Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour (Review)

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ABSTRACT

Background
Cardiotocography (sometimes known as electronic fetal monitoring), records changes in the fetal heart rate and their temporal relationship to uterine contractions. The aim is to identify babies who may be short of oxygen (hypoxic), so additional assessments of fetal well-being may be used, or the baby delivered by caesarean section or instrumental vaginal birth.

Objectives
To evaluate the effectiveness of continuous cardiotocography during labour.

Search strategy
We searched the Cochrane Pregnancy and Childbirth Group Trials Register (March 2006), CENTRAL (*The Cochrane Library* 2005, Issue 4), MEDLINE (1966 to December 2005), EMBASE (1974 to December 2005), Dissertation Abstracts (1980 to December 2005) and the National Research Register (December 2005).

Selection criteria
Randomised and quasi-randomised controlled trials involving a comparison of continuous cardiotocography (with and without fetal blood sampling) with (a) no fetal monitoring, (b) intermittent auscultation (c) intermittent cardiotocography.

Data collection and analysis
Two authors independently assessed eligibility, quality and extracted data.

Main results
Twelve trials were included (over 37,000 women); only two were high quality. Compared to intermittent auscultation, continuous cardiotocography showed no significant difference in overall perinatal death rate (relative risk (RR) 0.85, 95% confidence interval (CI) 0.59 to 1.23, n = 33,513, 11 trials), but was associated with a halving of neonatal seizures (RR 0.50, 95% CI 0.31 to 0.80, n = 32,386, nine trials) although no significant difference was detected in cerebral palsy (RR 1.74, 95% CI 0.97 to 3.11, n = 13,252, two trials). There was a significant increase in caesarean sections associated with continuous cardiotocography (RR 1.66, 95% CI 1.30 to 2.13, n =18,761, 10 trials). Women were also more likely to have an instrumental vaginal birth (RR 1.16, 95% CI 1.01 to 1.32, n = 18,151, nine trials). Data for subgroups of low-risk, high-risk, preterm pregnancies and high quality trials were consistent with overall results. Access to fetal blood sampling did not appear to influence the difference in neonatal seizures nor any other prespecified outcome.

Authors' conclusions
Continuous cardiotocography during labour is associated with a reduction in neonatal seizures, but no significant differences in cerebral palsy, infant mortality or other standard measures of neonatal well-being. However, continuous cardiotocography was associated with an increase in caesarean sections and instrumental vaginal births. The real challenge is how best to convey this uncertainty to women to enable them to make an informed choice without compromising the normality of labour.

PLAIN LANGUAGE SUMMARY

Comparing continuous electronic monitoring of the baby's heartbeat in labour using cardiotocography (CTG, sometimes known as EFM) with intermittent monitoring (intermittent auscultation, IA)

Monitoring the baby's heartbeat is one way of checking babies' well-being in labour. By listening to, or recording the baby's heartbeat, it is hoped to identify babies who are becoming short of oxygen (hypoxic) and who may benefit from caesarean section or instrumental vaginal birth. A baby's heartbeat can be monitored intermittently by using a fetal stethoscope, Pinard (special trumpet shaped device), or by a handheld Doppler device. The heartbeat can also be checked continuously by using a CTG machine. This method is sometimes known as electronic fetal monitoring (EFM) and produces a paper recording of the baby's heart rate and their mother's labour contractions. Whilst a continuous CTG gives a written record, it prevents women from moving during labour. This means that women may be unable to change positions or use a bath to help with comfort and control during labour. It also means that some resources tend to be focused on the needs of the CTG rather than the woman in labour. This review compared continuous CTG monitoring with intermittent auscultation (listening). It found 12 trials involving over 37,000 women. Most studies were not of high quality and the review is dominated by one large, well-conducted trial of almost 13,000 women who received care from one person throughout labour in a hospital where the membranes have either ruptured spontaneously or were artificial ruptured as early as possible and oxytocin stimulation of contractions was used in about a quarter of the women. There was no difference in the number of babies who died during or shortly after labour (about 1 in 300). Fits (neonatal seizures) in babies were rare (about 1 in 500 births), but they occurred significantly less often when continuous CTG was used to monitor fetal heart rate. There was no difference in the incidence of cerebral palsy, although other possible long-term effects have not been fully assessed and need further study. Continuous monitoring was associated with a significant increase in caesarean section and instrumental vaginal births. Both procedures are known to carry the risks associated with a surgical procedure although the specific adverse outcomes have not been assessed in the included studies.

BACKGROUND

Introduction

Through monitoring fetal heart rate changes during labour, it is hoped to identify those babies who may be compromised, or potentially compromised, by a shortage of oxygen (fetal hypoxia). If the shortage of oxygen is both prolonged and severe, babies are at risk of being born with a disability (physical and/or mental), or of dying during labour or shortly thereafter. When alterations in the fetal heart rate during labour suggest that the baby is hypoxic, or at risk of hypoxia, additional methods of assessment of fetal well-being (e.g. fetal blood sampling) may be used. Sometimes these fetal heart rate alterations trigger delivery by caesarean section or by an instrument such as forceps or vacuum extractor even without recourse to additional diagnostic tests.

The incidence of neonatal morbidity and mortality varies around the world, although direct comparisons may be difficult because of varying definitions and misclassifications. Nevertheless, large differences are reported between high-income countries (average 4 per 1000 live births) and low/middle-income countries (average of 33 per 1000 births) (Lawn 2005). Although the majority of perinatal morbidity and mortality may not be prevented by improved fetal monitoring in labour (Nelson 1996), failures to identify abnormal fetal heart rate patterns and lack of appropriate actions are considered to be significant contributing factors (MCHRC 1997; MCHRC 1998; MCHRC 1999).

Historical context

The baby's heart beat was first thought to be heard *in utero* in the middle of the seventeenth or eighteenth century (Gibb 1992; Grant 1989a), but it was not until the early nineteenth century that de Kergeradee suggested that listening to the baby's heartbeat might be clinically useful (Grant 1989a). He proposed that it could be used to diagnose fetal life and multiple pregnancies, and wondered whether it would be possible to assess fetal compromise from variations in the fetal heart rate. Since then, various methods of listening to the fetal heart have been developed and introduced into maternity care, each with the aim of improving outcomes for babies and reducing the heartache for mothers and families when a baby dies or suffers long-term disability. Today, monitoring the fetal heart during labour, by one method or another, appears to have become a routine part of care during labour, although access to such care varies across the world.

Methods of monitoring the fetal heart rate

The baby's heart rate can be monitored either intermittently (at regular intervals during labour) or continuously (recording the baby's heart rate throughout labour, stopping only briefly, e.g. for visits to the toilet) as follows.

(1) Fetal stethoscope (Pinard) and hand-held Doppler

Intermittent monitoring can be undertaken either by listening to the baby's heart rate using a fetal stethoscope (Pinard) or a hand-held Doppler ultrasound device and by palpating the mother's uterine contractions by hand. This is known as 'intermittent auscultation'.

(2) Cardiotocograph (CTG)

The baby's heart rate and the mother's uterine contractions can

be recorded electronically on a paper trace known as a cardiotocograph. This is achieved by using a Doppler ultrasound transducer to monitor the baby's heart rate and a pressure transducer to monitor uterine contractions, both of which are linked to a recording machine. This is known as external cardiotocography (external CTG). This is usually undertaken continuously in labour, although occasionally it is used intermittently during labour (intermittent CTG). In most units, external CTG requires the mother to wear a belt across her abdomen while monitoring is being conducted, which restricts her mobility. An alternative means of monitoring the baby's heart rate with the CTG machine is to attach an electrode directly to the baby's presenting part, usually its head. This form of continuous monitoring is known as 'internal CTG' and requires a ruptured amniotic sac (either spontaneously or artificially) and a scalp electrode (clip) attached to the baby's head. This also restricts the woman's mobility.

The term 'electronic fetal monitoring' is sometimes used synonymously with CTG monitoring, but is considered to be a less precise term because (1) CTG monitoring also includes monitoring the mother's contractions and (2) other forms of fetal monitoring might also be classed as 'electronic' e.g. ECG, fetal pulse oximetry.

Intermittent auscultation was the predominant method of monitoring during labour until CTGs became widely used in the latter part of the 20th century (Enkin 2000). Although there is a lack of empirical evidence on the optimal frequency of intermittent auscultation, there is a consensus in the guidelines from professional bodies that the fetal heart should be auscultated at least every 15 minutes in the first stage of labour and at least every five minutes in the second stage of labour (ACOG 1995; Liston 2002; RANZCOG 2002; RCOG 2001a) with each auscultation lasting at least 60 seconds (Liston 2002; RCOG 2001a). It appears that these auscultation protocols were developed initially in the context of clinical trials and were based on 'common sense' rather than research evidence. Compliance with these guidelines, whilst maintaining contemporaneous records, poses quite a challenge for caregivers during labour who usually have multiple tasks to fulfil simultaneously.

Information and interpretation

Both intermittent auscultation and CTG provide information on the baseline heart rate (usually between 110 and 160 beats per minute), accelerations (transient increases in the fetal heart rate) and decelerations (transient decreases in the fetal heart rate). It is known that some aspects of labour will cause natural alterations in fetal heart rate patterns. For example, the baby's sleep pattern is different from the pattern when the baby is awake. External stimuli, like uterine contractions and the mother moving, can cause fetal heart rate (FHR) changes, as can the administration of opiates to the mother. Some of these changes are quite subtle and can only be detected by continuous CTG e.g. baseline variability, temporal shape of decelerations. Consideration needs to be given to whether such information improves detection and outcome of those babies who are truly compromised.

Sensitivity and specificity

While specific abnormalities of the fetal heart rate pattern on CTG are proposed as being associated with an increased risk of cerebral palsy (Nelson 1996), the specificity of CTG for prediction of cerebral palsy is low with a reported false positive rate as high as 99.8%, even in the presence of multiple late decelerations or decreased variability (Nelson 1996).

Fetal heart rate pattern recognition, including the relationship between the uterine contractions and fetal heart rate decelerations, are fundamental to the use of continuous CTG monitoring. Algorithms have been developed to assess and record what is normal, what requires more careful attention and what is considered abnormal requiring immediate delivery of the baby (RCOG 2001a). However, CTG traces are often interpreted differently by different caregivers (inter-observer variation) and even by the same caregiver interpreting the same record at different times (intra-observer variation) (Devane 2005a). Such variation in interpretation of CTG tracings may result in inappropriate interventions, or false reassurance and lack of appropriate intervention. Although we were unable to locate studies that sought to investigate inter- and intra-observer variation in intermittent auscultation, it would seem reasonable to suggest that intermittent auscultation is not immune to similar problems caused by inter- and intra-observer variation.

Additional tests

Fetal blood sampling is a procedure whereby a small amount of blood is taken from the baby, usually from the scalp. Performing fetal blood sampling and then measuring the parameters of acid-base balance (pH, base excess/deficit, etc) has been introduced in an effort to identify those babies who are truly compromised and need to be born immediately from those who are not truly compromised. It is important to establish the value of this test as an adjunct to CTG. This question is addressed by a subgroup analysis in this review.

Other methods have been considered as additional tests, but there is little evidence to support their use, for example, vibroacoustic stimulation (East 2005). Several other methods of fetal monitoring have been proposed, either as an adjunct or an alternative to CTG, e.g. pulse oximetry (Carbone 1997; East 2004), near-infrared spectroscopy (Mozurkewich 2000), fetal ECG (Neilson 2003), ST segment analysis of the fetal ECG (Luttkus 2004) and fetal stimulation tests (Skupski 2002).

Possible advantages of CTG

- More measurable parameters related to fetal heart rate patterns (*see* above).
- The CTG trace gives a continuous recording of the fetal heart rate and uterine activity. This is a physical record, which can be examined at anytime in labour, or subsequently if required. The

examples where physical records may be useful include clinical audits, counseling parents if there has been as adverse outcome, and medico-legal situations.

Possible disadvantages of CTG

- The complexity of fetal heart rate patterns makes standardisation difficult.
- CTG prevents mobility and restricts the use of massage, different positions and/or immersion in water used to improve comfort, control and coping strategies during labour.
- Shifting staff focus and resources away from the mother may encourage a belief that all perinatal mortality and neurological injury can be prevented.

Specific situations that may influence the effectiveness or otherwise of CTG

(1) Continuous CTG is generally recommended for women who are regarded as being at increased risk of perinatal morbidity and mortality (Liston 2002; RCOG 2001a; RANZCOG 2002). This review will address the issue of differential effects of CTG in terms of risk status.

(2) Induction of labour is primarily performed where it is anticipated that the outcome for the mother and/or infant would be improved were labour to be induced. Given that induction of labour includes iatrogenic stimulation of uterine activity, which puts the baby at greater risk, a subgroup analysis by induction of labour will be performed (RCOG 2001b).

(3) Preterm birth is associated with an increased risk of mortality and neurological morbidity and these babies might benefit from being monitored more intensively. Therefore, a preterm subgroup analysis will be performed.

(4) Twin pregnancies carry a higher perinatal mortality rate than singleton pregnancies (RCOG 2001b), thus a subgroup analysis by twin pregnancy will be conducted.

Women's views

Some studies looking at women's preferences found that the support that women received from staff and labour companions was more important to them than the type of monitoring used (Garcia 1985; Killien 1989). A more recent study of women's views of routine continuous CTG in labour in the UK identified a lack of discussion about the need for and appropriateness of CTG. In addition, women felt that CTG limited their mobility and led to an acceptance of the machine's place as the focus of attention for the women and her partner (Munro 2004).

Rationale for the review

Concerns have been raised about the efficacy and safety of routine use of continuous CTG in labour (Thacker 1995). The apparent contradiction between the widespread use of continuous CTG and recommendations to limit its routine use (RCOG 2001a), indicates that a reassessment of this practice is warranted.

Several other Cochrane reviews have addressed other methods for assessing the condition of the fetus during labour including fetal electrocardiogram/ECG (Neilson 2003); fetal pulse oximetry (East 2004); near-infrared spectroscopy (Mozurkewich 2000) and vibroacoustic stimulation (East 2005). Also, the comparison of cardiotocography versus intermittent auscultation of fetal heart as an admission test on arrival to labour ward is assessed elsewhere (Devane 2005b).

OBJECTIVES

The objective of this review is to evaluate the effectiveness and safety of continuous cardiotocography when used as a method to monitor fetal well-being during labour.

CRITERIA FOR CONSIDERING STUDIES FOR THIS REVIEW

Types of studies

All randomised trials and quasi-randomised studies comparing continuous cardiotocography during labour, with and without fetal blood sampling, with (a) no fetal monitoring, (b) intermittent auscultation of the fetal heart rate with a Pinard stethoscope or hand-held Doppler ultrasound device or (c) intermittent CTG. Sensitivity analysis was undertaken for studies graded A on concealment allocation.

Types of participants

Pregnant women in labour and their babies.

Types of intervention

The main intervention of interest is continuous CTG during labour.

For the purpose of this review, the intervention is defined as an attempt to produce a continuous and simultaneous hard-copy recording of the fetal heart rate and uterine contractions in real-time throughout the woman's labour. As a guide, continuous CTG should be discontinued only for short periods (for example, visit to toilet) and the CTG should be used for clinical decision making during labour.

Control groups of interest include: (a) no fetal monitoring, (b) intermittent auscultation of the fetal heart rate with a Pinard stethoscope or hand-held Doppler ultrasound device or (c) intermittent CTG.

Types of outcome measures

The main outcomes of interest for the infant are:

(i) death;

(ii) seizures in the neonatal period, either apparent clinically or detected by electro-encephalographic recordings;

(iii) hypoxic ischaemic encephalopathy (as defined by trialists);
(iv) cerebral palsy;
(v) neurodevelopmental disability assessed at 12 months of age or more. Neurodevelopmental disability will be defined as any one or combination of the following: non-ambulant cerebral palsy, developmental delay, auditory and visual impairment. Development should have been assessed by means of a previously validated tool, such as Bayley Scales of Infant Development (Psychomotor Developmental Index and Mental Developmental Index (Bayley 1993);
(vi) Apgar less than seven at five minutes;
(vii) Apgar less than four at five minutes;
(viii) cord blood acidosis (low pH/low base excess as defined by trialists; where report included a range of pH values we have used cord pH less than 7.10 as a cut off for acidosis);
(ix) admission to neonatal special care and/or intensive care unit;
(x) length of stay in neonatal special care and/or intensive care unit;
(xi) fetal blood sampling;
(xii) damage/infection to baby's head from scalp electrode or fetal blood sampling.

The outcomes of interest for the mother are:
(i) caesarean section;
(ii) caesarean section for abnormal fetal heart rate pattern and/or fetal acidosis;
(iii) instrumental vaginal birth;
(iv) instrumental vaginal birth for abnormal fetal heart rate pattern and/or fetal acidosis;
(v) spontaneous vaginal birth not achieved;
(vii) use of all forms of pharmacological analgesia during labour and birth (including epidural);
(vii) epidural;
(viii) use of non pharmacological methods of coping with labour, e.g. transcutaneous electrical nerve stimulation, hydrotherapy;
(ix) amniotomy (artificial rupture of membranes);
(x) oxytocin during labour;
(xi) perineal trauma requiring repair (including episiotomy);
(xii) inability to adopt preferred position during labour;
(xiii) dissatisfaction with labour and/or perceived loss of control during labour;
(xiv) postpartum depression.

SEARCH METHODS FOR IDENTIFICATION OF STUDIES

See: methods used in reviews.

We searched the Cochrane Pregnancy and Childbirth Group Trials Register by contacting the Trials Search Co-ordinator (March 2006).

The Cochrane Pregnancy and Childbirth Group's Trials Register is maintained by the Trials Search Co-ordinator and contains trials identified from:
(1) quarterly searches of the Cochrane Central Register of Controlled Trials (CENTRAL);
(2) monthly searches of MEDLINE;
(3) handsearches of 30 journals and the proceedings of major conferences;
(4) weekly current awareness search of a further 37 journals.

Details of the search strategies for CENTRAL and MEDLINE, the list of handsearched journals and conference proceedings, and the list of journals reviewed via the current awareness service can be found in the 'Search strategies for identification of studies' section within the editorial information about the Cochrane Pregnancy and Childbirth Group.

Trials identified through the searching activities described above are given a code (or codes) depending on the topic. The codes are linked to review topics. The Trials Search Co-ordinator searches the register for each review using these codes rather than keywords.

In addition, we searched CENTRAL (*The Cochrane Library* 2005, Issue 4), MEDLINE (1966 to December 2005), CINAHL (1982 to December 2005) and EMBASE (1974 to December 2005) using the following search strategies:

CENTRAL
1. Labor Obstetric/
2. Delivery Obstetric/
2. Fetal Monitoring/
3. intrapartum near monitor*
4. fetal near surveillance
5. 1 or 2
6. 3 or 4 or 5
7. 6 and 7

MEDLINE
1. exp Labor, Obstetric/ or exp Delivery, Obstetric/
2. exp Fetal Monitoring/
3. (intrapartum adj2 monitor$).ti,ab.
4. (fetal adj surveillance).ti,ab.
5. randomized controlled trial.pt.
6. exp Controlled Clinical Trials/
7. controlled clinical trial.pt.
8. 2 or 3 or 4
9. 5 or 6 or 7
10. 1 and 8 and 9

CINAHL
1. exp Clinical Trials/
2. clinical trial.pt.
3. (clinic$ adj trial$1).tw.
4. ((singl$ or doubl$ or trebl$ or tripl$) adj (blind$3 or mask$3)).tw.
5. randomi?ed control$ trial$.tw.
6. exp Random Assignment/
7. random$ allocat$.tw.

8. placebo$.tw.
9. Quantitative studies/
10. allocat$ random$.tw.
11. Placebos/
12. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11
13. exp Fetal Monitoring/
14. (fetal adj2 monitor$).tw.
15. (intrapartum adj2 monitor$).tw.
16. (labor or labour).tw.
17. exp Childbirth/
18. 13 or 14 or 15
19. 16 or 17
20. 12 and 18 and 19

EMBASE
1. randomization/
2. double blind procedure/
3. crossover procedure/
4. intermethod comparison/
5. single blind procedure/
6. clinical study/
7. controlled study/
8. randomized controlled trial/
9. (clin$ adj2 trial$).tw.
10. ((singl$ or doubl$ or trebl$ or tripl$) adj2 (blind$ or mask$)).tw.
11. exp clinical trial/
12. placebo/
13. placebo$.tw.
14. random$.tw.
15. labour$ or labor or laboring.af.
16. Fetus-Electrocardiography/
17. Fetus-Monitoring/
18. fetal with monitor$
19. fetal adj surveillance
20. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14
21. 16 or 17 or 18 or 19
22. 20 and 21 and 15

We also searched for grey literature by searching Dissertation Abstracts (1980 to December 2005) and National Research Register (December 2005) databases, using terms identified above, adapted for each database.

We did not apply any language restrictions.

METHODS OF THE REVIEW

We developed the methods of the review in light of the advice contained in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2005).

Study identification

We considered all identified randomised and quasi-randomised controlled trials involving a comparison of continuous CTG, with and without fetal blood sampling, with (a) no fetal monitoring, (b) intermittent auscultation of the fetal heart rate with a Pinard stethoscope or hand-held Doppler ultrasound device or (c) intermittent CTG.

One review author (Declan Devane (DD)) ran the additional search strategies. Each potentially eligible trial identified by the search strategy was obtained as a full-text article and independently assessed for inclusion by Zarko Alfirevic (ZA) and Gill Gyte (GG). There were no disagreements regarding eligibility for inclusion that needed to be resolved by discussion with DD. We did not encounter problems with language or missing information requiring classification as 'Study awaiting assessment' (RevMan 2003).

Quality assessment of included studies

Two review authors (GG and DD) independently assessed the quality of all included trials, namely selection and attrition bias. With regard to performance bias, due to the differences in the *modus operandi* of the continuous CTG and intermittent auscultation, it is unlikely that clinicians or women will have been blinded to either intervention. Therefore, lack of blinding was not considered to undermine the validity of studies.

Selection bias

Studies were allocated a grade on the basis of allocation concealment as per criteria outlined in the Cochrane Handbook for Systematic Reviews of Interventions (Higgins 2005) i.e. (A) adequate, (B) unclear, (C) inadequate or (D) allocation concealment was not used. Approaches to allocation concealment considered to be clearly inadequate include: alternation, the use of case record numbers, dates of birth or day of the week, and any procedure that is entirely transparent before allocation, such as an open list of random numbers.

Attrition bias

Due to inadequacies in reporting how losses of participants (e.g. withdrawals, dropouts, protocol deviations) were handled, the review authors were cautious about implicit accounts of follow up. Given that study reports on attrition after allocation have not been found to be consistently related to bias, studies were not excluded on the basis of attrition. Studies were, however, graded for completeness of follow up using the following criteria. For completeness of follow up:
(A) less than 3% of participants excluded;
(B) 3% to 9.9% of participants excluded;
(C) 10% to 19.9% of participants excluded;
(D) more than 20% of participants excluded.

Data extraction

Two review authors (ZA and DD) independently extracted the data using predesigned data extraction forms, the fields of which

had been agreed by all review authors. Study eligibility was verified again at the time of data abstraction or collection.

Additional information was extracted from the included trials by one review author (GG) and recorded in an additional table (Table 01). The data include: (1) one carer to one woman support during labour; (2) labour induction; (3) the use of artificial rupture of membranes (ARM) in labour; (4) the use of oxytocin for augmentation of labour; (5) women's mobility during labour; (6) women's positions for giving birth; (7) women's views of labour and monitoring; (8) social and environmental context of trials; (9) experience of staff in CTG interpretation. These were considered to be factors that might impact on the comparison of outcomes. For example, it is unclear what impact the supine position, ARM and oxytocin use might have on the fetal heart rate patterns, and whether mobility in labour might reduce the use of such interventions.

Data analysis

We performed statistical analyses with the Review Manager Software (RevMan 2003). Dichotomous (or binary) outcomes are reported using the 'relative risk' summary statistic and their 95% confidence intervals. Continuous data are reported using the weighted mean differences and their 95% confidence intervals.

Denver 1979 was a three-arm trial with two experimental groups (CTG with and without access to fetal scalp sampling) and one control group (intermittent auscultation). Following statistical advice, we arbitrarily split the data for the controls into two equal groups and assigned them to each experimental arm. This approach ensured that there was no double-counting for controls when overall relative risks were calculated. An arbitrary decision was made when the number needing to be split was not an even number.

