of the non-experimental research. Most used a times series design, comparing a time period prior to the introduction of intrapartum CTG monitoring with a period following introduction of CTG monitoring,^{24,25,32–45} which always favoured CTG use among women at risk. The remaining studies used cross-sectional design. Three papers compared a population of women at low risk for poor perinatal outcome who were not monitored by CTG, with a population at high risk monitored by CTG during the same time period.^{46–48} Philpott and Stewart's research compared two high risk groups, with nature of the risk factors being different between the two groups.⁴⁹ One team compared a group of women where CTG monitoring was not used in labour with a group where it was used, and generated subsets on the basis of risk assessment.⁵⁰ The findings from the two highest risk subgroups have been merged. In this study, differences in the type of monitoring used arose due to limited numbers of monitors. It is probable that there were significant differences between the study populations that account for differences in outcomes.

Table 1

Non-experimental research on intrapartum CTG monitoring for women at increased risk for poor perinatal outcome.

ROBINS-I bias risk	Author, year	Country	Study design	Number of births	Stillbirth rate (per 1000 births)			Neonatal mortality rate (per 1000 births)			Perinatal mortality rate (per 1000 births)		
Critical	Prior to vs after introduction of CTG				Prior	After	RR (95% CI)	Prior	After	RR (95% CI)	Prior	After	RR (95% CI)
	Hill, 1972 ³²	USA	Time series	ND	ND	ND	NA	ND	ND	NA	10.0	5.0	NA
	Gabert & Stenchever, 1973 ³³	USA	Time series	2388	11.1	17.6	1.60 (0.79–3.22)	19.5	7	0.36 (0.15–0.86) ^a	30.6	24.6	0.80 (0.47–1.35)
	Koh, et al., 1975 ³⁴	Canada	Time series	2241	3.4	7.4	2.16 (0.65–7.19)	4.3	4.6	1.08 (0.31–3.72)	7.8	12.0	1.56 (0.66–3.66)
	Shenker et al., 1975 ³⁵	USA	Time series	11,770	6.7	7.8	1.16 (0.68–1.97)	7.9	5.7	0.72 (0.43–1.21)	14.6	13.5	0.92 (0.64–1.34)
	Hochuli et al., 1976 ³⁶	Switzerland	Time series	ND	Approx. 1	Approx. 1	NA	Approx. 5	Approx. 2	NA	9.0	5.0	NA
	Lee & Baggish, 1976 ³⁷	USA	Time series	7852	11.8	8.8	0.79 (0.50–1.24)	13.0	6.0	0.46 (0.28–0.75) ^a	24.1	14.7	0.61 (0.43–0.85) ^a
	Papageorgiou et al., 1977 ³⁸	Canada	Time series	8481	13.4	6.4	NA	7.6	4.5	NA	20.9	10.9	NA
	Hamilton et al., 1978 ³⁹	USA	Time series	8589	2.6	0.2	0.09 (0.01–0.70) ^a	8.9	8.8	0.99 (0.63–1.55)	21.1	14.4	0.68 (0.49–0.94) ^a
	Johnstone et al., 1978 ⁴⁰	UK	Time series	16,411	1.2	0.4	0.34 (0.09–1.22)	ND	ND	NA	1.9	0.8	0.44 (0.17–1.11)
	Weinraub et al., 1978 ⁴¹	Israel	Time series	1218	4.5	0	0.18 (0.01–3.41)	13.4	1.8	0.14 (0.02–1.07)	17.8	1.8	0.10 (0.01–0.78) ^a
	Fleet et al., 1976; Hopkins, et al., 1979 ^{24,25d}	USA	Time series	25,673	22.5	20.1	0.89 (0.73–1.09)	26.5	31.4	1.19 (1.00–1.41) ^a	49.0	51.5	1.05 (0.92–1.20)
	Shamsi et al., 1979 ⁴²	USA	Time series	10,853	7.3	7.6	1.04 (0.67–1.63)	10.0	7.7	0.77 (0.51–1.16)	17.3	15.3	0.88 (0.65–1.19)
	Mueller-Heubach et al., 1980 ⁴³	USA	Time series	14,914	2.2	0.6	0.27 (0.10–0.76) ^a	9.8	8.2	0.84 (0.59–1.18)	12.0	8.8	0.73 (0.53–1.01)
	Boehm et al., 1981 ⁴⁴	USA	Time series	2607	ND	ND	NA	22.6	5.1	NA	ND	ND	NA
	Heinrich, 1982 ⁴⁵	Germany	Time series	11,355	ND	ND	NA	ND	ND	NA	21.8	13.9	NA
	Low risk with IA vs high risk with CTG				IA	CTG	RR (95% CI)	IA	CTG	RR (95% CI)	IA	CTG	RR (95% CI)
	Tutera & Newman, 1975 ⁴⁶	USA	Cross-section	6792	6.0	2.0	NA	8.0	0	NA	14.0	2.0	NA
	Stevens et al., 1976 ⁴⁷	Canada	Cross-section	2721	2.3	0	0.19 (0.01–3.47)	7.0	7.9	1.12 (0.46–2.76)	9.4	7.9	0.84 (0.36–1.97)
	Yeh et al., 1982 ⁴⁸	USA	Cross-section	111,955	0.7	0.2	0.32 (0.16–0.64) ^a	4.6	3.5	0.76 (0.63–0.92) ^a	5.3	3.8	0.70 (0.59–0.84) ^a
	High risk with IA vs high risk with CTG				IA	CTG	RR (95% CI)	IA	CTG	RR (95% CI)	IA	CTG	RR (95% CI)
	Philpott & Stewart, 1974 ⁴⁹	Africa	Cross-section	426	ND	ND	NA	ND	ND	NA	19.7	16.6	NA
	Amato, 1977 ⁵⁰	USA	Cross-section	7207	4.0	0.2	0.06 (0.01–0.45) ^a	15.1	1.9	0.12 (0.06–0.26) ^a	19.1	2.1	0.11 (0.05–0.22) ^a
Serious	IA vs CTG in high risk population				IA	CTG	RR (95% CI)	IA	CTG	RR (95% CI)	IA	CTG	RR (95% CI)
	Greenland et al., 1985 ²⁶	Denmark	Cross-section	4096	ND	ND	NA	14.0	8.0	0.58 (0.25–1.35) ^b	ND	ND	NA