We used a fixed-effect model of meta-analysis for summarising the results of studies in the absence of substantial heterogeneity between trials. Where heterogeneity between trials was substantial a random-effects model was used. Measurements of heterogeneity were performed using the I-squared statistic, which is less affected by the number of trials in the analysis than the Chi-squared test. I-square of 30% to 50% suggests mild heterogeneity and more than 50% indicates substantial heterogeneity.

We planned subgroup analyses on the following a priori determined subgroups:
(a) low risk (absence of identifiable risk factors associated with increased in perinatal mortality and morbidity as defined by trialists);
(b) high risk for perinatal mortality and morbidity (as defined by trialists);
(c) spontaneous onset of labour;
(d) induction of labour;
(e) preterm (less than 37 + 0 weeks);
(f) term (greater than 37 + 0 weeks);
(g) singleton pregnancy;
(h) twin pregnancy;
(i) without fetal blood sampling (FBS) during labour;
(j) with FBS during labour;
(k) parity.

Sensitivity analysis

We performed sensitivity analysis based on quality comparing high-quality trials with trials of lower quality. Given that study reports on attrition after allocation have not been found to be consistently related to bias, 'high quality' was, for the purposes of this sensitivity analysis, defined as a trial having allocation concealment classified as 'A' (adequate).

DESCRIPTION OF STUDIES

Our search strategy identified 382 citations corresponding to 16 studies for potential inclusion. Of those, 12 studies with 37,615 women participating were included (Athens 1993; Copenhagen 1985; Dallas 1986; Denver 1976; Denver 1979; Dublin 1985; Lund 1994; Melbourne 1976; Melbourne 1981; Pakistan 1989; Seattle 1987; Sheffield 1978) and four were excluded (North America; Harare 1994; Ioannina 2001; Manchester 1982).

Eleven studies, with 33,581 women participating, compared continuous CTG with intermittent auscultation (Athens 1993; Copenhagen 1985; Dallas 1986; Denver 1976; Denver 1979; Dublin 1985; Melbourne 1976; Melbourne 1981; Pakistan 1989; Seattle 1987; Sheffield 1978). Five studies compared continuous CTG in conjunction with fetal blood sampling with intermittent auscultation (Copenhagen 1985; Dublin 1985; Melbourne 1976; Pakistan 1989; Seattle 1987), five compared continuous CTG without fetal blood sampling to intermittent auscultation (Athens 1993; Dallas 1986; Denver 1976; Melbourne 1981; Sheffield 1978) and one study had three groups comparing continuous CTG with and without fetal blood sampling to intermittent auscultation (Denver 1979). One study compared continuous CTG with fetal blood sampling to intermittent CTG with fetal blood sampling (Lund 1994).

Participants were assessed as low risk in three studies (Dallas 1986; Lund 1994; Melbourne 1981) and outcome data for low-risk women were available for one outcome, neonatal seizures, from one other study (Dublin 1985). Participants were assessed as high risk in five studies (Denver 1976; Denver 1979; Melbourne 1976; Pakistan 1989; Seattle 1987) including one study which specifically included women in preterm labour (28 to 32 weeks) and assessed outcomes for babies below 1750 g birthweights (Seattle 1987). The data for neonatal seizures in high-risk women were available from one other study (Dublin 1985). Participants were assessed as mixed risk in four studies (Athens 1993; Copenhagen 1985; Dublin 1985; Sheffield 1978).

METHODOLOGICAL QUALITY

Included studies were assessed for methodological quality on the basis of selection (allocation concealment) and attrition bias (*see* 'Methods of the review' above). Allocation concealment was graded as 'A-adequate' in two trials (Dublin 1985; Melbourne 1976), as 'B-unclear' in six trials (Copenhagen 1985; Denver 1976; Denver 1979; Lund 1994; Seattle 1987; Sheffield 1978), and as 'C-inadequate' in four trials (Athens 1993; Dallas 1986; Melbourne 1981; Pakistan 1989). Attrition bias was graded as 'A: less than 3% of participants excluded' in eight trials (Athens 1993; Copenhagen 1985; Denver 1976; Denver 1979; Dublin 1985; Lund 1994; Pakistan 1989; Sheffield 1978), as 'B: 3% to 9.9% of participants excluded' in two trials (Copenhagen 1985; Melbourne 1981), as 'D: more than 20% of participants excluded' in one trial (Seattle 1987) and information was unavailable on which to make an attrition assessment for two studies (Dallas 1986; Melbourne 1976).

RESULTS

1. Continuous cardiotocography (CTG) versus intermittent auscultation (all)

A total of 11 randomised trials have been included in this comparison with over 33,000 women participating (Athens 1993; Copenhagen 1985; Dallas 1986; Denver 1976; Denver 1979; Dublin 1985; Melbourne 1976; Melbourne 1981; Pakistan 1989; Seattle 1987; Sheffield 1978). Denver 1979 was a three-arm trial resulting in 12 trial comparisons for some outcomes (outcomes 01.02, 01,27).

There was a significant increase in the caesarean section rate in the CTG group (relative risk (RR) 1.66, 95% confidence interval (CI) 1.30 to 2.13, n = 18,761, 10 trials). Risk difference in the caesarean section rate was 5% (95%CI 2 to 8%), with two-thirds of the data from Dublin 1985, where the overall caesarean section rate was 2.3%. Overall, the differences in caesarean section rates showed substantial heterogeneity, although all studies showed either an increase or no significant difference in caesarean section with continuous CTG. In view of the significant heterogeneity, the caesarean section data (outcome 01.01) were analysed using a random-effects model.

It appears that the risk of having a caesarean section was influenced by the quality of trials (outcome 06:01, interaction test p = 0.02). In the two high-quality trials (Dublin 1985; Melbourne 1976), the heterogeneity remained significant (I-square = 54.9%), but the combined increase in caesarean section rates was not (RR 1.27, 95% CI 0.88 to 1.83).

Five studies had overall caesarean section rates below 10% (Athens 1993; Copenhagen 1985; Dublin 1985; Melbourne 1981; Sheffield 1978). The highest overall caesarean section rates were reported in Melbourne 1976 (18%) and Pakistan 1989 (23.5%). *Post-hoc* analysis, pooling together the trials with the overall caesarean section rates below or above 10% (outcome 01:06), showed a significant increase in caesarean section with continuous CTG in both groups. The magnitude of the increase in caesarean section rates was greater in the subgroup with caesarean section rates greater than 10% (interaction test p < 0.001).

Although numbers needed to treat (NNT) analyses remain controversial in the context of meta-analysis and should be interpreted with caution, we have calculated that, overall, one additional caesarean section was performed for every 58 women monitored continuously (95% CI 43 to 87).

Women in the continuous CTG group were also more likely to have a caesarean section for abnormal fetal heart rate and/or acidosis (outcome 01.02: RR 2.37; 95% CI 1.88 to 3.00, n = 33,379, 11 trials) or instrumental birth (outcome 01.03: RR 1.16; 95% CI 1.01 to 1.32, n = 18,515, nine trials). Failure to achieve spontaneous vaginal birth (outcome 01.05: RR 1.27; 95% CI 1.19 to 1.36, n = 18,761, 10 trials) was also more common in the CTG group.

There was a small increase in the overall use of analgesia in the continuous CTG group (outcome 01.07: RR 1.09, 95% CI 1.01 to 1.18, n = 2118, two trials), but no difference in epidural analgesia (outcome 01.08: RR 1.00; 95% CI 0.90 to 1.12, n = 17,630, eight trials) or use of pharmacological analgesia during labour (outcome 01.09: RR 1.00; 95% CI 0.93 to 1.08, n = 1677, three trials). The use of fetal blood sampling was reported in two trials (Copenhagen 1985; Dublin 1985) with significantly more sampling tests performed in the continuous CTG group (outcome 01.12: RR 1.24, 95% CI 1.03 to 1.49, n = 13,929, two trials).

There was no significant difference in perinatal mortality between the groups, (outcome 01.27: RR 0.85, 95% CI 0.59 to 1.23, n = 33,513, 11 trials). The use of continuous CTG monitoring in labour was associated with a halving of the risk of neonatal seizures (outcome 01.26: RR 0.50, 95% CI 0.31 to 0.80, n = 32,386, nine trials). This reduction was consistent across the trials and subgroups, although the incidence of neonatal seizures varied considerably between trials. In the two largest trials of 14,618 women (Dallas 1986) and 12,964 women (Dublin 1985), the incidence of neonatal seizures in the intermittent auscultation groups were 0.04% and 0.4% respectively (outcome 01.26). In the two trials of high quality (Dublin 1985; Melbourne 1976), the relative risk of neonatal seizures was RR 0.4, 95% CI 0.21 to 0.77 (n = 13,434; outcome 06.02).

Notwithstanding the caution regarding numbers-needed-to-treat (NNT) calculations, 661 women would have to be continuously monitored during labour to prevent one neonatal seizure (95% CI 384 to 2002). Combining NNT calculations for neonatal seizures and caesarean section suggests that a cohort of 628 women, if continuously monitored, could expect to have one neonatal seizure

less and 11 more caesarean sections compared to intermittently auscultated controls.

There was no difference in the incidence of cerebral palsy, although the lower limit of 95% confidence intervals was 0.97, implying that continuous CTG, at best, has no impact on cerebral palsy, but may be associated with an increase (outcome 01.29: RR 1.74, 95% CI 0.97 to 3.11, n = 13,252, two trials). The data on cerebral palsy are heavily influenced by one small trial (Seattle 1987) that randomised only very preterm babies (less than 32 weeks) and assessed outcomes for babies of birthweight less than 1750 g with a cerebral palsy rate of 19.5% in the CTG group compared with 7.7% in the controls (RR 2.54, 95% CI 1.10 to 5.86, n = 173). The other trial in this comparison (Dublin 1985) showed no significant difference in the incidence of cerebral palsy (RR 1.20, 95% CI 0.52 to 2.79, n = 13,079) with a cerebral palsy rate of 0.18% in the continuously CTG group and 0.15% in the intermittently monitored group. There was no evidence of any other benefit or harm for the babies in terms of Apgar scores, cord blood gasses, admission to neonatal intensive care unit or hypoxic ischemic encephalopathy.

There were no reported data suitable for analysis for the use of non-pharmacological methods for coping with labour, amniotomy, perineal trauma, inability to adopt preferred position in labour, dissatisfaction in labour and postpartum depression.

1.1. Subgroup analyses

1.1.1. Continuous cardiotocography (CTG) versus intermittent auscultation (low risk)

Only three trials reported some outcomes for women who could be classed as 'low risk' based on the information available at the time of randomisation (Dallas 1986; Dublin 1985; Melbourne 1981) and the data were consistent with overall results. Continuous CTG monitoring was associated with an increase in caesarean section for abnormal FHR pattern (outcome 02.02: RR 2.31, 95% CI 1.49 to 3.59, n = 15,545, two trials), increase in instrumental vaginal births (outcome 02.03, RR 1.29; 95% CI 1.02 to 1.62, n = 927, one trial) and more women not achieving spontaneous vaginal birth (outcome 02.05, RR 1.35; 95% CI 1.09 to 1.67, n = 927, one trial). There was no difference in the incidence of perinatal death (outcome 02.27: RR 1.02; 95% CI 0.31 to 3.31, n = 15,545, two trials). As in the analysis of all the trials, a reduction in neonatal seizures was seen (outcome 02.26: RR 0.36, 95% CI 0.16 to 0.81, n = 24,671, two trials), but incidence of cerebral palsy was not reported. Dallas 1986 and Melbourne 1981 reported an increase in the number of babies admitted to neonatal intensive care unit in the continuous CTG group (outcome 02.23: RR 1.37, 95% CI 1.01 to 1.87, n = 15,545, two trials).

1.1.2. Continuous cardiotocography (CTG) versus intermittent auscultation (high risk)

Results in this subgroup were also consistent with overall effects. The observed increase in the caesarean section rate in the continuous CTG group can be quantified as relative risk of 2.02 (95% CI 1.58 to 2.57, a risk difference of 9% (95% CI 6 to 12%) or numbers needed to treat of 12 (95% CI 9 to 18) i.e. one extra caesarean section was performed for every 12 high-risk women who had continuous CTG monitoring in labour (outcome 03.01: n = 1969, five trials). Only two other outcomes reached a statistical significance increase in the continuous CTG group i.e. caesarean section for abnormal FHR pattern (outcome 03.02, RR 2.46, 95% CI 1.69 to 3.59, n = 1969, five trials) and women not achieving spontaneous vaginal birth (outcome 03.05: RR 1.33, 95%CI 1.11 to 1.59, n = 1969, five trials). The relative risk for neonatal seizures was 0.66 but the confidence intervals included 1 (95% CI 0.36 to 1.22, n = 4805, five trials). There was an increase in cerebral palsy in the continuous CTG group (outcome 03.29, RR 2.54; 95% CI 1.10 to 5.86, n = 173, one trial), but this result comes from one trial in preterm babies (Seattle 1987), which is discussed above.
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1.1.3. Continuous cardiotocography (CTG) versus intermittent auscultation (preterm)

Only one trial is included in this subgroup (Seattle 1987), which recruited 246 women in preterm labour (less than 32 weeks). Ten outcomes have been compared in two groups and only an increase in cerebral palsy in the continuous CTG group reached the statistical significance (RR 2.54, 95% CI 1.10 to 5.86, n = 173), which is discussed above.

1.1.4. Continuous cardiotocography (CTG) versus intermittent auscultation (with FBS)

There was no evidence that the increase in caesarean section rate was greater in trials where fetal blood sampling was not available (subgroup interaction test p = 0.18). Access to fetal blood sampling did not appear to influence the difference in neonatal seizures nor any other prespecified outcome.

There are no data suitable for subgroup analyses for spontaneous or induced labour, term pregnancies, singleton or twin births and parity.

2. Continuous versus intermittent cardiotocography (CTG)

Lund 1994 compared two types of cardiotocography (continuous CTG versus intermittent CTG) only in high-risk women and found no significant differences in any of the eight outcomes included in this meta-analysis.

DISCUSSION

The main reason for the introduction of continuous CTG monitoring in clinical practice was a belief that it would reduce perinatal deaths and hypoxic brain injury. This review found no statistically significant difference in perinatal deaths between continuous CTG and intermittent auscultation. It does, however, seem unrealistic to expect that any intrapartum intervention in modern maternity care will result in a statistically significant improvement

in perinatal deaths. In order for a trial to test the hypothesis that continuous CTG can prevent one death in one thousand births (0.1%), more than 50,000 women would have to be randomised. It is, therefore, more logical to concentrate on morbidity. Unfortunately, very few clinically relevant neonatal outcomes have been reported consistently in all trials.

For decades, low Apgar scores have been used as a surrogate measure for birth asphyxia and subsequent adverse neurodevelopmental outcomes. This review found no evidence that continuous CTG monitoring has an impact on Apgar score. However, there were very few babies with clinically significant low Apgar scores in studies that assessed this outcome. Therefore, potentially important differences between the two groups cannot be ruled out.

Hypoxic ischaemic encephalopathy, a much more robust measure of hypoxic brain injury, has only been reported in one study (Athens 1993). Therefore, in the absence of any meaningful long-term follow-up data, the impact of continuous CTG monitoring on a neonate can only be evaluated based on the data from two clinically important outcomes, i.e. neonatal seizures and cerebral palsy.

For both neonatal seizures and cerebral palsy, the majority of data are provided by Dublin 1985. At first glance, the data appear contradictory with significant reduction in neonatal seizures in the continuous CTG group and no impact on cerebral palsy. If anything, the rates of cerebral palsy appear to be higher in the continuous CTG group, although the pooled result did not reach statistical significance. This apparent increase in cerebral palsy comes from Seattle 1987 which showed significant increase in cerebral palsy with continuous monitoring. However, the results from this study, the only study of preterm births, is not statistically significant using 99% confidence intervals. In addition, this study excluded infants with birthweight of more than 1750 grams (34% of randomised cohort) which may be a source of bias. Given that all other outcomes in this trial including caesarean section rates, neonatal seizures and deaths were almost identical this may have been a chance finding.

It is now generally accepted that cerebral palsy is more often caused by antepartum, rather than intrapartum, events (Palmer 1995). It may, therefore, be unrealistic to expect that intrapartum interventions will have the capacity to achieve significant reduction in cerebral palsy. However, there are, clearly, some cases of cerebral palsy that are a direct consequence of intrapartum hypoxic injury. These cases are very rare, and systematic reviews of randomised trials are unlikely to have sufficient power to test intrapartum CTG as a method to reduce cerebral palsy caused by acute and avoidable intrapartum events.

The reduction in seizures associated with continuous CTG monitoring is important, but has to be interpreted cautiously in the absence of long-term follow-up data. It has been suggested that seizures may be a "sentinel event" for peripartum adversity (Dennis 1978; Derham 1985) that does not always manifest as hypoxic encephalopathy (Keegan 1985; Lien 1995; Spellacy 1985). Once asphyxia, infection, brain malformation and metabolic causes are excluded, some neonatal seizures are associated with cerebral infarction or neonatal stroke (Estan 1997; Lien 1995). Although the underlying causes are not well understood, neonatal seizures may have long-term consequences other than cerebral palsy. One longitudinal study found that some babies who had neonatal seizures were classified as normal at five years and had normal overall intelligence in adolescence as assessed by IQ tests, but had some abnormal results on detailed neuropsychological testing (Temple 1995). Clearly, there is a need for comprehensive long-term follow up of the randomised cohorts that is not limited to gross outcomes such as cerebral palsy but also includes neuropsychological outcomes.

The results of the trials included in this review show that continuous CTG monitoring leads to an increase in caesarean sections and this effect appears to be consistent irrespective of clinical risk status (graph 07.01). Instrumental births are also undertaken more often when women are monitored with continuous CTG compared with intermittent auscultation. Put together, this leads to significantly fewer spontaneous vaginal births when CTG is used. Such an effect of continuous CTG is clinically plausible as CTG monitoring leads to more interventions (e.g. fetal blood sampling, amniotomy) and more diagnoses of presumed fetal compromise for which emergency caesarean section is seen as the only safe management option. The increased risk of respiratory morbidity and lacerations to the baby born by caesarean section, and the increased risk to the mother of bladder injury, further surgery, hysterectomy, thromboembolic disease, problems in future pregnancies and mortality all need to be weighted against the reduced incidence of seizures.

The caesarean section rate in included trials varied from 2.3% in Dublin 1985 to 35% in Pakistan 1989. We have therefore carried out a 'post-hoc' sensitivity analysis comparing the effects of continuous CTG monitoring on caesarean section in trials with low caesarean section rate (less than 10%) with those with caesarean section rate of greater than 10%. The test for interaction was statistically significant (chi-squared 12.7, degrees of freedom 1, $p < 0.001$) suggesting that an adverse impact of CTG monitoring on caesarean section rates may be greater when the baseline caesarean section rate is high. In other words, units with high caesarean section rates and low threshold to perform caesarean section for suspected or confirmed fetal compromise may experience greater increase in caesarean sections compared with units where such threshold is high and caesarean section rates are low. Also, there was some evidence that trial quality had influenced the size of the effects i.e. the increase in caesarean section rates appeared greater in studies of lower quality.

There was some evidence that labour was more painful in the continuous CTG group, but the statistically significant increase in the 'need for any analgesia' included general anaesthesia. It is,

therefore likely, that this difference was caused by an increase in the number of caesarean sections rather than necessarily more painful labour. Women do report more pain when lying on their backs during labour and at the times when the studies in this review were undertaken (between 1976 and 1994), women in the intermittent auscultation group may well also have been on their backs and not using mobility and positions to help them with their labours. Women who labour on their backs are known to reduce the blood flow to the placenta and baby, and thus possibly contribute to a reduced oxygen supply for the baby. There were no data from the trials included in the review to allow any analysis of this potential confounder.

We have prespecified several subgroups that could have been expected to influence the direction and size of the differences compared with results when all trials are considered together. We were conscious that any differences between subgroups and overall results would have to be interpreted with extreme caution (Rothwell 2005). The number of trials and women in subgroups was relatively small.

The subgroup based on risk assignment was included because of widespread differences in the use of CTG between high-risk and low-risk populations. High-risk women seem to be almost universally monitored whilst the use of CTG in low-risk women tend to be much lower with significant variation in the definition of low-risk status. We found no evidence that the impact of continuous CTG monitoring on important clinical outcomes vary significantly across risk classification in the trials included here.

Contrary to current practice recommendations, we found no evidence that the increase in caesarean section rate was greater if fetal blood sampling was unavailable; nor did access to fetal blood sampling influence the difference in neonatal seizures or any other prespecified outcome.

AUTHORS' CONCLUSIONS

Implications for practice

Translating the evidence from this review into clinical practice poses significant challenges. One would hope that the quality of CTG equipment, interpretation and training have improved over the years making the external validity of much of the data included in this review questionable. In most studies included in this review, intermittent auscultation was carried out according to the strict protocols in a hospital setting with quick recourse to continuous monitoring and intervention if required. In some trials, most notably the Dublin trial (Dublin 1985), intact fetal membranes were ruptured at the earliest opportunity to confirm absence of meconium and women were provided with one-to-one care from a midwife. This monitoring package differs significantly from practices in some modern birth settings (for example, stand alone midwifery units) where artificial rupture of membranes is avoided as long as possible, mobilisation and normality are promoted and rigid adherence to intermittent auscultation schedule may not be a priority. In addition, one-to-one care by a midwife or a nurse seems hard to implement in many healthcare settings and is likely be important for both types of fetal heart rate monitoring.

With this proviso, women should be informed that continuous CTG during labour is associated with a reduction in the incidence of neonatal seizures, has no obvious impact on cerebral palsy or perinatal mortality but is associated with an increase in the incidence of caesarean section and instrumental vaginal births. The adverse affects of operative births are well described, but possible long-term effects of preventable neonatal seizures remain unknown. Women need also to be informed of the loss of mobility associated with the use of continuous CTG in labour.

Women, practitioners and policy makers should consider carefully the absence of evidence that continuous CTG monitoring has a different impact on caesareans section and neonatal seizures in low- and high-risk populations.

The risk benefit debate will continue to focus on caesarean section and neonatal seizures. Given the perceived conflict between the risk for the mother (increased caesarean section and instrumental vaginal delivery rate) and benefit for the baby (decreased incidence of neonatal seizures), it is difficult to make quality judgments as to which effect is more important. The issue of effectiveness is particularly important. CTG advocates will continue to argue that lack of clear long-term benefit for the child merely reflects absence of evidence and is not proof that intermittent auscultation is safe. However, it would seem reasonable to base clinical decisions on the evidence we currently have. Obviously, the risk-benefit assessment will vary between individuals, policy makers and healthcare settings. The real challenge is how best to convey this uncertainty to women and help them to make an informed choice without compromising the normality of labour.

Implications for research

The question remains as to whether future randomised trials should measure efficacy (the intrinsic value of continuous CTG in trying to prevent adverse neonatal outcomes under optimal clinical conditions) or effectiveness (the effect of this technique in routine clinical practice).

Along with the need for further investigations into the long-term effects of operative births for women and babies, much remains to be learned about the causation and possible links between antenatal or intrapartum events, neonatal seizures and long-term neurodevelopmental outcome, bearing in mind the changes in clinical practice over the intervening years (one-to-one-support during labour, caesarean section rates). The large number of babies randomised in this review will now have reached adulthood, and could potentially provide us with a unique opportunity to clarify if a reduction in neonatal seizures is something inconsequential that

should not greatly influence women's and clinicians' choices, or if seizure reduction leads to long-term benefits for babies. Defining meaningful neurological and behavioural outcomes that could be measured in large cohorts of young adults poses huge challenges.

Data should also be collected from this cohort of women and babies, whilst the medical records still exist, to describe, where possible, the women's mobility and positions during labour and birth, to clarify if these might impact on outcomes. Research should also address the possible contribution of the supine position to adverse outcomes for the baby, and address the question of whether the use of mobility and positions can reduce the already low incidence of neonatal seizures and improve psychological outcomes for women.

POTENTIAL CONFLICT OF INTEREST

None known.

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REFERENCES

References to studies included in this review

Athens 1993 *{published and unpublished data}*

Vintzileos A, Nochimson D, Guzman E, Knuppel R. Comparison of intrapartum electronic fetal heart rate monitoring vs intermittent auscultation in detecting fetal acidemia at birth. *American Journal of Obstetrics and Gynecology* 1995;**172**:367.

Vintzileos AM, Antsaklis A, Varvarigos I, Papas C, Sofatzis I, Montgomery JT. A randomized trial of intrapartum electronic fetal heart rate monitoring versus intermittent auscultation. *Obstetrics & Gynecology* 1993;**81**:899–907.

Vintzileos AM, Antsaklis AJ, Varvarigos I, Karaiskakis P, Gazis I, Pappas C, et al. A prospective randomized trial of intrapartum electronic fetal heart rate monitoring vs intermittent auscultation. *American Journal of Obstetrics and Gynecology* 1993;**168**(6):343.

Vintzileos AM, Nochimson DJ, Antsaklis A, Varvarigos I, Guzman ER, Knuppel RA. Comparison of intrapartum electronic fetal heart rate monitoring vs intermittent auscultation in detecting fetal acidemia at birth. *American Journal of Obstetrics and Gynecology* 1995;**173**:1021–4.

Copenhagen 1985 *{published data only}*

Hansen PK, Smith SF, Nim J, Neldam S, Osler M. Maternal attitudes to fetal monitoring. *European Journal of Obstetrics & Gynecology and Reproductive Biology* 1985;**20**:43–51.

Neldam S, Osler M, Hansen PK, Nim J, Smith SF, Hertel J. Intrapartum fetal heart rate monitoring in a combined low- and high-risk population: a controlled clinical trial. *European Journal of Obstetrics & Gynecology and Reproductive Biology* 1986;**23**:1–11.

Neldam S, Osler M, Hansen PK, Nim J, Smith SF, Hertel J. Monitoring of labour with cardiotocography and stethoscopic examination in normal and at risk deliveries. A controlled clinical investigation. *Ugeskrift for Laeger* 1985;**147**:2901–7.

Dallas 1986 *{published and unpublished data}*

Leveno KJ, Cunningham FG, Nelson S, Roark ML, Williams ML, Guzick DS, et al. A prospective comparison of selective and universal electronic fetal monitoring in 34,995 pregnancies. *New England Journal of Medicine* 1986;**315**:615–9.

Leveno KJ, Cunningham FG, Nelson S, Roark ML, Williams ML, Guzick DS, et al. Selected versus universal electronic fetal monitoring: a randomized study of 31,352 women. Proceedings of 6th Annual Meeting of the Society of Perinatal Obstetricians; 1986 January 30-February 1; San Antonio, Texas, USA. 1986:208.

Denver 1976 *{published and unpublished data}*

Haverkamp AD, Thompson HE, McFee JG, Cetrulo C. The evaluation of continuous fetal heart rate monitoring in high-risk pregnancy. *American Journal of Obstetrics and Gynecology* 1976;**125**:310–7.

Denver 1979 *{published and unpublished data}*

Haverkamp AD, Orleans M, Langendoerfer S, McFee J, Murphy J,

Thompson HE. A controlled trial of the differential effects of intrapartum fetal monitoring. *American Journal of Obstetrics and Gynecology* 1979;**134**:399–412.

Koszalka MF Jr, Haverkamp AD, Orleans M, Murphy J. The effects of internal electronic fetal heart rate monitoring on maternal and infant infections in high-risk pregnancies. *Journal of Reproductive Medicine* 1982;**27**(10):661–5.

Langendoerfer S, Haverkamp AD, Murphy J, Nowick KD, Orleans M, Pacosa F, et al. Pediatric follow-up of a randomized controlled trial of intrapartum fetal monitoring techniques. *Journal of Pediatrics* 1980;**97**(1):103–7.

Dublin 1985 *{published and unpublished data}*

Boylan P, MacDonald D, Grant AM, Pereira M, Chalmers I. The Dublin randomised controlled trial of intrapartum fetal heart rate monitoring. In: KunzelW editor(s). *Fetal heart rate monitoring*. Berlin: Springer Verlag, 1985:231–3.

Ellison PH, Foster M, Sheridan-Pereira M, MacDonald D. Electronic fetal heart monitoring, auscultation, and neonatal outcome. *American Journal of Obstetrics and Gynecology* 1991;**164**(5 Pt 1):1281–9.

Garcia J, Corry M, MacDonald D, Elbourne DR, Grant AM. Mothers' views of continuous electronic fetal heart monitoring and intermittent auscultation in a randomized controlled trial. *Birth* 1985;**12**: 79–86.

Grant A, O'Brien N, Joy MT, Hennessy E, MacDonald D. Cerebral palsy among children born during the Dublin randomised trial of intrapartum monitoring. *Lancet* 1989;**8674**:1233–6.

Macdonald D, Grant A, Sheridan-Pereira M, Boylan P, Chalmers I. The Dublin randomized controlled trial of intrapartum fetal heart rate monitoring. *American Journal of Obstetrics and Gynecology* 1985; **152**:524–39.

Lund 1994 *{published and unpublished data}*

Herbst A, Ingemarsson I. Intermittent versus continuous electronic fetal monitoring in labour: a randomized study. *British Journal of Obstetrics and Gynaecology* 1994;**101**:663–8.

Herbst A, Ingemarsson I. Intermittent vs continuous monitoring in labour. Proceedings of 14th European Congress of Perinatal Medicine; 1994 June 5-8; Helsinki, Finland. 1994:474.

Melbourne 1976 *{published and unpublished data}*

Renou P, Chang A, Anderson I, Wood C. Controlled trial of fetal intensive care. *American Journal of Obstetrics and Gynecology* 1976; **126**:470–6.

Wood C, Renou P. Fetal heart rate monitoring, Chapter 23. In: BeardRW, NathanielszPW editor(s). *Fetal physiology and medicine*. London: Saunders, 1976:471–3.

Melbourne 1981 *{published data only}*

Wood C, Renou P, Oats J, Farrell E, Beischer N, Anderson I. A controlled trial of fetal heart rate monitoring in a low-risk obstetric population. *American Journal of Obstetrics and Gynecology* 1981;**141**: 527–34.

Pakistan 1989 *{unpublished data only}*

Azhar NA, Neilson JP. Randomised trial of electronic intrapartum fetal heart rate monitoring with fetal blood sampling versus intermittent auscultation in a developing country. Personal communication 2001.

Seattle 1987 *{published and unpublished data}*

Killien MG, Shy K. A randomized trial of electronic fetal monitoring in preterm labor: mother's views. *Birth* 1989;**16**:7–12.

Larson EB, van Belle G, Shy KK, Luthy DA, Strickland D, Hughes JP. Fetal monitoring and predictions by clinicians: observations during a randomized clinical trial in very low birth weight infants. *Obstetrics & Gynecology* 1989;**74**:584–89.

Luthy DA, Shy KK, Van Belle G, Larson EB, Hughes J, Benedetti TJ, et al. A randomized trial of electronic fetal heart rate monitoring in infants of low birth weight. Proceedings of 6th Annual Meeting of the Society of Perinatal Obstetricians; 1986 January 30-February 1; San Antonio, Texas, USA. 1986:207.

Luthy DA, Shy KK, van Belle G, Larson EB, Hughes JP, Benedetti TJ, et al. A randomized trial of electronic fetal monitoring in preterm labor. *Obstetrics & Gynecology* 1987;**69**:687–95.

Shy KK, Luthy DA, Bennett FC, Whitfield M, Larson EB, van Belle G, et al. Effects of electronic fetal heart rate monitoring, as compared with periodic auscultation, on the neurologic development of premature infants. *New England Journal of Medicine* 1990;**322**(9):588–93.

Sheffield 1978 *{published and unpublished data}*

Kelso IM, Parsons RJ, Lawrence GF, Arora SS, Edmonds DK, Cooke CD. An assessment of continuous fetal heart rate monitoring in labor: a randomized trial. *American Journal of Obstetrics and Gynecology* 1978;**131**:526–31.

References to studies excluded from this review

Harare 1994

Mahomed K, Nyoni R, Mlambo T, Jacobus E, Kasule J. Intrapartum foetal heart rate monitoring - continuous electronic vs intermittent doppler - a randomised controlled trial. *Central African Journal of Medicine* 1992;**38**:458–62.

Mahomed K, Nyoni R, Mulambo T, Kasule J, Jacobus E. Randomised controlled trial of intrapartum fetal heart rate monitoring. *BMJ* 1994; **308**:497–500.

Ioannina 2001

Stefos T, Sotiriadis A, Tsirkas P, Korkontzelos I, Papadimitriou D, Lolis D. Evaluation of fetal heart monitoring in the first stage of labor. *Journal of Maternal-Fetal Medicine* 2001;**10**:48–51.

Manchester 1982

D'Souza SW, Black P, MacFarlane T. Fetal scalp damage and neonatal jaundice: a risk of routine fetal scalp electrode monitoring. *Journal of Obstetrics and Gynaecology* 1982;**2**:161–4.

North America

Garite TJ, Dildy GA, McNamara H, Nageotte MP, Boehm FH, Dellinger EH, et al. A multicenter controlled trial of fetal pulse oximetry in the intrapartum management of nonreassuring fetal heart rate patterns. *American Journal of Obstetrics and Gynecology* 2000;**183**: 1049–58.

Additional references

ACOG 1995

American College of Obstetricians and Gynecologists. ACOG technical bulletin. Fetal heart rate patterns: monitoring, interpreta-

tion, and management. Number 207. July 1995 (replaces No. 132, September 1989). *International Journal of Gynecology & Obstetrics* 1995;**51**(1):65–74.

Bayley 1993
Bayley N. *Bayley Scales of Infant Development. 2nd edition*. USA: Harcourt Brace & Company, 1993.

Carbone 1997
Carbone B, Langer B, Goffinet F, Andibert F, Tardiff D, Le Goueff F, et al. Multicenter study on the clinical value of fetal pulse oximetry and fetal blood analysis. *American Journal of Obstetrics and Gynecology* 1997;**17**:593–8.

Dennis 1978
Dennis J. Neonatal convulsions: aetiology, late neonatal status and long-term outcome. *Developmental Medicine and Child Neurology* 1978;**20**:143–8.

Derham 1985
Derham RJ, Matthews TG, Clarke TA. Early seizures indicate quality of perinatal care. *Archives of Disease in Childhood* 1985;**60**:809–13.

Devane 2005a
Devane D, Lalor J. Midwives' visual interpretation of intrapartum cardiotocographs: intra- and inter- observer agreement. *Journal of Advanced Nursing* 2005;**52**(2):133–41.

Devane 2005b
Devane D, Lalor JG, Daly S, McGuire W. Cardiotocography versus intermittent auscultation of fetal heart on admission to labour ward for assessment of fetal wellbeing. *Cochrane Database of Systematic Reviews* 2005, Issue 1. Art. No.: CD005122. DOI: 10.1002/14651858.CD005122.

East 2004
East CE, Chan FY, Colditz PB. Fetal pulse oximetry for fetal assessment in labour. *Cochrane Database of Systematic Reviews* 2004, Issue 2. Art. No.: CD004075. DOI:10.1002/14651858.CD004075.pub3.

East 2005
East CE, Smyth R, Leader LR, Henshall NE, Colditz PB, Tan KH. Vibroacoustic stimulation for fetal assessment in labour in the presence of a nonreassuring fetal heart rate trace. *Cochrane Database of Systematic Reviews* 2005, Issue 2. Art. No.: CD004664. DOI: 10.1002/14651858.CD004664.pub2.

Enkin 2000
Enkin M, Keirse MJNC, Neilson J, Crowther C, Duley L, Hodnett E, et al. *A guide to effective care in pregnancy and childbirth*. 3rd Edition. Oxford: Oxford University Press, 2000.

Estan 1997
Estan J, Hope P. Unilateral neonatal cerebral infarction in full term infants. *Archives of Disease in Childhood. Fetal and Neonatal Edition* 1997;**76**:F88–F93.

Garcia 1985
Garcia J, Corry M, MacDonald D, Elbourne DR, Grant AM. Mothers' views of continuous electronic fetal heart monitoring and intermittent auscultation in a randomized controlled trial. *Birth* 1985;**12**: 79–86.

Gibb 1992
Gibb D, Arulkumaran S. *Fetal monitoring in practice*. Oxford: Butterworth-Heinemann Ltd, 1992.

Grant 1989a
Grant A. Monitoring the fetus during labour. *Effective care in pregnancy and childbirth*. Chalmers I, Enkin M, Keirse MJNC. Oxford: Oxford University Press, 1989:846–82.

Higgins 2005
Higgins JPT, Green S, editors. Cochrane Handbook for Systematic Reviews of Interventions 4.2.5 [updated May 2005]. www.cochrane.org/resources/handbook/hbook/htm accessed 2005.

Keegan 1985
Keegan KA Jr, Waffarn F, Quilligan EJ. Obstetric characteristics and fetal heart rate patterns of infants who convulse during the newborn period. *American Journal of Obstetrics and Gynecology* 1985;**153**:732–7.

Killien 1989
Killien MG, Shy K. A randomized trial of electronic fetal monitoring in preterm labor: mothers' views. *Birth* 1989;**16**:7–12.

Lawn 2005
Lawn JE, Cousens S, Zupan J. 4 million neonatal deaths: when? where? why?. *Lancet* 2005;**365**(9462):891–900.

Lien 1995
Lien JM, Towers CV, Quilligan EJ, de Veciana M, Toohey JS, Morgan MA. Term early-onset neonatal seizures: obstetric characteristics, etiologic classifications, and perinatal care. *Obstetrics & Gynecology* 1995;**85**:163–9.

Liston 2002
Liston R, Crane J, Hamilton E, Hughes O, Kuling S, MacKinnon C, et al. SOGC Clinical Practice Guidelines: fetal health surveillance in labour I. *Journal of Obstetrics and Gynaecology Canada: JOGC* 2002; **24**(3):250–76.

Luttkus 2004
Luttkus AK, Noren H, Stupin JH, Blad S, Arulkumaran S, Erkkola R, et al. Fetal scalp pH and ST analysis of the fetal ECG as an adjunct to CTG. A multicenter, observational study. *Journal of Perinatal Medicine* 2004;**32**:486–94.

MCHRC 1997
Maternal and Child Health Research Consortium. *Confidential enquiry into stillbirths and deaths in infancy (CESDI): 4th Annual Report*. London: Maternal and Child Health Research Consortium, 1997.

MCHRC 1998
Maternal and Child Health Research Consortium. *Confidential enquiry into stillbirths and deaths in infancy (CESDI): 5th Annual Report*. London: Maternal and Child Health Research Consortium, 1998.

MCHRC 1999
Maternal and Child Health Research Consortium. *Confidential enquiry into stillbirths and deaths in infancy (CESDI): 6th Annual Report*. London: Maternal and Child Health Research Consortium, 1999.

Mozurkewich 2000
Mozurkewich E, Wolf FM. Near-infrared spectroscopy for fetal assessment during labour. *Cochrane Database of Systematic Reviews* 2000, Issue 3. Art. No.: CD002254. DOI: 10.1002/14651858.CD002254.

Munro 2004
Munro J, Soltani H, Layhe N, Watts K, Hughes A. Can women relate to the midwifery behind the machines? An exploration of women's experience of electronic fetal monitoring: cross-sectional survey in

three hospitals. Normal labour and birth: 2nd Research Conference; 2004 June 9-11; University of Central Lancashire. 2004.

Neilson 2003
Neilson JP. Fetal electrocardiogram (ECG) for fetal monitoring during labour. *Cochrane Database of Systematic Reviews* 2003, Issue 2. Art. No.: CD000116. DOI:10.1002/14651858.CD000116.pub2.

Nelson 1996
Nelson KB, Dambrosia JM, Ting TY, Grether JK. Uncertain value of electronic fetal monitoring in predicting cerebral palsy. *New England Journal of Medicine* 1996;**334**:613–8.

Palmer 1995
Palmer L, Blair E, Petterson B, Burton P. Antenatal antecedents of moderate and severe cerebral palsy. *Paediatric and Perinatal Epidemiology* 1995;**9**:171–84.

RANZCOG 2002
The Royal Australian and New Zealand College of Obstetricians and Gynaecologists. *Clinical Guidelines: intrapartum surveillance*. East Melbourne: RANZCOG, 2002.

RCOG 2001a
Royal College of Obstetricians and Gynaecologists. *The use of electronic fetal monitoring: the use and interpretation of cardiotocography in intrapartum fetal surveillance. Evidence-based Clinical Guideline Number 8*. London: Royal College of Obstetricians and Gynaecologists, UK, 2001.

RCOG 2001b
Royal College of Obstetricians and Gynaecologists. *Induction of labour. Evidence-based Clinical Guideline Number 9*. London: Royal College of Obstetricians and Gynaecologists, 2001.

RevMan 2003
The Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager (RevMan). 4.2 for Windows. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2003.

Rothwell 2005
Rothwell PM. Subgroup analysis in randomised controlled trials: importance, indications, and interpretation. *Lancet* 2005;**365**:176–86.

Skupski 2002
Skupski DW, Rosenberg CR, Eglinton GS. Intrapartum stimulation tests: meta-analysis. *Obstetrics & Gynecology* 2002;**99**(1):129–34.

Spellacy 1985
Spellacy WN, Peterson PQ, Winegar A, Quilligan EJ. Neonatal seizures after cesarean delivery: higher risk with labor. *American Journal of Obstetrics and Gynecology* 1987;**157**:377–9.

Temple 1995
Temple CM, Dennis J, Carney R, Sharich J. Neonatal seizures: long-term outcome and cognitive development among 'normal' survivors. *Developmental Medicine and Child Neurology* 1995;**37**:109–18.

Thacker 1995
Thacker SB, Stroup DF, Peterson HB. Efficacy and safety of intrapartum electronic fetal monitoring: an update. *Obstetrics & Gynecology* 1995;**86**:613–20.

References to other published versions of this review

Thacker 2001
Thacker SB, Stroup D, Chang M. Continuous electronic heart rate monitoring for fetal assessment during labor. *The Cochrane Database of Systematic Reviews* 2001, Issue 2. Art. No.: CD000063. DOI: 10.1002/14651858.CD000063.pub2.

TABLES

Characteristics of included studies

Study	Athens 1993
Methods	Assignment by coin toss on admission. Mothers and obstetricians not blinded; neonatologists collecting data on neonatal outcomes were blinded.
Participants	Mixed-risk. Women with a singleton fetus at 26 or more weeks' gestation admitted in spontaneous labour or for induction of labour. Total of 1428 women participated with 746 in the CTG group and 682 in the IA group.
Interventions	Continuous CTG without FBS versus intermittent auscultation. CTG: external unless trace poor when internal CTG used.
Outcomes	Labour onset, oxytocin administration, duration of labour, premature rupture of the membranes, meconium stained liquor, mode of delivery, analgesia/anaesthesia, 'nonreassuring' FHR patterns, length of maternal hospital stay, postpartum maternal morbidity (infection or blood transfusion), duration of 'good quality tracing'. Presentation at birth, birthweight (< 2500, 2500-4000, > 4000), Apgar score < 7 @ 1 min and @ 5 min, cord arterial pH < 7.10, neonatal resuscitation, NICU admission, assisted ventilation, length of neonatal

	hospital stay, neonatal complications (none, HIE, intraventricular haemorrhage, seizures, hypotonia, necrotizing enterocolitis, respiratory distress, sepsis, hyperbilirubinemia, hypoglycaemia, congenital anomalies), intrapartum fetal death, neonatal death, perinatal death, perinatal death from hypoxia. Outcomes analyzed: caesarean deliveries, operative vaginal deliveries, 1 minute Apgar < 4 and < 7, neonatal seizures, NICU admissions, length of stay, and perinatal death. Outcomes not analyzed: presentation, labour, labour duration, PROM, meconium, maternal infection or blood transfusion.
Notes	Attrition bias: (A) less than 3% of participants excluded. Study period: October 1990 to June 1991.
Allocation concealment	C – Inadequate

Study	**Copenhagen 1985**
Methods	Weekly allocation to either group by random sampling. Method of randomisation unclear.
Participants	High- and low-risk women, only diabetics excluded. Among 1410 women who fulfilled the criteria for entering the study, 349 refused to participate (primarily due to preference for one form of monitoring). Total of 969 women participated with 482 in CTG group and 487 in IA group. Baseline outcomes collected for non-participating group of women.
Interventions	Continuous CTG in conjunction with FBS versus intermittent auscultation. CTG: external or internal
Outcomes	FHR pattern, corrective procedures for pathological FHR pattern (oxygen, change of maternal position, caesarean section, vacuum extraction), indications for termination of labour (mechanical disproportion, bleeding, cord prolapse, maternal disease, fetal disease, lack of progression, other), presentation at birth, administration of oxytocin, analgesia/anaesthesia. Apgar score 0-3, 4-6, 7-10 @ 1 min and @ 5 min, gestational age (including appropriate for gestational age, small-for-gestational age, large-for-gestational age), weight, NICU admissions, asphyxia, oxygen/CPAP requirement, intubation, ventilation, post-asphyxia pallor, seizures, irritability, neonatal infection, intrapartum death, antepartum death.
Notes	Attrition bias: (B) 3% to 9.9% of participants excluded (1061 women agreed to participate; 92 excluded). Study period: January 1981 to January 1982 (date women expected to deliver).
Allocation concealment	B – Unclear

Study	**Dallas 1986**
Methods	Randomisation by alternate months; selective monitoring (policy of using monitoring only in high-risk pregnancies) versus universal monitoring (use of a monitor for every pregnancy in which the fetus was considered viable i.e. irrespective of risk status).
Participants	Data extracted for 14,618 women with low-risk pregnancies; 7288 in universal monitoring group where all women monitored by CTG, and 7330 in selective monitoring where low-risk women monitored by IA.
Interventions	Continuous CTG versus intermittent auscultation. CTG: no information on external or internal.
Outcomes	Abnormal FHR pattern, caesarean section, intrapartum fetal deaths, neonatal deaths, assisted ventilation, Apgar score < 5 @ 5 min, NICU admission, seizures.
Notes	Attrition bias: information not available. Study period: information not available.
Allocation concealment	C – Inadequate

Characteristics of included studies (*Continued*)

Study	**Denver 1976**
Methods	Randomised sealed envelope with participants with even numbers having CTG while participants with odd numbers had intermittent auscultation.
Participants	High-risk women on point system rating; in addition those with meconium stained fluid, needing oxytocin or abnormal fetal heart tones during labour were eligible to participate. Total of 483 women participated, 242 in the CTG group and 241 in the IA group.
Interventions	Continuous CTG without FBS versus intermittent auscultation. CTG: internal.
Outcomes	FHR pattern, caesarean section, instrumental vaginal deliveries, anaesthesia, umbilical cord pH, mean Apgar scores and Apgar scores <= 7 and > 7 @ 1 min and @ 5 min, NICU admissions, temperate abnormalities, jaundice, lethargy, seizures, jitteriness, spontaneous respiration, intubation, ventilation.
Notes	Attrition bias: (A) less than 3% of participants excluded. Study period: information not available. Intermittent auscultation group had a CTG monitor attached, which was turned off at bedside but which was recorded on a covered monitor in the hallway. This CTG was not available to clinicians during the woman's labour.
Allocation concealment	B – Unclear

Study	**Denver 1979**
Methods	Allocation by random numbers in sealed envelopes.
Participants	High-risk women in labour. Total of 690 women participating with 1) 230 women in CTG without FBS group; 2) 229 women in CTG with FBS group; 3) 231 women in IA group.
Interventions	Three groups: continuous CTG with FBS versus continuous CTG without FBS versus intermittent auscultation. CTG: external until internal feasible.
Outcomes	Pre-eclampsia, amnionitis, FHR patterns, caesarean section, instrumental vaginal deliveries, anaesthesia, maternal postpartum infections, oxytocin administration during labour, meconium. Gestational age (including appropriate for gestational age, small-for-gestational age, large-for-gestational age), mean Apgar score and Apgar score 0-3, 4-7, 8-10 @ 1 min and @ 5 min, umbilical cord blood gases (pH, pO2, pCO2), respiratory distress, pneumonia, seizures, sepsis, meningitis, NICU admission, required antibiotics, Bayley scales and Milani-Comparetti tests at 9 months of age.
Notes	Attrition bias: (A) less than 3% of participants excluded. Study period: July 1975 to July 1977.
Allocation concealment	B – Unclear

Study	**Dublin 1985**
Methods	Random allocation by opening the next envelope in a series of serially numbered, opaque, sealed envelopes.
Participants	Women at > 28 weeks' gestation, in labour, clear liquor previously demonstrated. Mixed risk. Total of 12,964 women participated with 6474 in the CTG group and 6490 in the IA group.
Interventions	Continuous CTG in conjunction with FBS versus intermittent auscultation. CTG: internal.
Outcomes	Use of FBS, scalp pH values, randomisation-delivery interval, oxytocin use, analgesia, caesarean section, operative vaginal deliveries, Apgar score < 3 @ 1 min and @ 5 min, intubation, NICU admission, umbilical

	cord venous pH values neonatal trauma (e.g. fractured clavicle, facial nerve injury, intrapartum death, neonatal death, seizures, abnormalities of tone and reflexes, primary cause of stillbirths and neonatal deaths, labour length, cerebral palsy at 4 years of age.
Notes	Attrition bias: (A) less than 3% of participants excluded. Study period: March 1981-April 1983. Zelen deign.
Allocation concealment	A – Adequate

Study	**Lund 1994**
Methods	Shuffled opaque envelopes in randomly permuted blocks.
Participants	Women with low to moderate risk factors for complications during labour. Total of 4044 women participated with 2029 in the continuous CTG group and 2015 in the intermittent CTG group.
Interventions	Continuous CTG with FBS versus intermittent CTG with FBS. CTG: no information on external or internal
Outcomes	FHR pattern, time from admission to delivery, length of labour, duration of cardiotocography, caesarean section, instrumental vaginal deliveries, normal deliveries, umbilical cord arterial pH values, Apgar score <7 @ 1 min and 5 min, NICU admission.
Notes	Attrition bias: (A) less than 3% of participants excluded. Study period: October 1989 May 1991.
Allocation concealment	B – Unclear

Study	**Melbourne 1976**
Methods	Randomised cards in sealed, consecutively numbered envelopes.
Participants	High-risk mothers. Total of 350 women participated with 175 in CTG group and 175 in IA group.
Interventions	Continuous CTG with FBS versus intermittent auscultation. CTG: external.
Outcomes	Length of labour, induction-delivery interval, oxytocin use, IV fluid volume use, ketonuria, analgesia, caesarean section, instrumental vaginal deliveries, maternal infection. Apgar score (mean grouped) 0-3, 4-6, 7-10 (? timing), resuscitation, NICU admission, twitching, apneic episodes, hypotonia, convulsions, tachypnea, high-pitched cry, hypertonus, neonatal infection, umbilical cord arterial and venous blood gases.
Notes	Attrition bias: information not available. One obstetrician withdrew his participants 'from the trial' . It is not clear if this was pre- or post-randomisation nor is it clear how may participants were withdrawn. Study period: March 1974 - April 1975.
Allocation concealment	A – Adequate

Study	**Melbourne 1981**
Methods	Randomised cards; envelopes unsealed; biased randomisation in one of the participating hospitals; 62 low parity women excluded post-hoc to correct for imbalance in randomisation.
Participants	Low-risk women. Total of 989 women participated with 445 in the CTG group and 482 in the IA group.