Moderate	IA vs CTG in high risk population		Cross-section	USA	235	IA ND	CTG ND	RR (95% CI) NA	IA Highest risk 303.8 High risk 80.7	CTG Highest risk 195.1 High risk 37.7	RR (95% CI) c	IA ND	CTG ND	RR (95% CI) NA
	Hall & Alexander, 1982 ²⁸		Cross-section	USA	1389	15.7	6.4	0.40 (0.13–1.20)	6.7	5.3	0.79 (0.19–3.31)	22.4	11.7	0.51 (0.22–1.22)
	National data set, IA vs CTG, corrected for confounders													
	McCusker et al., 1988 ²⁹		Cross-section	USA	5863	IA ND	CTG ND	RR (95% CI) NA	IA 11.0	CTG 8.0	RR (95% CI) 1.46 (0.82–2.58) ^b	IA ND	CTG ND	RR (95% CI) NA
	Lidegaard et al., 1994 ³⁰		Cross-section	Denmark	179,572	ND	ND	NA	ND	ND	NA	ND	ND	c
	Grytten et al., 2018 ³¹		Cross-section	Norway	1.2 mill	ND	ND	c	ND	ND	NA	ND	ND	NA

ND—no data provided.

NA—not able to calculate as insufficient raw data provided in the paper.

^a Statistically significant.^b This statistic calculated by original authors.^c No significant difference, calculated by original authors.^d Data from Fleet et al.²⁴ and Hopkins, Fleet and Rose²⁵ were merged, as one provided data prior to and the other after CTG monitoring was introduced.

Greenland et al. used analytical techniques to correct for confounding.²⁶ Neutra et al.²⁷ and Hall and Alexander²⁸ used a similar approach, and determined entry into the high-risk group on the basis of predetermined rather than retrospective criteria. Neutra et al.²⁷ stratified the population into five risk tiers (highest, high, medium, low and lowest), with the findings from the highest and high categories included in this review. The remaining three papers examined large data sets of routinely collected perinatal data^{29–31} and used analytical techniques to control for confounding. Two calculated the relationship between the incidence of CTG monitoring (which was primarily used for monitoring women at increased risk) and perinatal mortality,^{29,30} with the other calculating the relationship between introduction of CTG monitoring to specific maternity units and subsequent changes in stillbirth incidence.³¹