Characteristics of included studies (*Continued*)

	Randomisation was open and there was a disproportionate number of low-parity women in the monitored group. Numbers were adjusted by random elimination of 62 women. Analysis was undertaken using the corrected figures.
Interventions	Continuous CTG without FBS versus intermittent auscultation. CTG: external until membranes ruptured then internal.
Outcomes	Analgesia, ketonuria, caesarean section, instrumental vaginal deliveries, normal deliveries. Apgar score 0-3, 4-6, 7-10 @ 1 min, days in 'isolette', days in nursery, phototherapy, neonatal death, neurological signs & symptoms (unspecified).
Notes	Attrition bias: (B) 3% to 9.9% of participants excluded; Study period: information not given.
Allocation concealment	C – Inadequate

Study	**Pakistan 1989**
Methods	Randomisation by woman selecting one of 200 sealed, opaque, unnumbered envelopes.
Participants	High-risk women (all participants had meconium stained liquor). Total of 200 women participated with 100 in the CTG group and 100 in the IA group.
Interventions	Continuous CTG with FBS versus intermittent auscultation. CTG: external.
Outcomes	Apgar score < 7 @ 1 min and @ 5 min, caesarean section, instrumental vaginal deliveries, normal deliveries, stillbirths, early neonatal deaths.
Notes	Attrition bias: (A) less than 3% of participants excluded. Study period: 1988-1989. Data extracted from unpublished trial lodged with Cochrane centre.
Allocation concealment	C – Inadequate

Study	**Seattle 1987**
Methods	Randomisation by numbered, sealed envelopes.
Participants	High-risk women. Preterm labour (28-32 weeks' gestation), estimated fetal weight 700-1750 g. Total of 386 women participated with 188 in the CTG group and 188 in the IA group. Assessing birthweights under 1750 g left 122 in the CTG group and 124 in the IA group.
Interventions	Continuous CTG with FBS versus intermittent auscultation. CTG: external until rupture of membranes then internal.
Outcomes	Use of tocolytic agents/antenatal glucocorticoids/oxytocin, regional anaesthesia, premature rupture of membranes, caesarean section, caesarean section. Birthweight, sex of infant, Apgar score 0-3 and 4-10 @ 1 min and @ 5 min, umbilical cord blood gases, intracranial haemorrhage, severe respiratory distress syndrome, seizures, perinatal death.
Notes	Attrition bias: (D) more than 20% of participants excluded. Study period: Nov 1981 - Feb 1985.
Allocation concealment	B – Unclear

Study	**Sheffield 1978**
Methods	Sealed envelopes; randomisation details not described.

Participants	Mixed-risk women. Total of 504 women participated with 253 in the CTG group and 251 in the IA group.
Interventions	Continuous CTG without FBS versus intermittent auscultation. CTG: internal.
Outcomes	Analgesia/anaesthesia, duration of labour, intra or postpartum pyrexia, length of maternal postpartum stay. Birthweight, congenital anomalies, length of hospital stay, type of labour onset, caesarean section, instrumental vaginal deliveries, normal deliveries, Apgar score (6 or less @ 1 min), NICU admission (including reasons for admission), hypertonicity, umbilical cord blood gases, perinatal deaths.
Notes	Attrition bias: (A) less than 3% of participants excluded. Study period: July 1976 - June 1977.
Allocation concealment	B – Unclear

CPAP: continuous positive airways pressure
CTG: cardiotocography
FBS: fetal blood sampling
FHR: fetal heart rate
HIE: hypoxic ischaemic encephalopathy
IA: intermittent auscultation
IV: intravenous
min: minutes
NICU: neonatal intensive care unit
PROM: preterm rupture of membranes

Characteristics of excluded studies

Study	Reason for exclusion
Harare 1994	This randomised study did not include continuous CTG. Four randomised groups received (i) CTG 10 minutes in every 30 minutes, (ii) Doppler ultrasound monitoring by research midwife, (iii) Pinard stethoscope by research midwife or (iv) routine auscultation by Pinard (last 10 minutes of every 30 minutes).
Ioannina 2001	Non-randomised trial; 468 women in labour with cervical dilatation less than 5 cm who were continuously monitored were compared with 346 women in whom CTG monitoring was commenced when cervix was more than 4 cm dilated. According to the trial report the cohort was divided into two groups 'according to cervical dilatation'.
Manchester 1982	This quasi-randomised study of 426 low risk women was excluded because there were no reported data for the control group.
North America	Study design compared CTG to CTG plus continuous fetal pulse oximetry.

CTG: cardiotocography
EFM: electronic fetal monitoring

ADDITIONAL TABLES

Table 01. Additional descriptive information from included studies

Study	1 carer to 1 woman	Induction	ARM	Oxytocin	Mobility	Birth positions	Women's views	Social context	Experience of staff
Athens 1993	Yes	Induction - 11% overall	No information	Augmentation - 46% overall	No mobility - all women with IV line inserted	Semi-Fowler or lateral	No information	No information	IA standard practice, EFM intensive training provided
Copenhagen 1985	No information	No information	No information	No information	EFM only applied when women no longer wished to walk around.	No information	No information	No information	No information
Dallas 1986	2 women : 1 nurse	Excluded women whose labours were induced	No information	Excluded women	No information	No information	No information	No information	No information
Denver 1976	IA: yes CTG: no infomation	Included women whose labours were induced	No information	Included women given oxytocin for augmentation	No information	No information	No information	No information	No information
Denver 1979	Yes	No specific information	No information	29% of women given oxytocin for augmentation	No information	No information	No information	No information	No information
Dublin 1985	Yes	Included women whose labours were induced	ARM within an hour of admission to check liquor	23% of women given oxytocin for augmentation	IA prob more mobile	No information	Women's views sought and published separately.	No information	No information
Lund 1994	No information	Included women whose labours	No information	48% of women were given ocytocin	Women in CTG group offered	No information	No information	No information	No information

Table 01. Additional descriptive information from included studies (*Continued*)

Study	1 carer to 1 woman	Induction	ARM	Oxytocin	Mobility	Birth positions	Women's views	Social context	Experience of staff
		were induced		for induction or acceleration	telemetry if wished mobility				
Melbourne 1976	No information	Induction - 42% overall	No information	63% of women given oxytocin in labour	No information	No information	No information	No information	Exp staff.
Melbourne 1981	No information	No information	ARM when in established labour or for obstetric reasons	No information	No information	No information	No information	No information	No information
Pakistan 1989	No information	No information	No information	No information	No information	No information	No information	No information	No information
Seattle 1987	Yes	No information	ARM at 7 cm unless clinically indicated prior to 7 cm	Included women given oxytocin	No information	No information	Women's views sought and published separately.	No information	No information
Sheffield 1978	No information	Included women whose labours were induced	Augmentation with ARM alone or in combination with oxytocin if progress fell below nomogram.	Oxytocin was administered to all women as indicated	No information	No information	No information	No information	No information

Table 02. Methods of fetal heart rate monitoring

Method	Description
Fetal stethoscope (Pinard) - for intermittent monitoring (IA)	This is a trumpet shaped device which is placed on the mother's abdomen and the caregiver listens for the heart beat at the other end. This is a simple instrument of relatively low cost.
Hand-held Doppler ultrasound monitor - for intermittent	The device is placed on the mother's abdomen with gel smeared

Table 02. Methods of fetal heart rate monitoring (*Continued*)

Method	Description
monitoring (IA)	on the underside of the ultrasound transducer. This allows the ultrasound beam to travel from the fetal heart to the transducer without interruption.
External cardiotocography - for continuous or intermittent monitoring	The fetal heart rate and the activity of the uterine muscle are detected by two transducers placed on the mother's abdomen (one above the fetal heart and the other at the fundus). Doppler ultrasound provides the information which is recorded on a paper strip known as a cardiotocograph (CTG).
Internal cardiotocography - for continuous monitoring	An electrode is placed directly on the baby's presenting part to detect the fetal ECG signal. Again the signals are recorded on a paper strip (CTG). This method can only be used if membranes (fore-waters) have ruptured either spontaneously or artificially.

ANALYSES

Comparison 01. Continuous CTG versus intermittent auscultation (all)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Caesarean section	11	18761	Relative Risk (Random) 95% CI	1.66 [1.30, 2.13]
02 Caesarean section for abnormal FHR pattern and/or acidosis	12	33379	Relative Risk (Fixed) 95% CI	2.37 [1.88, 3.00]
03 Instrumental vaginal birth	10	18515	Relative Risk (Random) 95% CI	1.16 [1.01, 1.32]
04 Instrumental vaginal birth for abnormal CTG or fetal acidosis	1	12964	Relative Risk (Fixed) 95% CI	2.54 [1.95, 3.31]
05 Spontaneous vaginal birth not achieved	11	18761	Relative Risk (Fixed) 95% CI	1.27 [1.19, 1.36]
06 CS low CS versus high CS (post hoc)	10	18761	Odds Ratio (Random) 95% CI	1.77 [1.31, 2.38]
07 Need for any analgesia (incl. general)	3	2118	Relative Risk (Fixed) 95% CI	1.09 [1.01, 1.18]
08 Epidural analgesia	9	17630	Relative Risk (Fixed) 95% CI	1.00 [0.90, 1.12]
09 Use of pharmacological analgesia during labour	4	1677	Relative Risk (Random) 95% CI	1.00 [0.93, 1.08]
12 Fetal blood sampling	2	13929	Relative Risk (Fixed) 95% CI	1.24 [1.03, 1.49]
13 Oxytocin during 1st and/or 2nd stage of labour	6	3683	Relative Risk (Random) 95% CI	1.08 [0.87, 1.35]
20 Apgar score < 7 at 5 minutes	5	4037	Relative Risk (Fixed) 95% CI	0.97 [0.72, 1.31]
21 Apgar score < 4 at 5 minutes	4	1919	Relative Risk (Fixed) 95% CI	1.43 [0.61, 3.34]
22 Cord blood acidosis	2	2494	Relative Risk (Random) 95% CI	0.92 [0.27, 3.11]
23 Neonatal ICU admissions	10	33067	Relative Risk (Fixed) 95% CI	1.01 [0.93, 1.10]
24 Length of stay on NICU	1	206	Weighted Mean Difference (Fixed) 95% CI	0.20 [-1.17, 1.57]
25 Hypoxic ischaemic encephalopathy	1	1428	Relative Risk (Fixed) 95% CI	0.46 [0.04, 5.03]
26 Neonatal seizures	10	32386	Relative Risk (Fixed) 95% CI	0.50 [0.31, 0.80]
27 Perinatal death	12	33513	Relative Risk (Fixed) 95% CI	0.85 [0.59, 1.23]
28 Neurodevelopmental dissability at at least 12 months of age	1	173	Relative Risk (Fixed) 95% CI	3.88 [0.83, 18.17]

29 Cerebral palsy (CP)	2	13252	Relative Risk (Fixed) 95% CI	1.74 [0.97, 3.11]
30 Damage/infection from scalp electrode or scalp sampling	2	665	Relative Risk (Fixed) 95% CI	2.99 [0.31, 28.61]

Comparison 02. Continuous CTG versus intermittent ausculatation (low risk)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Caesarean section	1	927	Relative Risk (Fixed) 95% CI	1.95 [0.91, 4.18]
02 Caesarean section for abnormal FHR pattern and/or acidosis	2	15545	Relative Risk (Fixed) 95% CI	2.31 [1.49, 3.59]
03 Instrumental vaginal birth	1	927	Relative Risk (Fixed) 95% CI	1.29 [1.02, 1.62]
05 Spontaneous vaginal birth not achieved	1	927	Relative Risk (Fixed) 95% CI	1.35 [1.09, 1.67]
23 Neonatal ICU admissions	2	15545	Relative Risk (Fixed) 95% CI	1.37 [1.01, 1.87]
26 Neonatal seizures	2	24671	Relative Risk (Fixed) 95% CI	0.36 [0.16, 0.81]
27 Perinatal death	2	15545	Relative Risk (Fixed) 95% CI	1.02 [0.31, 3.31]

Comparison 03. Continuous CTG versus intermittent auscultation (high risk)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Caesarean section	6	1969	Relative Risk (Fixed) 95% CI	2.02 [1.58, 2.57]
02 Caesarean section for abnormal FHR pattern and/or acidosis	6	1969	Odds Ratio (Fixed) 95% CI	2.46 [1.69, 3.59]
03 Instrumental vaginal birth	5	1723	Relative Risk (Random) 95% CI	1.03 [0.85, 1.26]
05 Spontaneous vaginal birth not achieved	6	1969	Relative Risk (Random) 95% CI	1.33 [1.11, 1.59]
07 Need for any analgesia (incl. general)	2	690	Relative Risk (Fixed) 95% CI	1.06 [1.00, 1.12]
08 Epidural analgesia	5	1769	Relative Risk (Fixed) 95% CI	0.96 [0.82, 1.12]
09 Use of pharmacological analgesia during labour	1	483	Relative Risk (Fixed) 95% CI	0.94 [0.85, 1.03]
13 Oxytocin during 1st and/or 2nd stage of labour	4	1286	Relative Risk (Fixed) 95% CI	0.99 [0.87, 1.13]
20 Apgar score < 7 at 5 minutes	1	200	Relative Risk (Fixed) 95% CI	0.75 [0.33, 1.70]
21 Apgar score < 4 at 5 minutes	3	941	Relative Risk (Fixed) 95% CI	1.65 [0.67, 4.07]
23 Neonatal ICU admissions	4	1528	Relative Risk (Random) 95% CI	0.80 [0.48, 1.33]
26 Neonatal seizures	6	4805	Relative Risk (Fixed) 95% CI	0.66 [0.36, 1.22]
27 Perinatal death	6	1974	Relative Risk (Fixed) 95% CI	1.02 [0.61, 1.71]
28 Neurodevelopmental dissability at at least 12 months of age	1	173	Relative Risk (Fixed) 95% CI	3.88 [0.83, 18.17]
29 Cerebral palsy (CP)	1	173	Relative Risk (Fixed) 95% CI	2.54 [1.10, 5.86]
30 Damage/infection from scalp electrode or scalp sampling	2	665	Relative Risk (Fixed) 95% CI	2.99 [0.31, 28.61]

Comparison 04. Continuous CTG versus intermittent auscultation (preterm)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Caesarean section	1	246	Relative Risk (Fixed) 95% CI	1.02 [0.57, 1.82]
02 Caesarean section for abnormal FHR pattern and/or acidosis	1	246	Relative Risk (Fixed) 95% CI	1.45 [0.57, 3.69]
05 Spontaneous vaginal birth not achieved	1	246	Relative Risk (Fixed) 95% CI	1.28 [0.83, 1.99]
08 Epidural analgesia	1	246	Relative Risk (Fixed) 95% CI	1.07 [0.81, 1.42]
13 Oxytocin during 1st and/or 2nd stage of labour	1	246	Relative Risk (Fixed) 95% CI	0.83 [0.60, 1.16]
20 Apgar score < 4 at 5 minutes	1	246	Relative Risk (Fixed) 95% CI	2.29 [0.72, 7.23]
26 Neonatal seizures	1	246	Relative Risk (Fixed) 95% CI	1.02 [0.37, 2.81]
27 Perinatal death	1	246	Relative Risk (Fixed) 95% CI	0.96 [0.52, 1.77]
28 Neurodevelopmental dissability at at least 12 months of age	1	173	Relative Risk (Fixed) 95% CI	3.88 [0.83, 18.17]
29 Cerebral palsy (CP)	1	173	Relative Risk (Fixed) 95% CI	2.54 [1.10, 5.86]

Comparison 05. Continuous CTG versus intermittent CTG

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Caesarean section	1	4044	Relative Risk (Fixed) 95% CI	1.29 [0.84, 1.97]
02 Caesarean section for abnormal FHR pattern and/or acidosis	1	4044	Relative Risk (Fixed) 95% CI	1.19 [0.66, 2.15]
03 Instrumental vaginal birth	1	4044	Relative Risk (Fixed) 95% CI	1.16 [0.92, 1.46]
05 Spontaneous vaginal birth not achieved	1	4044	Relative Risk (Fixed) 95% CI	1.19 [0.97, 1.45]
08 Epidural analgesia	1	4044	Relative Risk (Fixed) 95% CI	1.06 [0.92, 1.21]
20 Apgar score < 7 at 5 minutes	1	4044	Relative Risk (Fixed) 95% CI	2.65 [0.70, 9.97]
22 Cord blood acidosis	1	4044	Relative Risk (Fixed) 95% CI	1.43 [0.95, 2.14]
23 Neonatal ICU admissions	1	4044	Relative Risk (Fixed) 95% CI	1.34 [0.91, 1.98]

Comparison 06. Continuous CTG versus IA (high quality versus rest)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Caesarean section	10	18761	Relative Risk (Random) 95% CI	1.65 [1.28, 2.13]
02 Neonatal seizures	9	32386	Relative Risk (Fixed) 95% CI	0.50 [0.31, 0.80]

Comparison 07. Continuous CTG versus IA (high risk versus low risk)

Outcome title	No. of studies	No. of participants	Statistical method	Effect size
01 Caesarean section	6	2896	Relative Risk (Fixed) 95% CI	2.01 [1.60, 2.53]
02 Neonatal seizures	7	29476	Relative Risk (Fixed) 95% CI	0.52 [0.32, 0.85]

INDEX TERMS

Medical Subject Headings (MeSH)

Cardiotocography [*methods]; Cesarean Section [statistics & numerical data]; Heart Auscultation [*methods]; Infant, Newborn; Infant Mortality; *Labor, Obstetric; Randomized Controlled Trials

MeSH check words

Female; Humans; Pregnancy

COVER SHEET

Title	Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour
Authors	Alfirevic Z, Devane D, Gyte GML
Contribution of author(s)	Zarko Alfirevic (ZA) drafted the protocol. Declan Devane (DD) and Gill Gyte (GG) commented on all its sections. ZA and GG assessed studies in respect of inclusion and exclusion criteria. DD ran additional searches. ZA and DD extracted the data independently and double entered them into Review Manager. GG extracted additional descriptive information from included studies. All three authors wrote and agreed the final version of the review.
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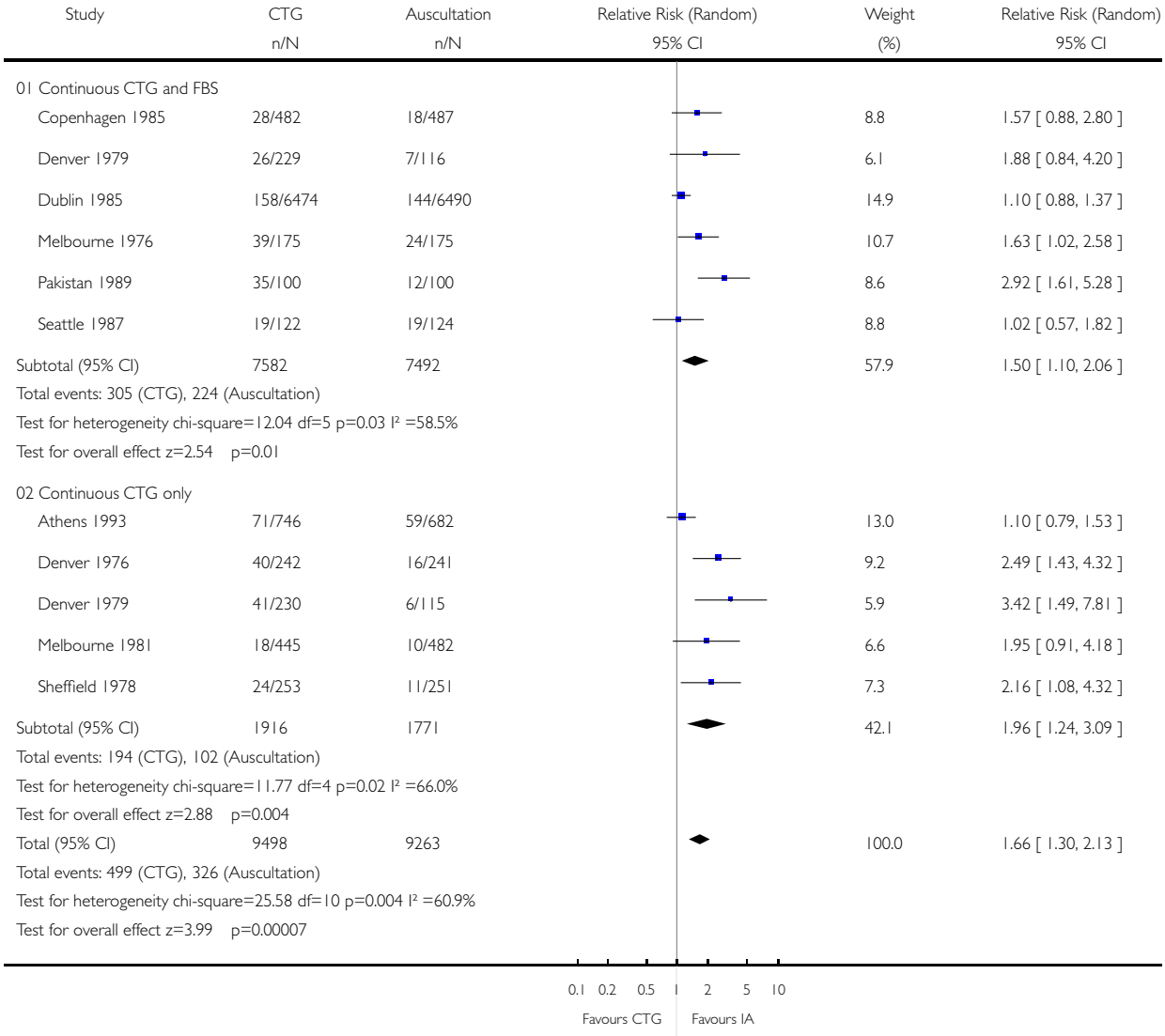
Analysis 01.01. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 01 Caesarean section

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 01 Caesarean section



Analysis 01.02. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 02 Caesarean section for abnormal FHR pattern and/or acidosis

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 02 Caesarean section for abnormal FHR pattern and/or acidosis

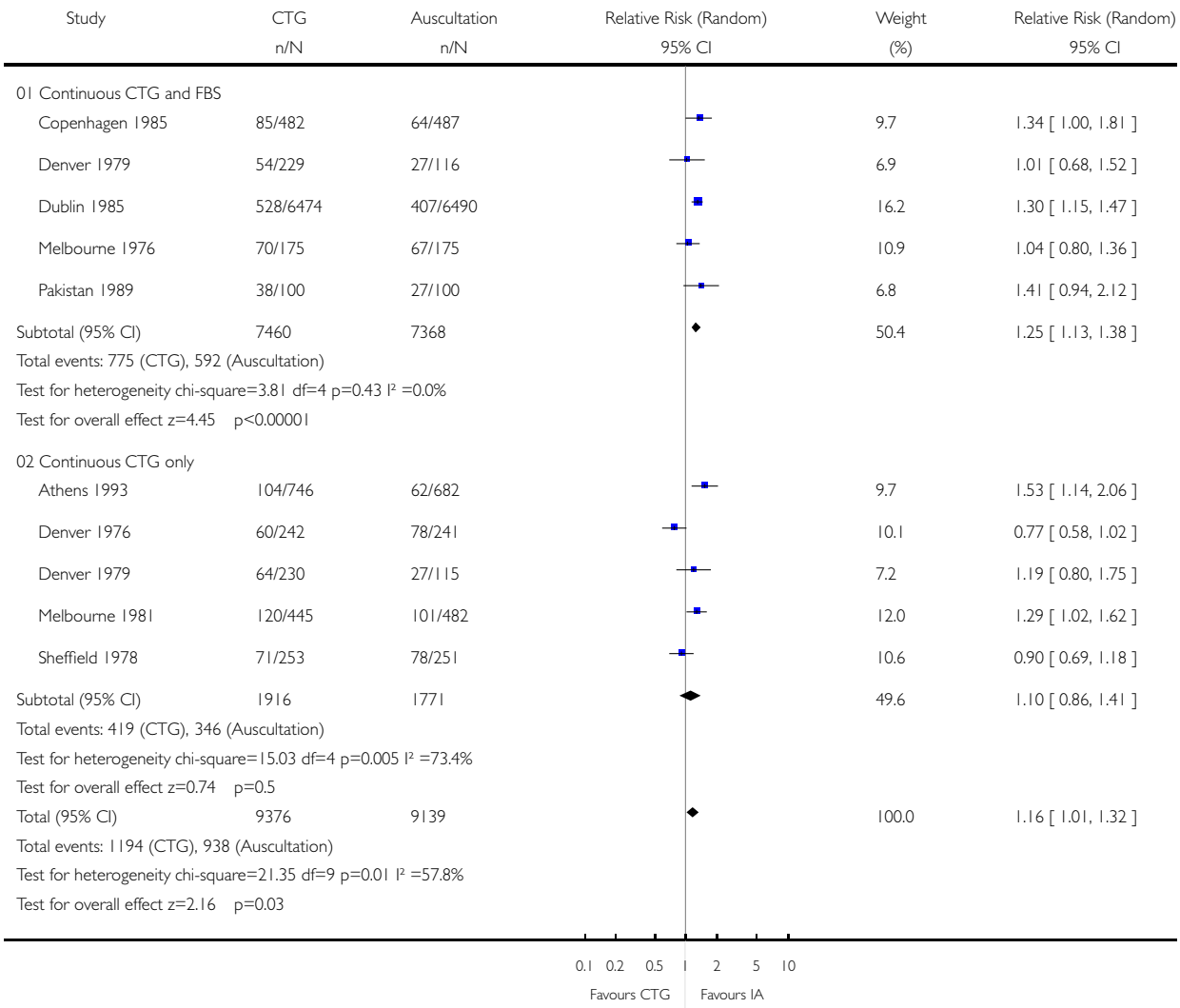
Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Copenhagen 1985	8/482	7/487		7.1	1.15 [0.42, 3.16]
Denver 1979	8/229	1/116		1.4	4.05 [0.51, 32.01]
Dublin 1985	25/6474	10/6490		10.2	2.51 [1.20, 5.21]
Melbourne 1976	28/175	14/175		14.3	2.00 [1.09, 3.67]
Pakistan 1989	19/100	7/100		7.1	2.71 [1.19, 6.17]
Seattle 1987	10/122	7/124		7.1	1.45 [0.57, 3.69]
Subtotal (95% CI)	7582	7492		47.2	2.07 [1.47, 2.91]
Total events: 98 (CTG), 46 (Auscultation)					
Test for heterogeneity chi-square=2.94 df=5 p=0.71 I^2 =0.0%					
Test for overall effect z=4.16 p=0.00003					
02 Continuous CTG only					
Athens 1993	40/746	16/682		17.1	2.29 [1.29, 4.04]
Dallas 1986	64/7288	28/7330		28.5	2.30 [1.48, 3.58]
Denver 1976	18/242	3/241		3.1	5.98 [1.78, 20.02]
Denver 1979	16/230	0/115		0.7	16.57 [1.00, 273.78]
Melbourne 1981	1/445	0/482		0.5	3.25 [0.13, 79.55]
Sheffield 1978	4/253	3/251		3.1	1.32 [0.30, 5.85]
Subtotal (95% CI)	9204	9101		52.8	2.64 [1.92, 3.64]
Total events: 143 (CTG), 50 (Auscultation)					
Test for heterogeneity chi-square=4.87 df=5 p=0.43 I^2 =0.0%					
Test for overall effect z=5.94 p<0.00001					
Total (95% CI)	16786	16593		100.0	2.37 [1.88, 3.00]
Total events: 241 (CTG), 96 (Auscultation)					
Test for heterogeneity chi-square=8.47 df=11 p=0.67 I^2 =0.0%					
Test for overall effect z=7.24 p<0.00001					

Analysis 01.03. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 03 Instrumental vaginal birth

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 03 Instrumental vaginal birth



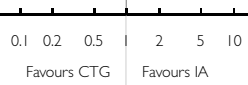
Analysis 01.04. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 04 Instrumental vaginal birth for abnormal CTG or fetal acidosis

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 04 Instrumental vaginal birth for abnormal CTG or fetal acidosis

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Dublin 1985	190/6474	75/6490		100.0	2.54 [1.95, 3.31]
Subtotal (95% CI)	6474	6490		100.0	2.54 [1.95, 3.31]
Total events: 190 (CTG), 75 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=6.89 p<0.00001					
02 Continuous CTG only					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
Total (95% CI)	6474	6490		100.0	2.54 [1.95, 3.31]
Total events: 190 (CTG), 75 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=6.89 p<0.00001					



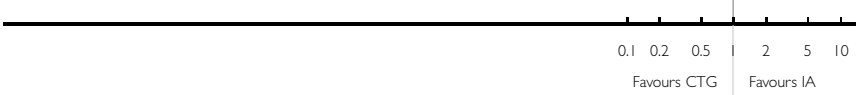
Analysis 01.05. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 05 Spontaneous vaginal birth not achieved

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 05 Spontaneous vaginal birth not achieved

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Copenhagen 1985	113/482	82/487		6.3	1.39 [1.08, 1.80]
Denver 1979	80/229	34/116		3.5	1.19 [0.85, 1.66]
Dublin 1985	686/6474	551/6490		42.5	1.25 [1.12, 1.39]
Melbourne 1976	109/175	91/175		7.0	1.20 [1.00, 1.44]
Pakistan 1989	73/100	39/100		3.0	1.87 [1.43, 2.46]
Seattle 1987	34/122	27/124		2.1	1.28 [0.83, 1.99]
Subtotal (95% CI)	7582	7492		64.4	1.28 [1.18, 1.39]
Total events: 1095 (CTG), 824 (Auscultation)					
Test for heterogeneity chi-square=8.75 df=5 p=0.12 I^2 =42.9%					
Test for overall effect z=6.03 p<0.00001					
02 Continuous CTG only					
Athens 1993	175/746	121/682		9.8	1.32 [1.07, 1.63]
Denver 1976	100/242	94/241		7.3	1.06 [0.85, 1.32]
Denver 1979	105/230	33/115		3.4	1.59 [1.15, 2.19]
Melbourne 1981	138/445	111/482		8.2	1.35 [1.09, 1.67]
Sheffield 1978	95/253	89/251		6.9	1.06 [0.84, 1.33]
Subtotal (95% CI)	1916	1771		35.6	1.25 [1.13, 1.38]
Total events: 613 (CTG), 448 (Auscultation)					
Test for heterogeneity chi-square=7.11 df=4 p=0.13 I^2 =43.8%					
Test for overall effect z=4.22 p=0.00002					
Total (95% CI)	9498	9263		100.0	1.27 [1.19, 1.36]
Total events: 1708 (CTG), 1272 (Auscultation)					
Test for heterogeneity chi-square=16.29 df=10 p=0.09 I^2 =38.6%					
Test for overall effect z=7.36 p<0.00001					

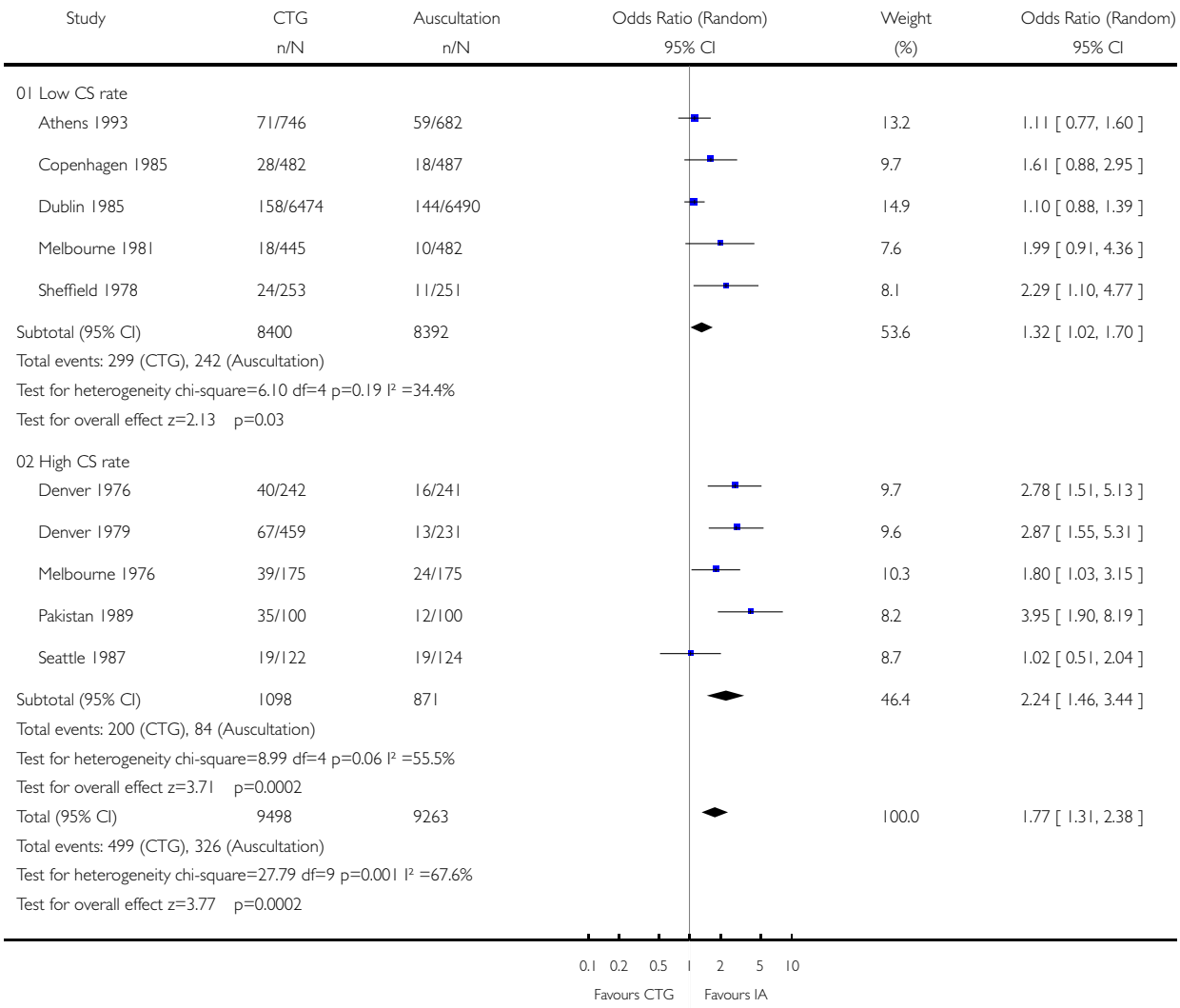


Analysis 01.06. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 06 CS low CS versus high CS (post hoc)

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 06 CS low CS versus high CS (post hoc)



Analysis 01.07. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 07 Need for any analgesia (incl. general)

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 07 Need for any analgesia (incl. general)

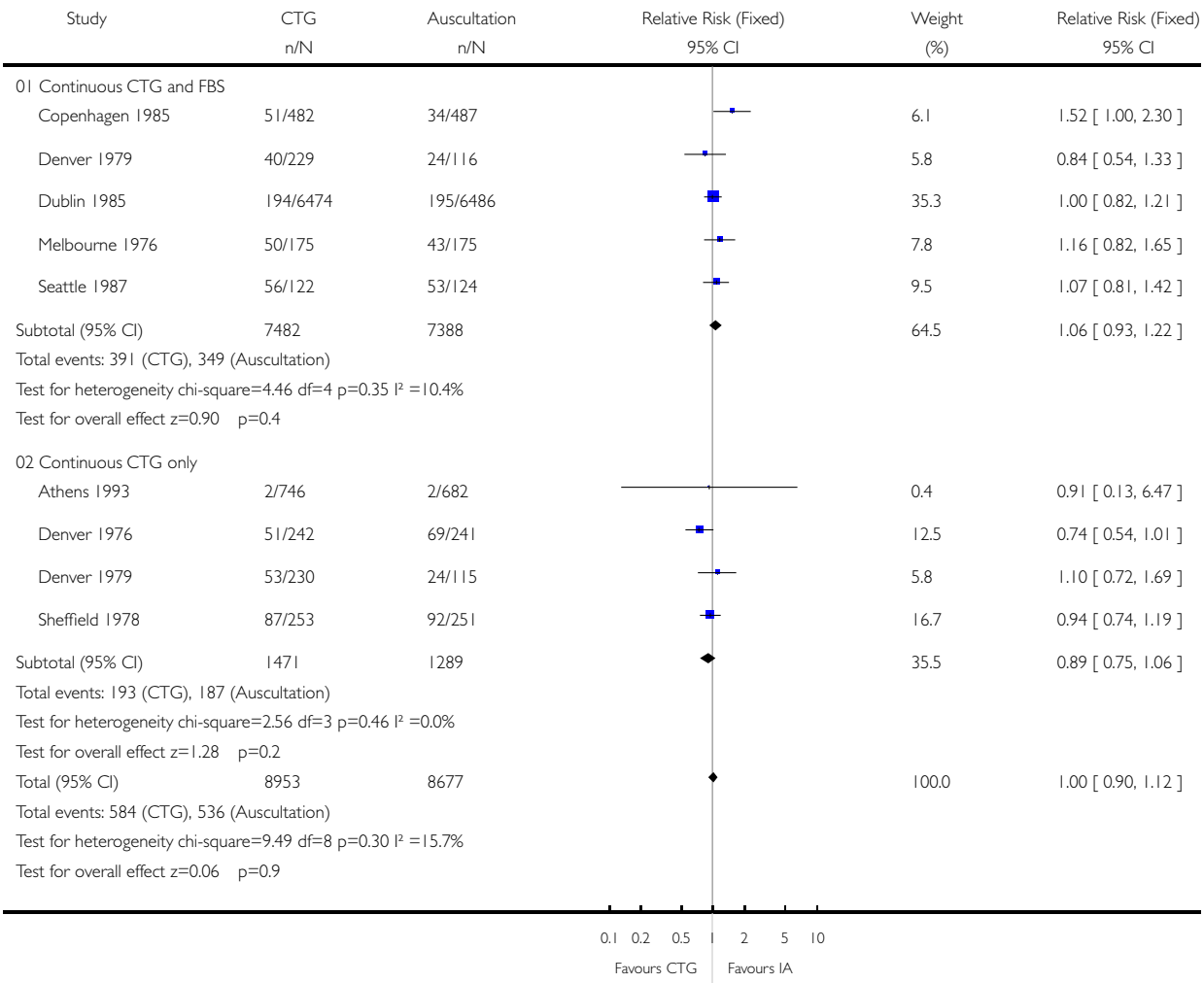
Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Denver 1979	211/229	101/116		40.0	1.06 [0.98, 1.15]
Subtotal (95% CI)	229	116		40.0	1.06 [0.98, 1.15]
Total events: 211 (CTG), 101 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.39 p=0.2					
02 Continuous CTG only					
Athens 1993	87/746	65/682		20.3	1.22 [0.90, 1.66]
Denver 1979	213/230	100/115		39.8	1.07 [0.98, 1.15]
Subtotal (95% CI)	976	797		60.0	1.12 [0.99, 1.26]
Total events: 300 (CTG), 165 (Auscultation)					
Test for heterogeneity chi-square=1.79 df=1 p=0.18 I^2 =44.2%					
Test for overall effect z=1.84 p=0.07					
Total (95% CI)	1205	913		100.0	1.09 [1.01, 1.18]
Total events: 511 (CTG), 266 (Auscultation)					
Test for heterogeneity chi-square=1.65 df=2 p=0.44 I^2 =0.0%					
Test for overall effect z=2.25 p=0.02					

Analysis 01.08. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 08 Epidural analgesia

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 08 Epidural analgesia



Analysis 01.09. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 09 Use of pharmacological analgesia during labour

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 09 Use of pharmacological analgesia during labour

Study	CTG n/N	Auscultation n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 Continuous CTG and FBS					
Denver 1979	209/229	100/116		28.8	1.06 [0.97, 1.15]
Subtotal (95% CI)	229	116		28.8	1.06 [0.97, 1.15]
Total events: 209 (CTG), 100 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.35 p=0.2					
02 Continuous CTG only					
Denver 1976	183/242	194/241		26.1	0.94 [0.85, 1.03]
Denver 1979	209/230	99/115		28.6	1.06 [0.97, 1.15]
Sheffield 1978	141/253	152/251		16.5	0.92 [0.79, 1.07]
Subtotal (95% CI)	725	607		71.2	0.98 [0.89, 1.08]
Total events: 533 (CTG), 445 (Auscultation)					
Test for heterogeneity chi-square=5.05 df=2 p=0.08 I^2 =60.4%					
Test for overall effect z=0.44 p=0.7					
Total (95% CI)	954	723		100.0	1.00 [0.93, 1.08]
Total events: 742 (CTG), 545 (Auscultation)					
Test for heterogeneity chi-square=7.21 df=3 p=0.07 I^2 =58.4%					
Test for overall effect z=0.05 p=1					

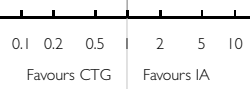
Analysis 01.12. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 12 Fetal blood sampling

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 12 Fetal blood sampling

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Copenhagen 1985	3/482	2/487		1.0	1.52 [0.25, 9.03]
Dublin 1985	240/6474	194/6486		99.0	1.24 [1.03, 1.49]
Subtotal (95% CI)	6956	6973		100.0	1.24 [1.03, 1.49]
Total events: 243 (CTG), 196 (Auscultation)					
Test for heterogeneity chi-square=0.05 df=1 p=0.83 I^2 =0.0%					
Test for overall effect z=2.30 p=0.02					
02 Continuous CTG only					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
Total (95% CI)	6956	6973		100.0	1.24 [1.03, 1.49]
Total events: 243 (CTG), 196 (Auscultation)					
Test for heterogeneity chi-square=0.05 df=1 p=0.83 I^2 =0.0%					
Test for overall effect z=2.30 p=0.02					



Analysis 01.13. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 13 Oxytocin during 1st and/or 2nd stage of labour

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 13 Oxytocin during 1st and/or 2nd stage of labour

Study	CTG n/N	Auscultation n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 Continuous CTG and FBS					
Copenhagen 1985	194/482	195/487		19.1	1.01 [0.86, 1.17]
Denver 1979	76/229	32/116		13.8	1.20 [0.85, 1.70]
Melbourne 1976	109/175	110/175		18.9	0.99 [0.84, 1.17]
Seattle 1987	41/122	50/124		14.3	0.83 [0.60, 1.16]
Subtotal (95% CI)	1008	902		66.3	1.00 [0.90, 1.10]
Total events: 420 (CTG), 387 (Auscultation)					
Test for heterogeneity chi-square=2.29 df=3 p=0.52 I^2 =0.0%					
Test for overall effect z=0.06 p=1					
02 Continuous CTG only					
Athens 1993	508/746	308/682		20.3	1.51 [1.37, 1.66]
Denver 1979	63/230	32/115		13.4	0.98 [0.69, 1.41]
Subtotal (95% CI)	976	797		33.7	1.26 [0.83, 1.91]
Total events: 571 (CTG), 340 (Auscultation)					
Test for heterogeneity chi-square=5.06 df=1 p=0.02 I^2 =80.2%					
Test for overall effect z=1.11 p=0.3					
Total (95% CI)	1984	1699		100.0	1.08 [0.87, 1.35]
Total events: 991 (CTG), 727 (Auscultation)					
Test for heterogeneity chi-square=37.64 df=5 p=<0.0001 I^2 =86.7%					
Test for overall effect z=0.71 p=0.5					

Analysis 01.20. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 20 Apgar score < 7 at 5 minutes

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 20 Apgar score < 7 at 5 minutes

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Copenhagen 1985	0/485	2/493		3.0	0.20 [0.01, 4.22]
Pakistan 1989	9/100	12/100		14.5	0.75 [0.33, 1.70]
Subtotal (95% CI)	585	593		17.5	0.66 [0.30, 1.43]
Total events: 9 (CTG), 14 (Auscultation)					
Test for heterogeneity chi-square=0.68 df=1 p=0.41 I^2 =0.0%					
Test for overall effect z=1.06 p=0.3					
02 Continuous CTG only					
Athens 1993	31/746	26/682		32.9	1.09 [0.65, 1.82]
Melbourne 1981	39/445	40/482		46.5	1.06 [0.69, 1.61]
Sheffield 1978	0/253	2/251		3.0	0.20 [0.01, 4.11]
Subtotal (95% CI)	1444	1415		82.5	1.04 [0.75, 1.43]
Total events: 70 (CTG), 68 (Auscultation)					
Test for heterogeneity chi-square=1.19 df=2 p=0.55 I^2 =0.0%					
Test for overall effect z=0.23 p=0.8					
Total (95% CI)	2029	2008		100.0	0.97 [0.72, 1.31]
Total events: 79 (CTG), 82 (Auscultation)					
Test for heterogeneity chi-square=2.81 df=4 p=0.59 I^2 =0.0%					
Test for overall effect z=0.19 p=0.8					

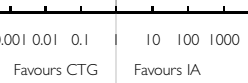
Analysis 01.21. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 21 Apgar score < 4 at 5 minutes

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 21 Apgar score < 4 at 5 minutes

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Copenhagen 1985	0/485	1/493		16.9	0.34 [0.01, 8.30]
Denver 1979	0/230	1/116		22.7	0.17 [0.01, 4.11]
Seattle 1987	9/122	4/124		45.2	2.29 [0.72, 7.23]
Subtotal (95% CI)	837	733		84.8	1.33 [0.53, 3.33]
Total events: 9 (CTG), 6 (Auscultation)					
Test for heterogeneity chi-square=3.16 df=2 p=0.21 I^2 =36.7%					
Test for overall effect z=0.61 p=0.5					
02 Continuous CTG only					
Denver 1979	4/233	1/116		15.2	1.99 [0.23, 17.62]
Subtotal (95% CI)	233	116		15.2	1.99 [0.23, 17.62]
Total events: 4 (CTG), 1 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.62 p=0.5					
Total (95% CI)	1070	849		100.0	1.43 [0.61, 3.34]
Total events: 13 (CTG), 7 (Auscultation)					
Test for heterogeneity chi-square=3.23 df=3 p=0.36 I^2 =7.0%					
Test for overall effect z=0.83 p=0.4					



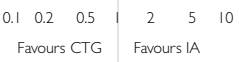
Analysis 01.22. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 22 Cord blood acidosis