Outcomes

CP was not reported on as an outcome measure in any of the non-experimental research. The majority of the non-experimental research was hampered by critical risk of bias, particularly in relation to the risk of confounding explaining the findings, which appeared to demonstrate reductions in stillbirth, neonatal mortality and perinatal mortality with the use of intrapartum CTG monitoring. When the five papers with moderate risk of bias were examined,^{27–31} this apparent benefit was no longer present. Three examined neonatal mortality and demonstrated no statistically significant difference in between women with intrapartum CTG monitoring and those who without.^{27–29} Two assessed the stillbirth rate and found no statistically significant difference,^{28,31} while Hall and Alexander²⁸ and Lidegaard et al.³⁰ measured the overall perinatal mortality rate, again finding no significant difference.

Randomised controlled trials

Eleven papers reported on nine RCTs with Grant et al.⁵¹ and Shy et al.⁵² providing cerebral palsy data from the same trials reported by MacDonald et al.⁵³ and Luthy et al.⁵⁴ respectively. The RCTs were conducted between 1976 and 2006. Research papers came from Canada (n = 2), Ireland (n = 2), USA (n = 2), Australia (n = 1), Denmark (n = 1), Greece (n = 1), India (n = 1), and the UK (n = 1).

Risk of bias assessment

The RCT conducted by Vintzileos et al.⁵⁵ demonstrated high risk for bias (predominantly due to problems with randomisation that resulted in significant differences between the two groups at entry). Renou et al.⁵⁶ demonstrated low risk of bias, as did the two papers reporting on the Dublin trial.^{51,53} The remaining seven papers were assessed as moderate risk due to absence of blinding for outcome assessment.^{52,54,57–61}

Research approaches

The RCTs are summarised in Table 2. Five trials focused on women at high risk.^{52,54,56–59} Both RCTs led by Haverkamp et al.^{57,58} used a risk scoring system to determine the sample, also including women with meconium-stained liquor, oxytocin infusion or abnormal fetal heart patterns detected during auscultation. Renou et al.⁵⁶ recruited women with meconium-stained liquor, medical or obstetrical complications, or with abnormal fetal heart patterns detected during auscultation. Women in labour with a singleton infant between 26 and 32 weeks of gestation were recruited by Luthy et al.,⁵⁴ with Shy et al.⁵² reporting on cerebral palsy outcomes for this cohort. The final RCT⁵⁹ enrolled women with one previous lower uterine segment caesarean section.

Four RCTs, published over five papers, included a mix of women at lower and higher risk.^{51,53,55,60,61} These papers did not stratify

Table 2
RCT research on intrapartum CTG monitoring for women at increased risk for poor perinatal outcome.

Risk of bias	Author, year	Country	No of births	Stillbirth rate (per 1000 births)			Neonatal mortality rate (per 1000 births)			Perinatal mortality rate (per 1000 births)			Cerebral palsy rate (per 1000 births)		
				IA	CTG	RR (95%CI)	IA	CTG	RR (95%CI)	IA	CTG	RR (95%CI)	IA	CTG	RR (95%CI)
Mod	High risk population														
	Haverkamp et al., 1976 ⁵⁷	USA	483	0	0	NA	0	4.1	2.99 (0.12–72.98)	0	4.1	2.99 (0.12–72.98)	ND	ND	NA
	Haverkamp et al., 1979 ⁵⁸	USA	695	0	0	NA	0	6.5	3.52 (0.18–67.77)	0	6.5	3.52 (0.18–67.77)	ND	ND	NA
Low	Luthy et al., 1987; Shy et al., 1990 ^{52,54}	Canada	239	8.3	8.4	1.01 (0.06–15.94)	108.3	109.2	1.01 (0.49–2.08)	116.7	117.6	1.01 (0.50–2.02)	76.9	195.1	2.91 (1.13–7.48) ^a
	Madaan & Trivedi, 2006 ⁵⁹	India	100	0	0	NA	0	0	NA	0	0	NA	ND	ND	NA
	Renou et al., 1976 ⁵⁶	Australia	440	4.5	0	0.34 (0.01–8.29)	0	4.6	3.05 (0.13–74.58)	4.5	4.6	1.02 (0.06–16.18)	ND	ND	NA
	Total		1957	2.3	0.9	0.61 (0.08–4.58)	15.0	16.5	1.26 (0.65–2.44)	17.3	17.4	1.17 (0.62–2.22)	76.9	195.1	2.91 (1.13–7.48) ^a
High	Mixed risk population														
	Vintzileos et al., 1993 ⁵⁵	Greece	1428	2.9	0	0.18 (0.01–3.80)	10.3	2.7	0.26 (0.05–1.25)	13.2	2.7	0.23 (0.05–1.07)	ND	ND	NA
Mod	Kelso et al., 1978 ⁶⁰	UK	504	0	0	NA	4.0	0	0.33 (0.01–8.08)	4.0	0	0.33 (0.01–8.08)	ND	ND	NA
	Badawi and Keogh, 1986 ⁶⁵	Denmark	978	2.0	0	0.34 (0.01–8.30)	0	0	NA	2.0	0	0.34 (0.01–8.30)	ND	ND	NA
Low	Grant et al., 1989; MacDonald et al., 1985 ^{51,53}	Ireland	13,084	0.3	0.5	1.51 (0.25–9.01)	1.8	1.7	0.92 (0.41–2.08)	2.1	2.1	1.00 (0.48–2.10)	1.5	1.8	1.20 (0.52–2.79)
	Total		15,994	0.6	0.4	0.65 (0.19–2.30)	2.5	1.6	0.65 (0.33–1.28)	3.1	2.0	0.67 (0.36–1.23)	1.5	1.8	1.20 (0.52–2.79)