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 22 Cord blood acidosis

Study	CTG n/N	Auscultation n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 Continuous CTG and FBS					
Dublin 1985	5/540	11/535		43.6	0.45 [0.16, 1.29]
Subtotal (95% CI)	540	535		43.6	0.45 [0.16, 1.29]
Total events: 5 (CTG), 11 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.49 p=0.1					
02 Continuous CTG only					
Athens 1993	31/739	18/680		56.4	1.58 [0.89, 2.81]
Subtotal (95% CI)	739	680		56.4	1.58 [0.89, 2.81]
Total events: 31 (CTG), 18 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.58 p=0.1					
Total (95% CI)	1279	1215		100.0	0.92 [0.27, 3.11]
Total events: 36 (CTG), 29 (Auscultation)					
Test for heterogeneity chi-square=4.26 df=1 p=0.04 I^2 =76.5%					
Test for overall effect z=0.14 p=0.9					

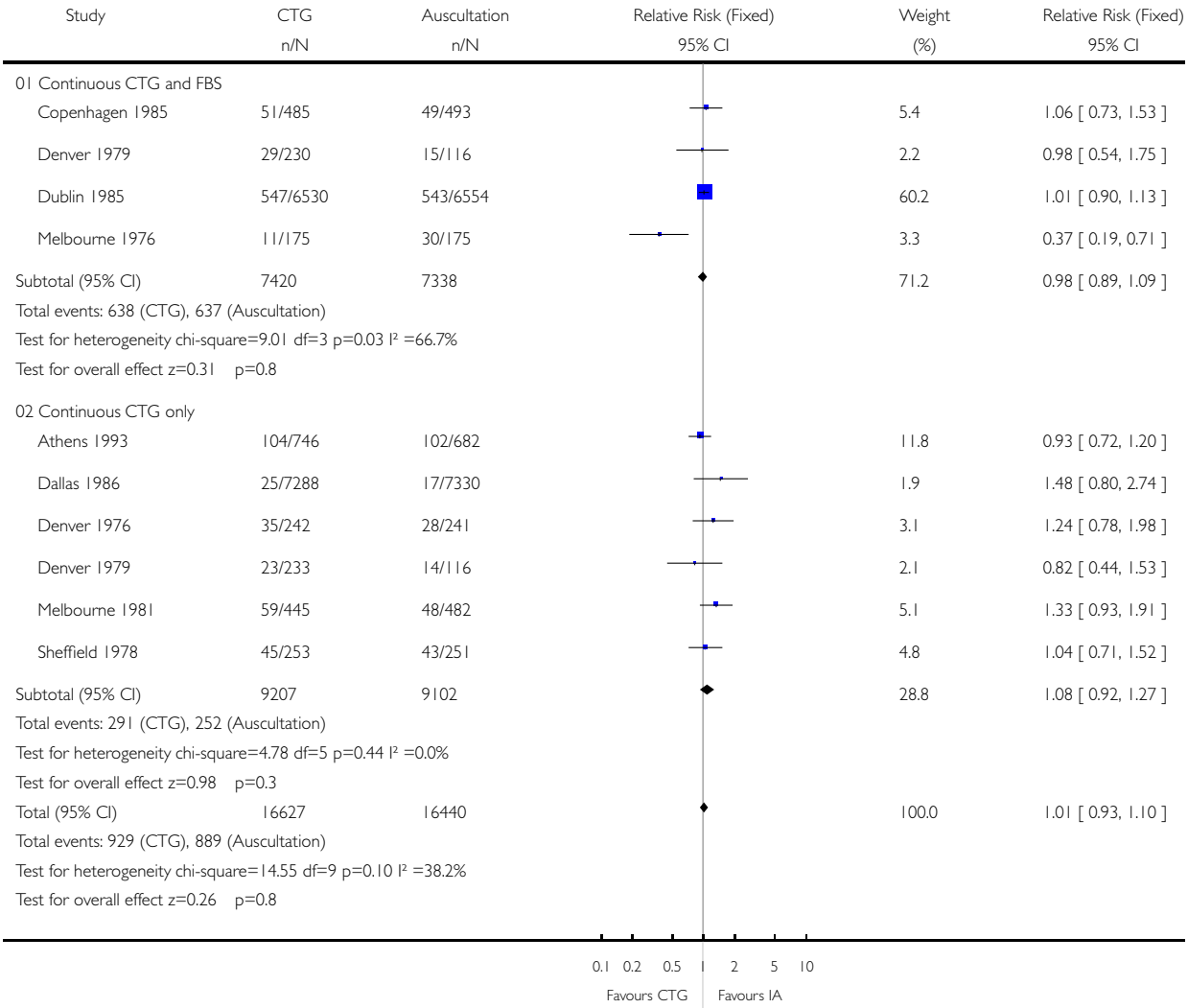


Analysis 01.23. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 23 Neonatal ICU admissions

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 23 Neonatal ICU admissions



Analysis 01.24. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 24 Length of stay on NICU

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 24 Length of stay on NICU

Study	CTG N	CTG Mean(SD)	Auscultation N	Auscultation Mean(SD)	Weighted Mean Difference (Fixed) 95% CI	Weight (%)	Weighted Mean Difference (Fixed) 95% CI
01 Continuous CTG and FBS							
Subtotal (95% CI)	0		0			0.0	Not estimable
Test for heterogeneity: not applicable							
Test for overall effect: not applicable							
02 Continuous CTG only							
Athens 1993	104	5.20 (5.00)	102	5.00 (5.00)		100.0	0.20 [-1.17, 1.57]
Subtotal (95% CI)	104		102			100.0	0.20 [-1.17, 1.57]
Test for heterogeneity: not applicable							
Test for overall effect z=0.29 p=0.8							
Total (95% CI)	104		102			100.0	0.20 [-1.17, 1.57]
Test for heterogeneity: not applicable							
Test for overall effect z=0.29 p=0.8							

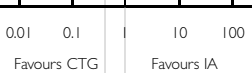
Analysis 01.25. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 25 Hypoxic ischaemic encephalopathy

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 25 Hypoxic ischaemic encephalopathy

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
02 Continuous CTG only					
Athens 1993	1/746	2/682		100.0	0.46 [0.04, 5.03]
Subtotal (95% CI)	746	682		100.0	0.46 [0.04, 5.03]
Total events: 1 (CTG), 2 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.64 p=0.5					



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Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
Total (95% CI)	746	682		100.0	0.46 [0.04, 5.03]
Total events: 1 (CTG), 2 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.64 p=0.5					

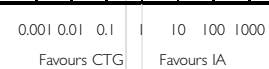
Analysis 01.26. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 26 Neonatal seizures

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 26 Neonatal seizures

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
× Copenhagen 1985	0/485	0/493		0.0	Not estimable
Denver 1979	0/230	1/116		3.9	0.17 [0.01, 4.11]
Dublin 1985	12/6530	27/6554		53.0	0.45 [0.23, 0.88]
Melbourne 1976	0/175	4/175		8.9	0.11 [0.01, 2.05]
Seattle 1987	7/122	7/124		13.7	1.02 [0.37, 2.81]
Subtotal (95% CI)	7542	7462		79.4	0.49 [0.29, 0.84]
Total events: 19 (CTG), 39 (Auscultation)					
Test for heterogeneity chi-square=3.46 df=3 p=0.33 I^2 =13.4%					
Test for overall effect z=2.61 p=0.009					
02 Continuous CTG only					
Athens 1993	0/746	2/682		5.1	0.18 [0.01, 3.80]
Dallas 1986	1/7288	3/7330		5.9	0.34 [0.03, 3.22]
Denver 1976	2/242	2/241		3.9	1.00 [0.14, 7.01]
Denver 1979	2/233	1/116		2.6	1.00 [0.09, 10.87]
Sheffield 1978	0/253	1/251		3.0	0.33 [0.01, 8.08]
Subtotal (95% CI)	8762	8620		20.6	0.51 [0.18, 1.44]
Total events: 5 (CTG), 9 (Auscultation)					
Test for heterogeneity chi-square=1.40 df=4 p=0.84 I^2 =0.0%					
Test for overall effect z=1.28 p=0.2					



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Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
Total (95% CI)	16304	16082	◆	100.0	0.50 [0.31, 0.80]
Total events: 24 (CTG), 48 (Auscultation)					
Test for heterogeneity chi-square=4.86 df=8 p=0.77 I^2 =0.0%					
Test for overall effect z=2.91 p=0.004					

Analysis 01.27. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 27 Perinatal death

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 27 Perinatal death

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Copenhagen 1985	2/485	3/493		5.0	0.68 [0.11, 4.04]
Denver 1979	1/230	0/116		1.1	1.52 [0.06, 37.01]
Dublin 1985	14/6530	14/6554		23.5	1.00 [0.48, 2.10]
Melbourne 1976	1/175	1/175		1.7	1.00 [0.06, 15.86]
Pakistan 1989	4/100	5/100		8.4	0.80 [0.22, 2.89]
Seattle 1987	17/122	18/124		30.0	0.96 [0.52, 1.77]
Subtotal (95% CI)	7642	7562	◆	69.7	0.95 [0.62, 1.44]
Total events: 39 (CTG), 41 (Auscultation)					
Test for heterogeneity chi-square=0.31 df=5 p=1.00 I^2 =0.0%					
Test for overall effect z=0.26 p=0.8					
02 Continuous CTG only					
Athens 1993	2/746	9/682		15.8	0.20 [0.04, 0.94]
Dallas 1986	4/7288	5/7330		8.4	0.80 [0.22, 3.00]
Denver 1976	2/242	1/241		1.7	1.99 [0.18, 21.82]
Denver 1979	2/233	0/116		1.1	2.50 [0.12, 51.65]
Melbourne 1981	1/445	0/482		0.8	3.25 [0.13, 79.55]
Sheffield 1978	0/253	1/251		2.5	0.33 [0.01, 8.08]
Subtotal (95% CI)	9207	9102	◆	30.3	0.65 [0.31, 1.35]

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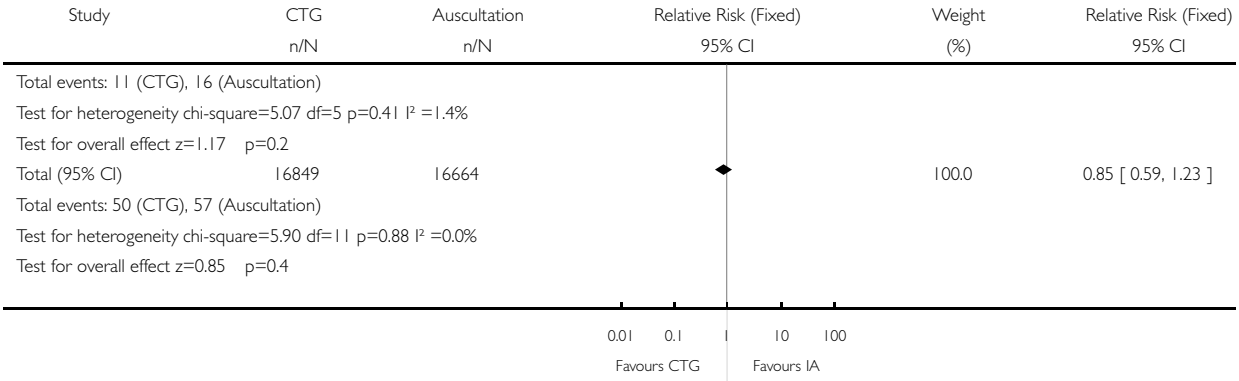
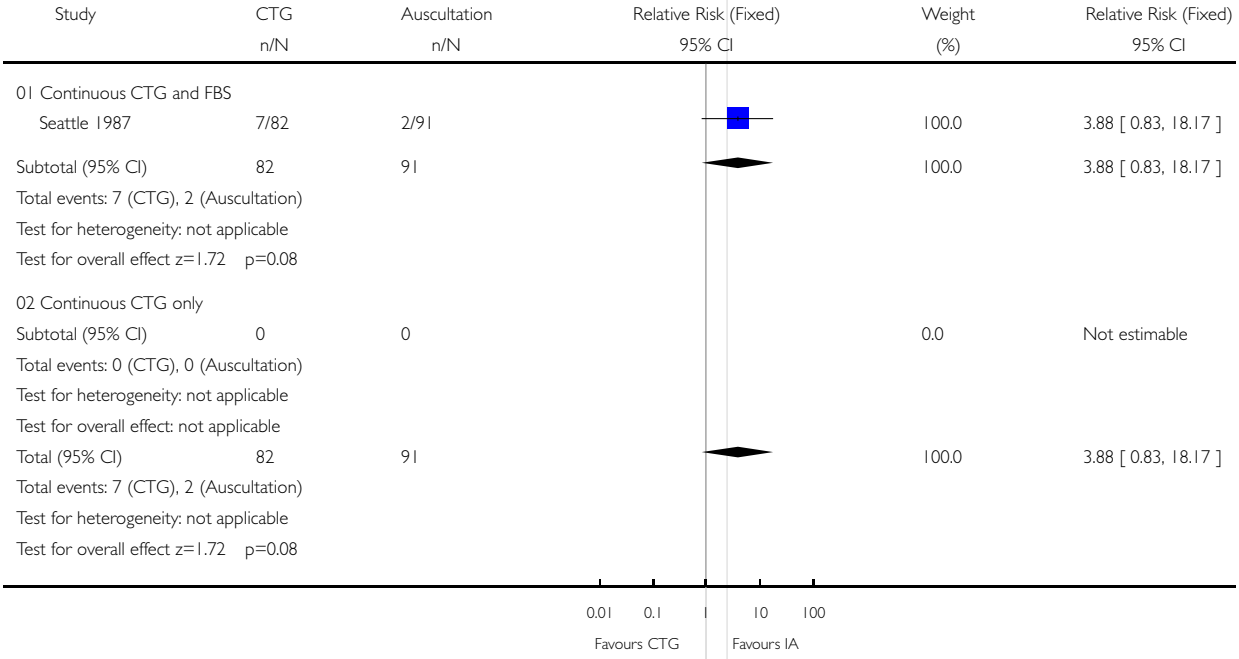


Analysis 01.28. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 28 Neurodevelopmental dissability at at least 12 months of age

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 28 Neurodevelopmental dissability at at least 12 months of age

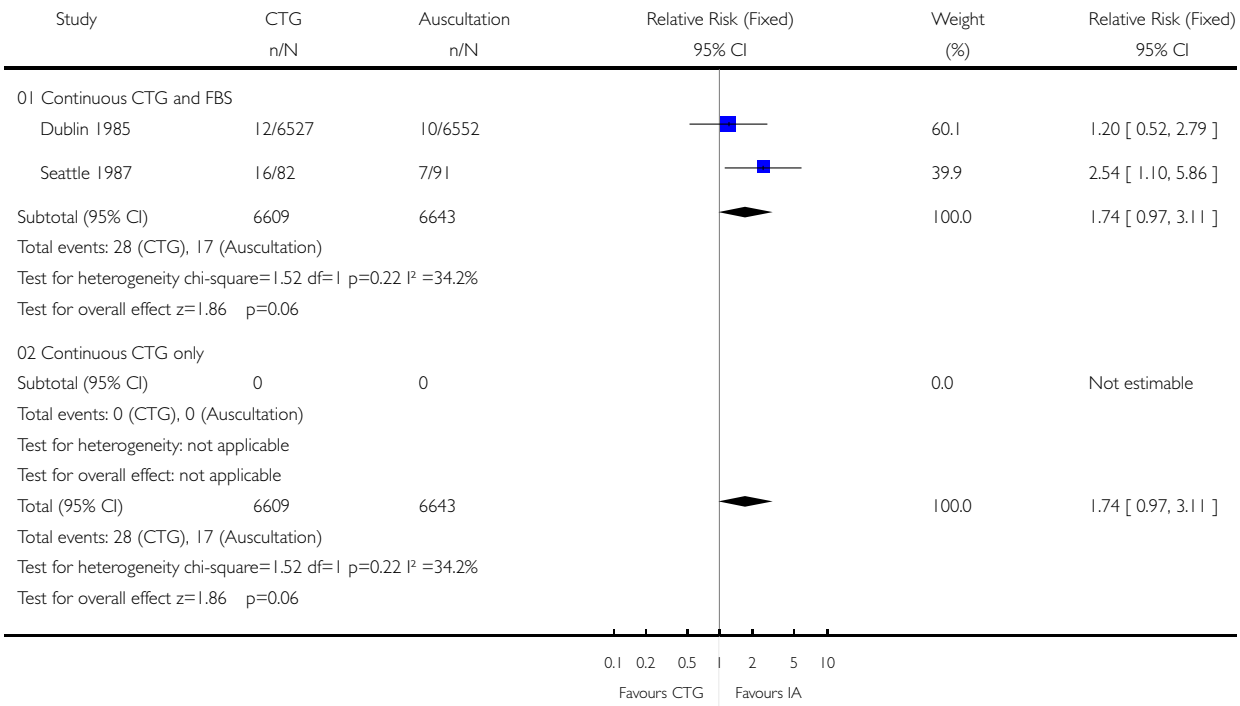


Analysis 01.29. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 29 Cerebral palsy (CP)

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 29 Cerebral palsy (CP)

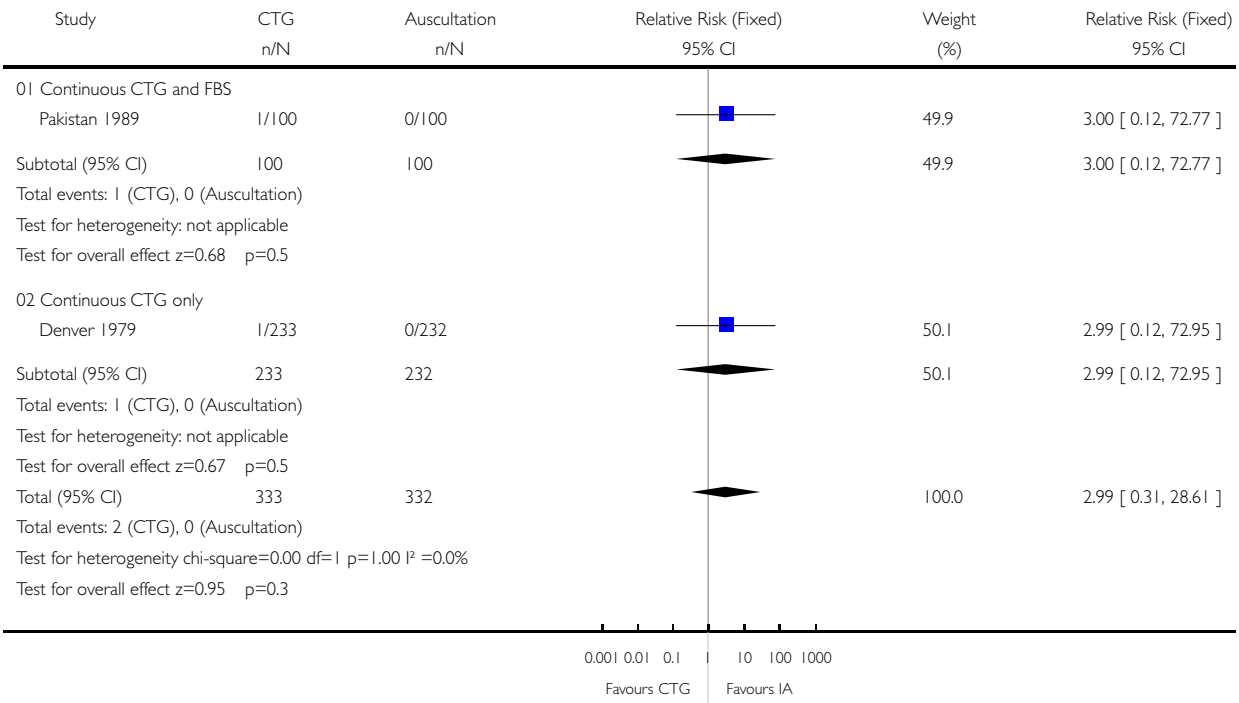


Analysis 01.30. Comparison 01 Continuous CTG versus intermittent auscultation (all), Outcome 30 Damage/infection from scalp electrode or scalp sampling

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 01 Continuous CTG versus intermittent auscultation (all)

Outcome: 30 Damage/infection from scalp electrode or scalp sampling



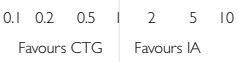
Analysis 02.01. Comparison 02 Continuous CTG versus intermittent ausculatation (low risk), Outcome 01 Caesarean section

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 02 Continuous CTG versus intermittent ausculatation (low risk)

Outcome: 01 Caesarean section

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
02 Continuous CTG only					
Melbourne 1981	18/445	10/482		100.0	1.95 [0.91, 4.18]
Subtotal (95% CI)	445	482		100.0	1.95 [0.91, 4.18]
Total events: 18 (CTG), 10 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.72 p=0.09					
Total (95% CI)	445	482		100.0	1.95 [0.91, 4.18]
Total events: 18 (CTG), 10 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.72 p=0.09					



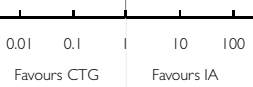
Analysis 02.02. Comparison 02 Continuous CTG versus intermittent ausculatation (low risk), Outcome 02 Caesarean section for abnormal FHR pattern and/or acidosis

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 02 Continuous CTG versus intermittent ausculatation (low risk)

Outcome: 02 Caesarean section for abnormal FHR pattern and/or acidosis

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
02 Continuous CTG only					
Dallas 1986	64/7288	28/7330		98.3	2.30 [1.48, 3.58]
Melbourne 1981	1/445	0/482		1.7	3.25 [0.13, 79.55]
Subtotal (95% CI)	7733	7812		100.0	2.31 [1.49, 3.59]
Total events: 65 (CTG), 28 (Auscultation)					
Test for heterogeneity chi-square=0.04 df=1 p=0.83 I^2 =0.0%					
Test for overall effect z=3.75 p=0.0002					
Total (95% CI)	7733	7812		100.0	2.31 [1.49, 3.59]
Total events: 65 (CTG), 28 (Auscultation)					
Test for heterogeneity chi-square=0.04 df=1 p=0.83 I^2 =0.0%					
Test for overall effect z=3.75 p=0.0002					



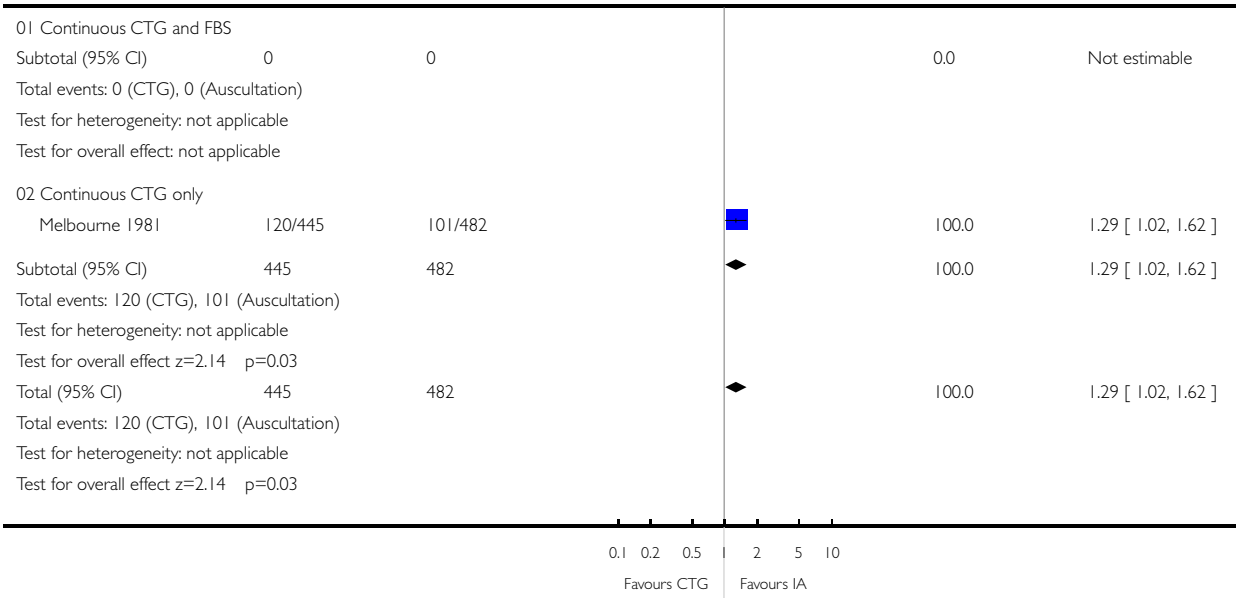
Analysis 02.03. Comparison 02 Continuous CTG versus intermittent ausculatation (low risk), Outcome 03 Instrumental vaginal birth