ND – no data provided.

NA – not able to calculate as insufficient raw data provided in the paper.

^a statistically significant.

women according to risk and given that the risk factors reported were not mutually exclusive it is difficult to ascertain the number of women within each risk category. The proportions of women with risk factors described are summarised in Table 3 and suggest that the majority of women in these trials would be considered at high risk.

Outcomes

High risk. No RCT in a population of women at high risk demonstrated statistically significant differences in stillbirth, neonatal mortality, or perinatal mortality rates according to monitoring method (Table 2). Meta-analysis of the pooled data ($n = 1957$) also showed no statistically significant differences in stillbirth rate (2.3 IA vs 0.9 CTG, RR 0.61, 95% CI 0.08–4.58), neonatal mortality rate (15.0 IA vs 16.5 CTG, RR 1.26, 95% CI 0.65–2.44), or perinatal mortality rate (17.3 IA vs 17.4 CTG, RR 1.17, 95% CI 0.62–2.22). There was however a statistically significant increase in the incidence of CP among infants monitored by intrapartum CTG rather than IA (76.9 IA vs 195.1 CTG, RR 2.91, 95% CI 1.13–7.48). This finding emerged from a population of women at risk as a consequence of preterm birth.⁵²

Mixed risk. Among the RCTs conducted in populations of women at mixed risk, none demonstrated statistically significant differences in stillbirth, neonatal mortality, or perinatal mortality rates. Meta-analysis of the pooled data from all RCTs regarding women of mixed risk ($n = 15,994$) found no differences in the rate of stillbirth (0.6 IA vs 0.4 CTG, RR 0.65, 95% CI 0.19–2.30), neonatal mortality (2.5 IA vs 1.6 CTG, RR 0.65, 95% CI 0.33–1.28) or perinatal mortality (3.1 IA vs 2.0 CTG, RR 0.67, 95% CI 0.36–1.23). The only trial to assess CP⁵¹ found no difference in this outcome (1.5 IA vs 1.8 CTG, RR 1.20, 95% CI 0.52–2.79).

Discussion

Only non-experimental studies at critical risk of bias showed reductions in perinatal mortality related to intrapartum CTG monitoring. During the 1970s and 1980s significant advances occurred in neonatal care.^{62,63} Contraception and pregnancy termination became increasingly available, and there was a reduction in preterm birth which is known to be a strong determinant of perinatal mortality.⁶⁴ These changes occurred contemporaneously with the introduction and expansion of CTG use and may well explain the apparent benefit from

Table 3
RCTs in mixed risk populations: reported proportion of women with risk factors for poor perinatal outcome.