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 02 Continuous CTG versus intermittent ausculatation (low risk)

Outcome: 03 Instrumental vaginal birth

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
02 Continuous CTG only					
Melbourne 1981	120/445	101/482		100.0	1.29 [1.02, 1.62]
Subtotal (95% CI)	445	482		100.0	1.29 [1.02, 1.62]
Total events: 120 (CTG), 101 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=2.14 p=0.03					
Total (95% CI)	445	482		100.0	1.29 [1.02, 1.62]
Total events: 120 (CTG), 101 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=2.14 p=0.03					



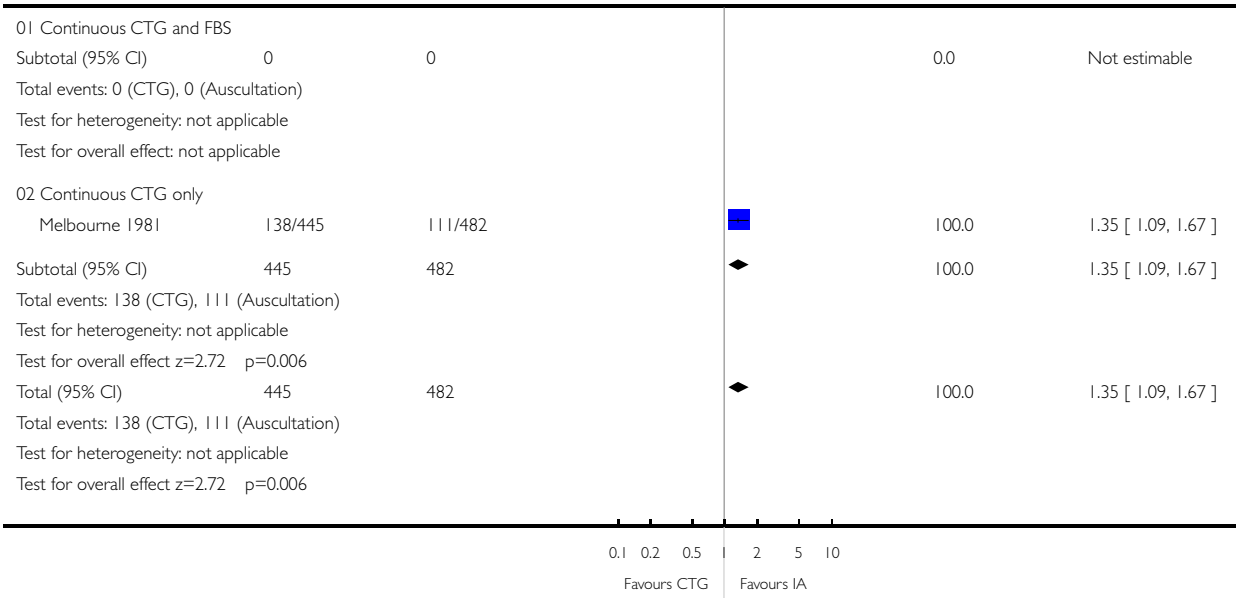
Analysis 02.05. Comparison 02 Continuous CTG versus intermittent ausculatation (low risk), Outcome 05 Spontaneous vaginal birth not achieved

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 02 Continuous CTG versus intermittent ausculatation (low risk)

Outcome: 05 Spontaneous vaginal birth not achieved

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
02 Continuous CTG only					
Melbourne 1981	138/445	111/482		100.0	1.35 [1.09, 1.67]
Subtotal (95% CI)	445	482		100.0	1.35 [1.09, 1.67]
Total events: 138 (CTG), 111 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=2.72 p=0.006					
Total (95% CI)	445	482		100.0	1.35 [1.09, 1.67]
Total events: 138 (CTG), 111 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=2.72 p=0.006					



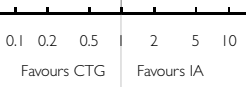
Analysis 02.23. Comparison 02 Continuous CTG versus intermittent ausculatation (low risk), Outcome 23 Neonatal ICU admissions

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 02 Continuous CTG versus intermittent ausculatation (low risk)

Outcome: 23 Neonatal ICU admissions

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
02 Continuous CTG only					
Dallas 1986	25/7288	17/7330		26.9	1.48 [0.80, 2.74]
Melbourne 1981	59/445	48/482		73.1	1.33 [0.93, 1.91]
Subtotal (95% CI)	7733	7812		100.0	1.37 [1.01, 1.87]
Total events: 84 (CTG), 65 (Auscultation)					
Test for heterogeneity chi-square=0.08 df=1 p=0.77 I^2 =0.0%					
Test for overall effect z=1.99 p=0.05					
Total (95% CI)	7733	7812		100.0	1.37 [1.01, 1.87]
Total events: 84 (CTG), 65 (Auscultation)					
Test for heterogeneity chi-square=0.08 df=1 p=0.77 I^2 =0.0%					
Test for overall effect z=1.99 p=0.05					

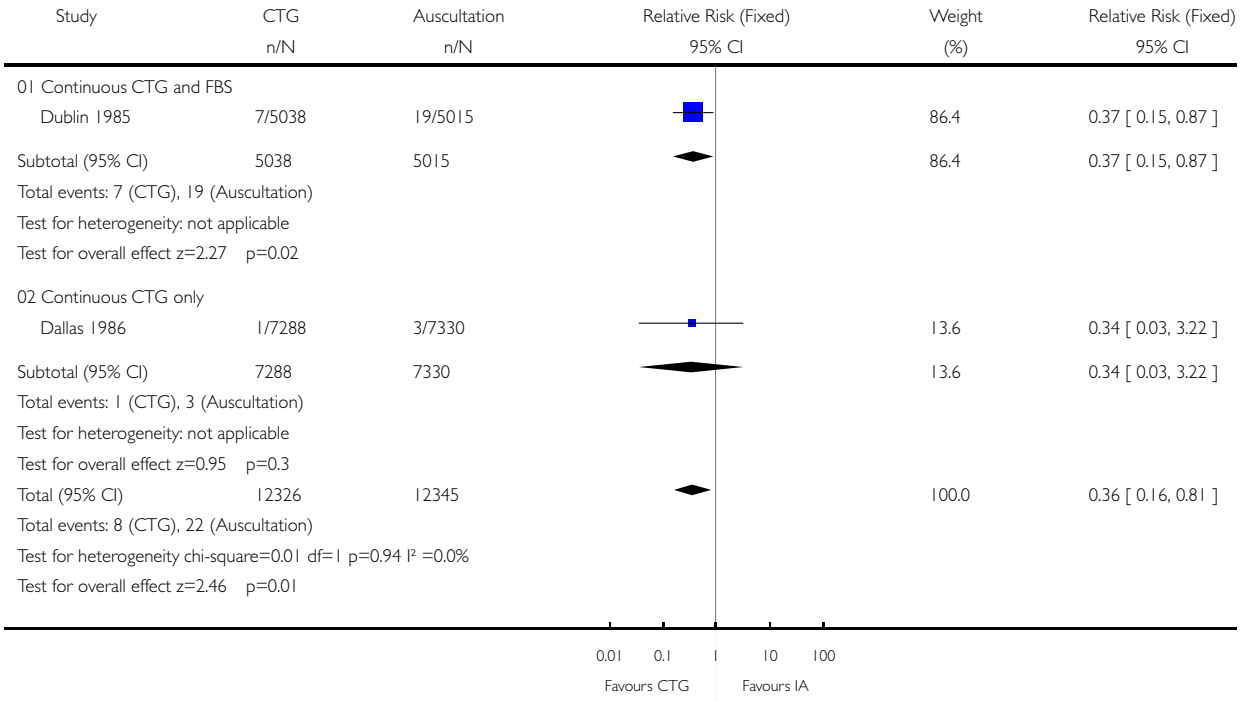


Analysis 02.26. Comparison 02 Continuous CTG versus intermittent ausculatation (low risk), Outcome 26 Neonatal seizures

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 02 Continuous CTG versus intermittent ausculatation (low risk)

Outcome: 26 Neonatal seizures



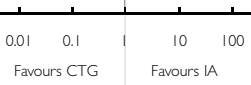
Analysis 02.27. Comparison 02 Continuous CTG versus intermittent ausculatation (low risk), Outcome 27 Perinatal death

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 02 Continuous CTG versus intermittent ausculatation (low risk)

Outcome: 27 Perinatal death

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
02 Continuous CTG only					
Dallas 1986	4/7288	5/7330		91.2	0.80 [0.22, 3.00]
Melbourne 1981	1/445	0/482		8.8	3.25 [0.13, 79.55]
Subtotal (95% CI)	7733	7812		100.0	1.02 [0.31, 3.31]
Total events: 5 (CTG), 5 (Auscultation)					
Test for heterogeneity chi-square=0.63 df=1 p=0.43 I^2 =0.0%					
Test for overall effect z=0.03 p=1					
Total (95% CI)	7733	7812		100.0	1.02 [0.31, 3.31]
Total events: 5 (CTG), 5 (Auscultation)					
Test for heterogeneity chi-square=0.63 df=1 p=0.43 I^2 =0.0%					
Test for overall effect z=0.03 p=1					



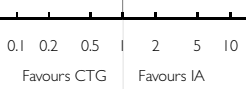
Analysis 03.01. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 01 Caesarean section

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 01 Caesarean section

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Denver 1979	26/229	7/116		10.5	1.88 [0.84, 4.20]
Melbourne 1976	39/175	24/175		27.2	1.63 [1.02, 2.58]
Pakistan 1989	35/100	12/100		13.6	2.92 [1.61, 5.28]
Seattle 1987	19/122	19/124		21.4	1.02 [0.57, 1.82]
Subtotal (95% CI)	626	515		72.7	1.72 [1.30, 2.29]
Total events: 119 (CTG), 62 (Auscultation)					
Test for heterogeneity chi-square=6.25 df=3 p=0.10 I^2 =52.0%					
Test for overall effect z=3.75 p=0.0002					
02 Continuous CTG only					
Denver 1976	40/242	16/241		18.2	2.49 [1.43, 4.32]
Denver 1979	41/230	6/115		9.1	3.42 [1.49, 7.81]
Subtotal (95% CI)	472	356		27.3	2.80 [1.76, 4.44]
Total events: 81 (CTG), 22 (Auscultation)					
Test for heterogeneity chi-square=0.40 df=1 p=0.53 I^2 =0.0%					
Test for overall effect z=4.37 p=0.00001					
Total (95% CI)	1098	871		100.0	2.02 [1.58, 2.57]
Total events: 200 (CTG), 84 (Auscultation)					
Test for heterogeneity chi-square=9.74 df=5 p=0.08 I^2 =48.7%					
Test for overall effect z=5.67 p<0.00001					



Analysis 03.02. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 02 Caesarean section for abnormal FHR pattern and/or acidosis

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 02 Caesarean section for abnormal FHR pattern and/or acidosis

Study	CTG n/N	Auscultation n/N	Odds Ratio (Fixed) 95% CI	Weight (%)	Odds Ratio (Fixed) 95% CI
01 Continuous CTG and FBS					
Denver 1979	8/229	1/116		3.4	4.16 [0.51, 33.69]
Melbourne 1976	28/175	14/175		30.9	2.19 [1.11, 4.32]
Pakistan 1989	19/100	7/100		14.9	3.12 [1.25, 7.79]
Seattle 1987	19/122	19/124		41.8	1.02 [0.51, 2.04]
Subtotal (95% CI)	626	515		91.1	1.88 [1.25, 2.83]
Total events: 74 (CTG), 41 (Auscultation)					
Test for heterogeneity chi-square=4.93 df=3 p=0.18 I^2 =39.1%					
Test for overall effect z=3.01 p=0.003					
02 Continuous CTG only					
Denver 1976	18/242	3/241		7.3	6.38 [1.85, 21.94]
Denver 1979	16/230	0/115		1.6	17.77 [1.06, 298.88]
Subtotal (95% CI)	472	356		8.9	8.45 [2.72, 26.27]
Total events: 34 (CTG), 3 (Auscultation)					
Test for heterogeneity chi-square=0.47 df=1 p=0.49 I^2 =0.0%					
Test for overall effect z=3.69 p=0.0002					
Total (95% CI)	1098	871		100.0	2.46 [1.69, 3.59]
Total events: 108 (CTG), 44 (Auscultation)					
Test for heterogeneity chi-square=11.02 df=5 p=0.05 I^2 =54.6%					
Test for overall effect z=4.72 p<0.00001					

Analysis 03.03. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 03 Instrumental vaginal birth

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 03 Instrumental vaginal birth

Study	CTG n/N	Auscultation n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 Continuous CTG and FBS					
Denver 1979	54/229	27/116		16.2	1.01 [0.68, 1.52]
Melbourne 1976	70/175	67/175		26.5	1.04 [0.80, 1.36]
Pakistan 1989	38/100	27/100		16.0	1.41 [0.94, 2.12]
Subtotal (95% CI)	504	391		58.7	1.11 [0.91, 1.35]
Total events: 162 (CTG), 121 (Auscultation)					
Test for heterogeneity chi-square=1.70 df=2 p=0.43 I^2 =0.0%					
Test for overall effect z=1.05 p=0.3					
02 Continuous CTG only					
Denver 1976	60/242	78/241		24.3	0.77 [0.58, 1.02]
Denver 1979	64/230	27/115		17.0	1.19 [0.80, 1.75]
Subtotal (95% CI)	472	356		41.3	0.93 [0.61, 1.43]
Total events: 124 (CTG), 105 (Auscultation)					
Test for heterogeneity chi-square=3.13 df=1 p=0.08 I^2 =68.1%					
Test for overall effect z=0.32 p=0.7					
Total (95% CI)	976	747		100.0	1.03 [0.85, 1.26]
Total events: 286 (CTG), 226 (Auscultation)					
Test for heterogeneity chi-square=6.85 df=4 p=0.14 I^2 =41.6%					
Test for overall effect z=0.32 p=0.8					

Analysis 03.05. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 05 Spontaneous vaginal birth not achieved

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 05 Spontaneous vaginal birth not achieved

Study	CTG n/N	Auscultation n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 Continuous CTG and FBS					
Denver 1979	80/229	34/116		14.5	1.19 [0.85, 1.66]
Melbourne 1976	109/175	91/175		22.2	1.20 [1.00, 1.44]
Pakistan 1989	73/100	39/100		17.4	1.87 [1.43, 2.46]
Seattle 1987	34/122	27/124		10.6	1.28 [0.83, 1.99]
Subtotal (95% CI)	626	515		64.7	1.36 [1.08, 1.72]
Total events: 296 (CTG), 191 (Auscultation)					
Test for heterogeneity chi-square=7.73 df=3 p=0.05 I^2 =61.2%					
Test for overall effect z=2.61 p=0.009					
02 Continuous CTG only					
Denver 1976	100/242	94/241		20.3	1.06 [0.85, 1.32]
Denver 1979	105/230	33/115		15.1	1.59 [1.15, 2.19]
Subtotal (95% CI)	472	356		35.3	1.28 [0.86, 1.90]
Total events: 205 (CTG), 127 (Auscultation)					
Test for heterogeneity chi-square=4.27 df=1 p=0.04 I^2 =76.6%					
Test for overall effect z=1.20 p=0.2					
Total (95% CI)	1098	871		100.0	1.33 [1.11, 1.59]
Total events: 501 (CTG), 318 (Auscultation)					
Test for heterogeneity chi-square=12.79 df=5 p=0.03 I^2 =60.9%					
Test for overall effect z=3.06 p=0.002					

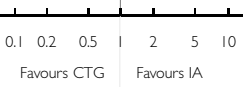
Analysis 03.07. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 07 Need for any analgesia (incl. general)

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 07 Need for any analgesia (incl. general)

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Denver 1979	211/229	101/116		50.1	1.06 [0.98, 1.15]
Subtotal (95% CI)	229	116		50.1	1.06 [0.98, 1.15]
Total events: 211 (CTG), 101 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.39 p=0.2					
02 Continuous CTG only					
Denver 1979	213/230	100/115		49.9	1.07 [0.98, 1.15]
Subtotal (95% CI)	230	115		49.9	1.07 [0.98, 1.15]
Total events: 213 (CTG), 100 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.55 p=0.1					
Total (95% CI)	459	231		100.0	1.06 [1.00, 1.12]
Total events: 424 (CTG), 201 (Auscultation)					
Test for heterogeneity chi-square=0.01 df=1 p=0.91 I^2 =0.0%					
Test for overall effect z=2.08 p=0.04					



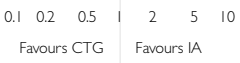
Analysis 03.08. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 08 Epidural analgesia

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 08 Epidural analgesia

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Denver 1979	40/229	24/116		13.9	0.84 [0.54, 1.33]
Melbourne 1976	50/175	43/175		18.8	1.16 [0.82, 1.65]
Seattle 1987	56/122	53/124		23.0	1.07 [0.81, 1.42]
Subtotal (95% CI)	526	415		55.8	1.05 [0.86, 1.28]
Total events: 146 (CTG), 120 (Auscultation)					
Test for heterogeneity chi-square=1.24 df=2 p=0.54 I² =0.0%					
Test for overall effect z=0.45 p=0.7					
02 Continuous CTG only					
Denver 1976	51/242	69/241		30.2	0.74 [0.54, 1.01]
Denver 1979	53/230	24/115		14.0	1.10 [0.72, 1.69]
Subtotal (95% CI)	472	356		44.2	0.85 [0.66, 1.10]
Total events: 104 (CTG), 93 (Auscultation)					
Test for heterogeneity chi-square=2.24 df=1 p=0.13 I² =55.4%					
Test for overall effect z=1.24 p=0.2					
Total (95% CI)	998	771		100.0	0.96 [0.82, 1.12]
Total events: 250 (CTG), 213 (Auscultation)					
Test for heterogeneity chi-square=5.22 df=4 p=0.27 I² =23.3%					
Test for overall effect z=0.50 p=0.6					



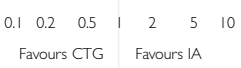
Analysis 03.09. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 09 Use of pharmacological analgesia during labour

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 09 Use of pharmacological analgesia during labour

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
02 Continuous CTG only					
Denver 1976	183/242	194/241		100.0	0.94 [0.85, 1.03]
Subtotal (95% CI)	242	241		100.0	0.94 [0.85, 1.03]
Total events: 183 (CTG), 194 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.29 p=0.2					
Total (95% CI)	242	241		100.0	0.94 [0.85, 1.03]
Total events: 183 (CTG), 194 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.29 p=0.2					

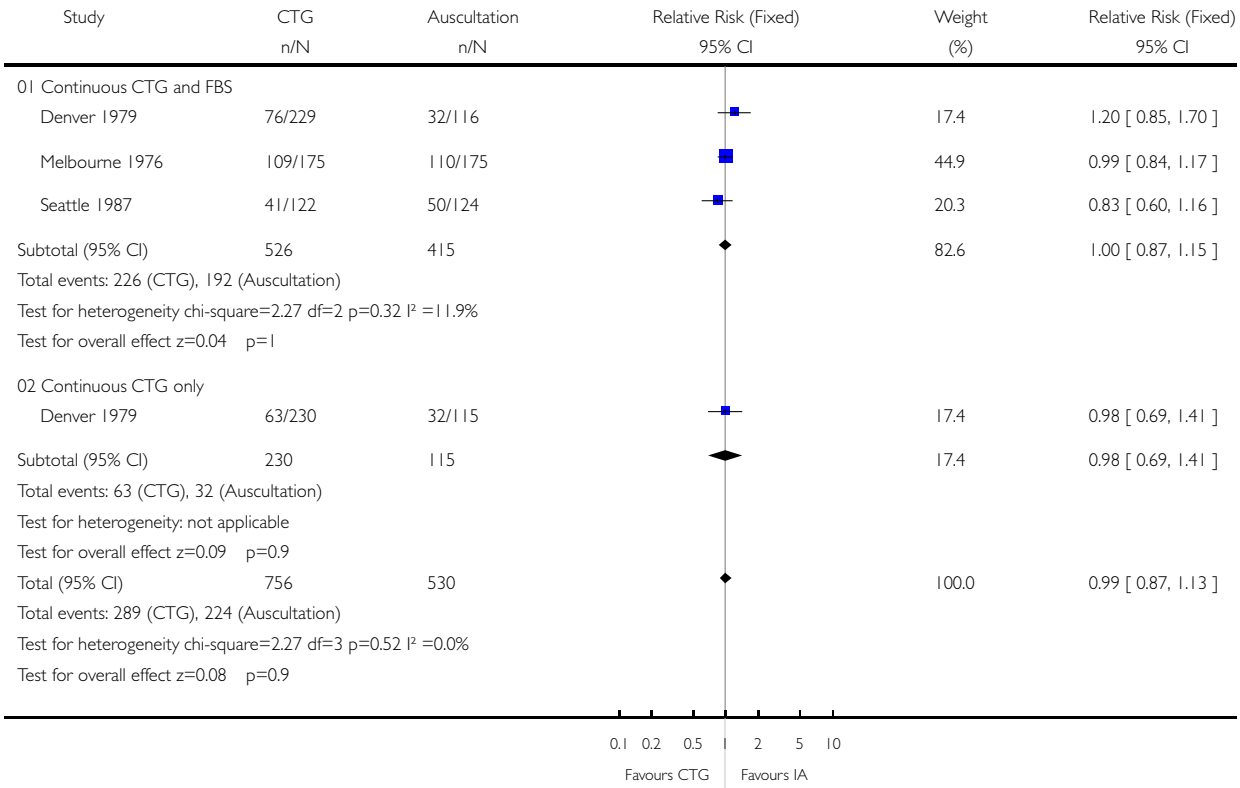


Analysis 03.13. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 13 Oxytocin during 1st and/or 2nd stage of labour

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 13 Oxytocin during 1st and/or 2nd stage of labour



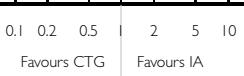
Analysis 03.20. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 20 Apgar score < 7 at 5 minutes

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 20 Apgar score < 7 at 5 minutes

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Pakistan 1989	9/100	12/100		100.0	0.75 [0.33, 1.70]
Subtotal (95% CI)	100	100		100.0	0.75 [0.33, 1.70]
Total events: 9 (CTG), 12 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.69 p=0.5					
02 Continuous CTG only					
Subtotal (95% CI)	0	0		0.0	Not estimable
Total events: 0 (CTG), 0 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect: not applicable					
Total (95% CI)	100	100		100.0	0.75 [0.33, 1.70]
Total events: 9 (CTG), 12 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.69 p=0.5					



Analysis 03.21. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 21 Apgar score < 4 at 5 minutes

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 21 Apgar score < 4 at 5 minutes

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Denver 1979	0/230	1/116		27.3	0.17 [0.01, 4.11]
Seattle 1987	9/122	4/124		54.4	2.29 [0.72, 7.23]
Subtotal (95% CI)	352	240		81.7	1.58 [0.59, 4.23]
Total events: 9 (CTG), 5 (Auscultation)					
Test for heterogeneity chi-square=2.28 df=1 p=0.13 I^2 =56.2%					
Test for overall effect z=0.91 p=0.4					
02 Continuous CTG only					
Denver 1979	4/233	1/116		18.3	1.99 [0.23, 17.62]
Subtotal (95% CI)	233	116		18.3	1.99 [0.23, 17.62]
Total events: 4 (CTG), 1 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.62 p=0.5					
Total (95% CI)	585	356		100.0	1.65 [0.67, 4.07]
Total events: 13 (CTG), 6 (Auscultation)					
Test for heterogeneity chi-square=2.29 df=2 p=0.32 I^2 =12.8%					
Test for overall effect z=1.10 p=0.3					

Analysis 03.23. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 23 Neonatal ICU admissions

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 23 Neonatal ICU admissions

Study	CTG n/N	Auscultation n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 Continuous CTG and FBS					
Denver 1979	29/230	15/116		25.0	0.98 [0.54, 1.75]
Melbourne 1976	11/175	30/175		22.8	0.37 [0.19, 0.71]
Subtotal (95% CI)	405	291		47.8	0.61 [0.23, 1.58]
Total events: 40 (CTG), 45 (Auscultation)					
Test for heterogeneity chi-square=4.79 df=1 p=0.03 I^2 =79.1%					
Test for overall effect z=1.02 p=0.3					
02 Continuous CTG only					
Denver 1976	35/242	28/241		28.4	1.24 [0.78, 1.98]
Denver 1979	23/233	14/116		23.7	0.82 [0.44, 1.53]
Subtotal (95% CI)	475	357		52.2	1.07 [0.72, 1.59]
Total events: 58 (CTG), 42 (Auscultation)					
Test for heterogeneity chi-square=1.12 df=1 p=0.29 I^2 =10.4%					
Test for overall effect z=0.31 p=0.8					
Total (95% CI)	880	648		100.0	0.80 [0.48, 1.33]
Total events: 98 (CTG), 87 (Auscultation)					
Test for heterogeneity chi-square=9.13 df=3 p=0.03 I^2 =67.1%					
Test for overall effect z=0.86 p=0.4					