Author, year	Risk factors described
Vintzileos et al., 1993 ⁵⁵	Antenatal history 13%, oxytocin infusion 57%, meconium stained liquor 14%, preterm labour 7%, post-term labour 3%, breech presentation 2%.
Kelso et al., 1978 ⁶⁰	Oxytocin infusion 50%, epidural 36%. Meconium stained liquor was not an exclusion criterion, but the proportion of women with this was not documented.
Neldam et al., 1986 ⁶¹	43% described as high risk. This classification was not inclusive of oxytocin infusion in 40%, epidural in 9%. Whether meconium stained liquor was an exclusion criterion was not described and the proportion of women with this was not documented.
Grant et al., 1989; Macdonald et al., 1985 ^{51,53}	23% were described as high risk. This classification was not inclusive of oxytocin infusion in 23%, preterm labour 3%, post-term labour 13%, epidural 3%. Moderate to heavy meconium staining of liquor was an exclusion criterion, with the number of women with light meconium staining not described.

CTG monitoring seen in this research. Non-experimental research addressing such confounders showed no statistically significant differences in mortality rates.

These findings aligned with evidence from RCTs, which also demonstrated no difference in mortality rates between the two intrapartum monitoring options. The impact on CP has been under-investigated, having been addressed by only two RCTs. The first (in a mixed risk cohort) found no difference in the rate of CP with intrapartum CTG monitoring.⁵¹ There has been increasing recognition that intrapartum hypoxia does not play a major role in the development of CP,⁶⁵ so this finding is perhaps unsurprising. What was surprising (particularly given that no other research has sought to replicate the findings in the three decades since), was the 291% increase in CP when women with preterm labour were randomised to intrapartum CTG monitoring.⁵² It is not clear why this occurred, with no differences in Apgar scores, cord blood gas pH or caesarean rates noted between the two approaches to monitoring.⁵⁴ Earlier gestational age increases the incidence and severity of CP,¹⁷ so even a small increase in relative risk is likely to have a significant impact on the incidence of CP at a whole of population level.

Since its introduction assumptions have been made that intrapartum CTG monitoring would provide maternity professionals with “an essential diagnostic technique in obstetrical practice which improves such fetal outcomes as perinatal mortality, morbidity and neonatal status”.⁶⁶ This assumption cannot be supported by research undertaken to date.

Strengths and limitations

A Cochrane review has considered only the RCT evidence regarding intrapartum CTG monitoring.⁸ This literature review reiterates their analysis of the RCT evidence and also incorporates critique and analysis of the large body of non-experimental evidence. The search was limited to the English language, so it remains possible that publications in other languages might have contributed different findings. Given the age of the research, obtaining additional material from authors was considered unfeasible. As a consequence, unpublished data that might have added to the findings is absent. Significant changes in the provision of maternity care and the social context in which care is provided have occurred since the majority of the research was undertaken, which impact on the generalisability of the findings.

Conclusion

Evidence from quality non-experimental research and RCTs shows no difference in the rates of stillbirth, neonatal mortality or perinatal mortality between the use of IA or CTG monitoring during labour in populations that include or consist of women considered to be at increased risk for poor perinatal outcome. Intrapartum fetal surveillance guidelines which recommend CTG monitoring for women considered to be at risk are not consistent with the evidence base. Clinicians and professional bodies have an obligation to provide maternity consumers with recommendations that are underpinned by sound evidence.

Recommendations

It is important that pregnant women receive accurate information regarding the lack of evidence of benefit for intrapartum CTG monitoring when risk factors for poor perinatal outcome are present. Women experiencing preterm labour should be advised that the use of intrapartum CTG monitoring might be associated with an increased risk of CP, with no other apparent perinatal benefits.

Assumptions that intrapartum CTG monitoring improves perinatal outcomes potentially hamper research efforts to identify alternate interventions that might be effective in preventing perinatal loss or CP. There is urgent need to verify whether intrapartum CTG monitoring during preterm labour impacts on CP rates. High-quality research is urgently required to identify which women, if any, obtain a perinatal benefit from intrapartum CTG monitoring.

Ethics statement

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Conflict of interest

None declared.

CRediT authorship contribution statement

Kirsten A. Small: Conceptualization, Data curation, Formal analysis, Methodology, Writing - original draft, Writing - review & editing. **Mary Sidebotham:** Supervision, Validation, Writing - review & editing. **Jennifer Fenwick:** Supervision, Writing - review & editing. **Jenny Gamble:** Supervision, Validation, Writing - review & editing.

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