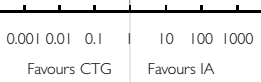
Analysis 03.26. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 26 Neonatal seizures

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 26 Neonatal seizures

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Denver 1979	0/230	1/116		8.1	0.17 [0.01, 4.11]
Dublin 1985	5/1492	8/1539		32.0	0.64 [0.21, 1.97]
Melbourne 1976	0/175	4/175		18.3	0.11 [0.01, 2.05]
Seattle 1987	7/122	7/124		28.2	1.02 [0.37, 2.81]
Subtotal (95% CI)	2019	1954		86.5	0.61 [0.31, 1.20]
Total events: 12 (CTG), 20 (Auscultation)					
Test for heterogeneity chi-square=2.91 df=3 p=0.41 I^2 =0.0%					
Test for overall effect z=1.44 p=0.2					
02 Continuous CTG only					
Denver 1976	2/242	2/241		8.1	1.00 [0.14, 7.01]
Denver 1979	2/233	1/116		5.4	1.00 [0.09, 10.87]
Subtotal (95% CI)	475	357		13.5	1.00 [0.22, 4.52]
Total events: 4 (CTG), 3 (Auscultation)					
Test for heterogeneity chi-square=0.00 df=1 p=1.00 I^2 =0.0%					
Test for overall effect z=0.01 p=1					
Total (95% CI)	2494	2311		100.0	0.66 [0.36, 1.22]
Total events: 16 (CTG), 23 (Auscultation)					
Test for heterogeneity chi-square=3.11 df=5 p=0.68 I^2 =0.0%					
Test for overall effect z=1.32 p=0.2					



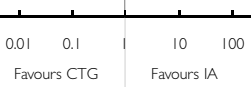
Analysis 03.27. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 27 Perinatal death

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 27 Perinatal death

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Denver 1979	1/230	0/116		2.5	1.52 [0.06, 37.01]
Melbourne 1976	1/175	1/175		3.8	1.00 [0.06, 15.86]
Pakistan 1989	4/100	5/100		19.1	0.80 [0.22, 2.89]
Seattle 1987	17/122	18/124		68.2	0.96 [0.52, 1.77]
Subtotal (95% CI)	627	515		93.6	0.94 [0.55, 1.61]
Total events: 23 (CTG), 24 (Auscultation)					
Test for heterogeneity chi-square=0.15 df=3 p=0.98 I^2 =0.0%					
Test for overall effect z=0.21 p=0.8					
02 Continuous CTG only					
Denver 1976	2/242	1/241		3.8	1.99 [0.18, 21.82]
Denver 1979	2/233	0/116		2.5	2.50 [0.12, 51.65]
Subtotal (95% CI)	475	357		6.4	2.19 [0.33, 14.41]
Total events: 4 (CTG), 1 (Auscultation)					
Test for heterogeneity chi-square=0.01 df=1 p=0.91 I^2 =0.0%					
Test for overall effect z=0.82 p=0.4					
Total (95% CI)	1102	872		100.0	1.02 [0.61, 1.71]
Total events: 27 (CTG), 25 (Auscultation)					
Test for heterogeneity chi-square=0.87 df=5 p=0.97 I^2 =0.0%					
Test for overall effect z=0.09 p=0.9					

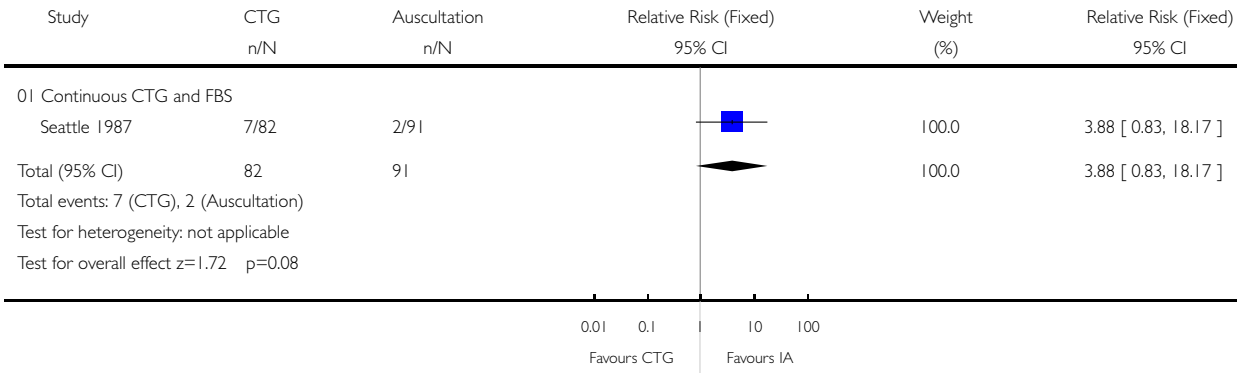


Analysis 03.28. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 28 Neurodevelopmental dissability at at least 12 months of age

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 28 Neurodevelopmental dissability at at least 12 months of age

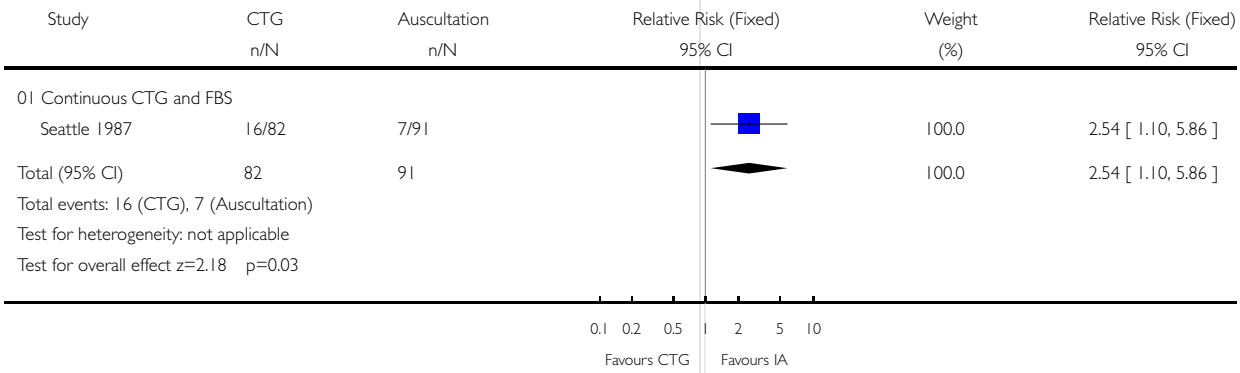


Analysis 03.29. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 29 Cerebral palsy (CP)

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 29 Cerebral palsy (CP)

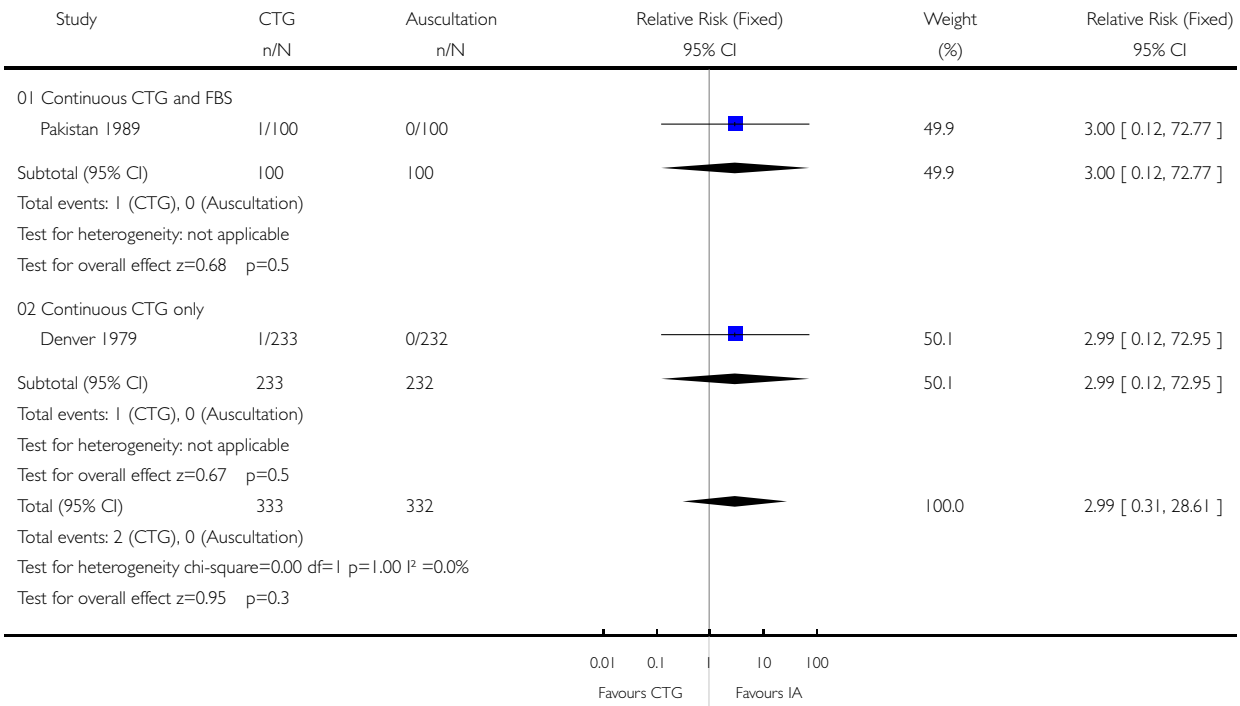


Analysis 03.30. Comparison 03 Continuous CTG versus intermittent auscultation (high risk), Outcome 30 Damage/infection from scalp electrode or scalp sampling

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 03 Continuous CTG versus intermittent auscultation (high risk)

Outcome: 30 Damage/infection from scalp electrode or scalp sampling

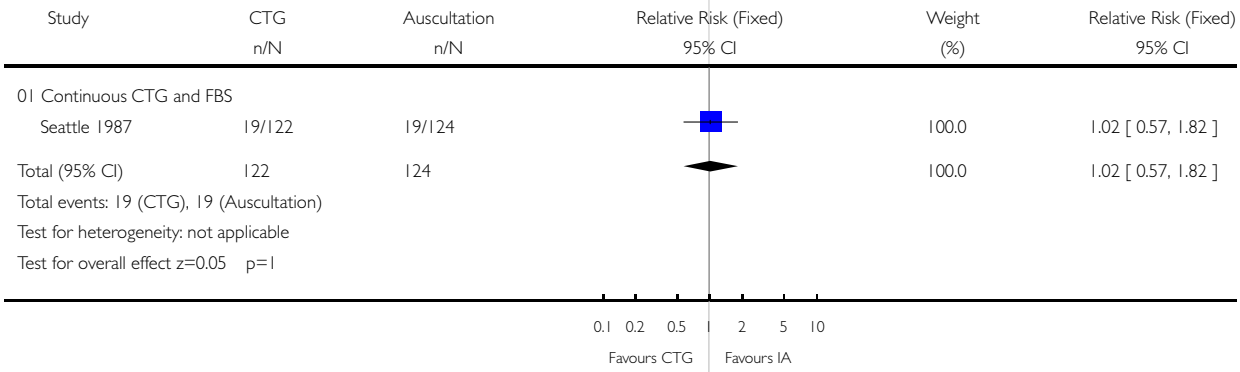


Analysis 04.01. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 01 Caesarean section

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 01 Caesarean section

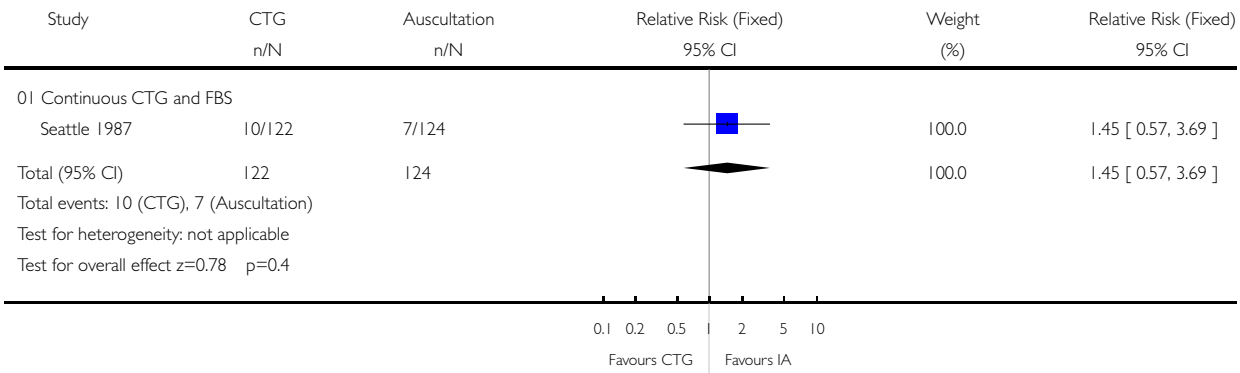


Analysis 04.02. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 02 Caesarean section for abnormal FHR pattern and/or acidosis

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 02 Caesarean section for abnormal FHR pattern and/or acidosis

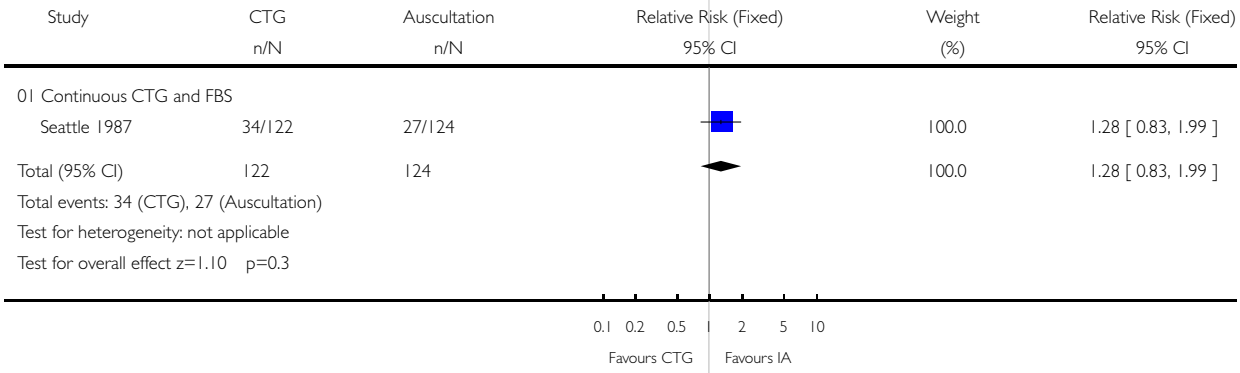


Analysis 04.05. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 05 Spontaneous vaginal birth not achieved

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 05 Spontaneous vaginal birth not achieved



Analysis 04.08. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 08 Epidural analgesia

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 08 Epidural analgesia

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Seattle 1987	56/122	53/124		100.0	1.07 [0.81, 1.42]
Total (95% CI)	122	124		100.0	1.07 [0.81, 1.42]
Total events: 56 (CTG), 53 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.50 p=0.6					

Analysis 04.13. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 13 Oxytocin during 1st and/or 2nd stage of labour

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 13 Oxytocin during 1st and/or 2nd stage of labour

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Seattle 1987	41/122	50/124		100.0	0.83 [0.60, 1.16]
Total (95% CI)	122	124		100.0	0.83 [0.60, 1.16]
Total events: 41 (CTG), 50 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.09 p=0.3					

Analysis 04.20. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 20 Apgar score < 4 at 5 minutes

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 20 Apgar score < 4 at 5 minutes

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Seattle 1987	9/122	4/124		100.0	2.29 [0.72, 7.23]
Total (95% CI)	122	124		100.0	2.29 [0.72, 7.23]
Total events: 9 (CTG), 4 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.41 p=0.2					

Analysis 04.26. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 26 Neonatal seizures

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 26 Neonatal seizures

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Seattle 1987	7/122	7/124		100.0	1.02 [0.37, 2.81]
Total (95% CI)	122	124		100.0	1.02 [0.37, 2.81]
Total events: 7 (CTG), 7 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.03 p=1					

Analysis 04.27. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 27 Perinatal death

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 27 Perinatal death

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Seattle 1987	17/122	18/124		100.0	0.96 [0.52, 1.77]
Total (95% CI)	122	124		100.0	0.96 [0.52, 1.77]
Total events: 17 (CTG), 18 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.13 p=0.9					

Analysis 04.28. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 28 Neurodevelopmental dissability at at least 12 months of age

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 28 Neurodevelopmental dissability at at least 12 months of age

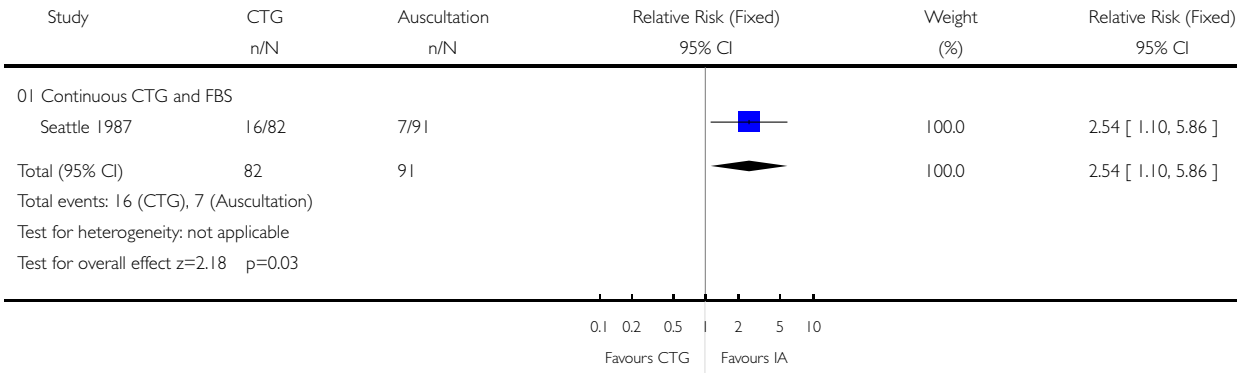
Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Seattle 1987	7/82	2/91		100.0	3.88 [0.83, 18.17]
Total (95% CI)	82	91		100.0	3.88 [0.83, 18.17]
Total events: 7 (CTG), 2 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.72 p=0.08					

Analysis 04.29. Comparison 04 Continuous CTG versus intermittent auscultation (preterm), Outcome 29 Cerebral palsy (CP)

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 04 Continuous CTG versus intermittent auscultation (preterm)

Outcome: 29 Cerebral palsy (CP)

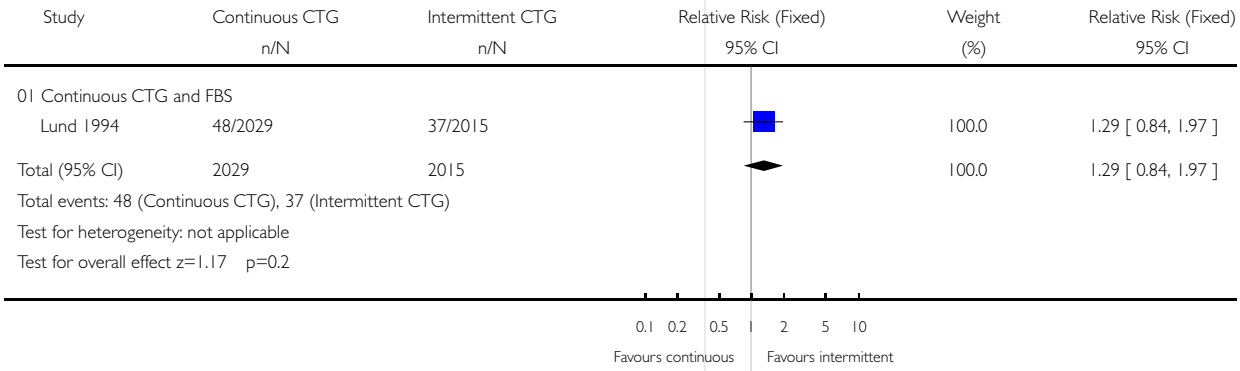


Analysis 05.01. Comparison 05 Continuous CTG versus intermittent CTG, Outcome 01 Caesarean section

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 05 Continuous CTG versus intermittent CTG

Outcome: 01 Caesarean section

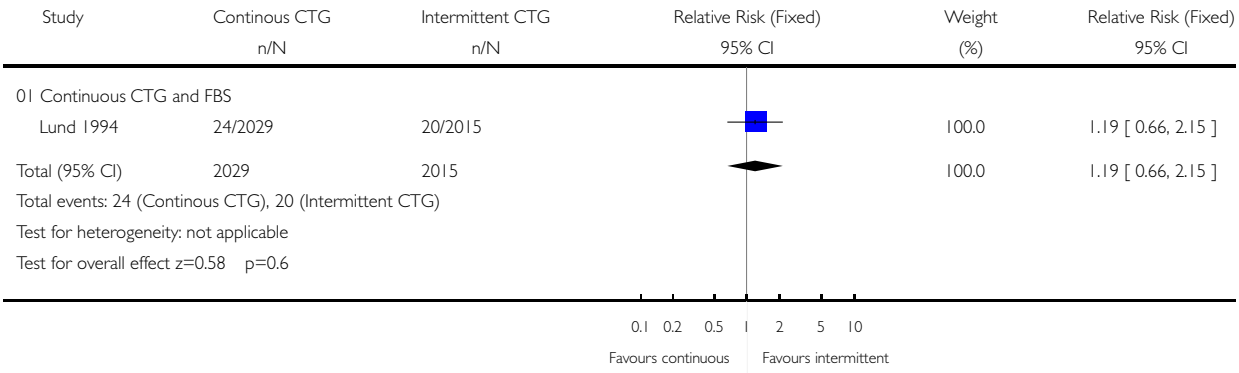


Analysis 05.02. Comparison 05 Continuous CTG versus intermittent CTG, Outcome 02 Caesarean section for abnormal FHR pattern and/or acidosis

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 05 Continuous CTG versus intermittent CTG

Outcome: 02 Caesarean section for abnormal FHR pattern and/or acidosis

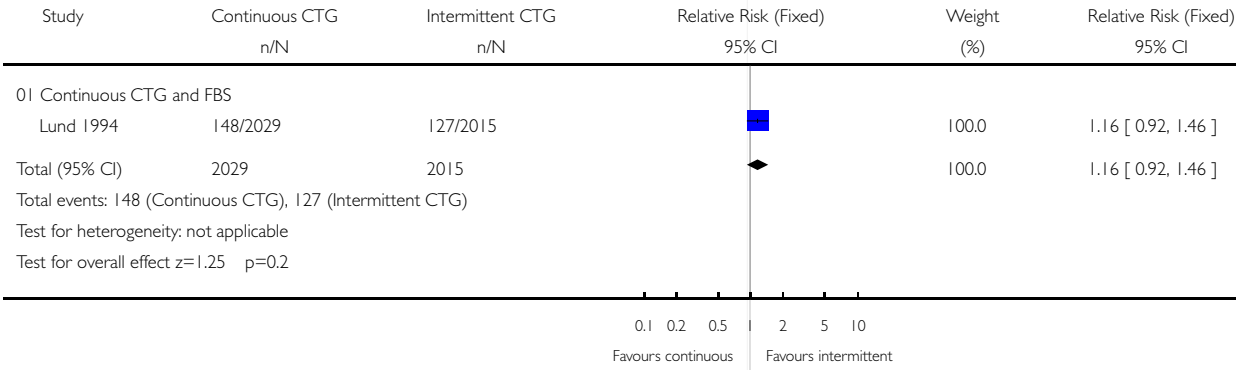


Analysis 05.03. Comparison 05 Continuous CTG versus intermittent CTG, Outcome 03 Instrumental vaginal birth

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 05 Continuous CTG versus intermittent CTG

Outcome: 03 Instrumental vaginal birth



Analysis 05.05. Comparison 05 Continuous CTG versus intermittent CTG, Outcome 05 Spontaneous vaginal birth not achieved

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 05 Continuous CTG versus intermittent CTG

Outcome: 05 Spontaneous vaginal birth not achieved

Study	Continuous CTG n/N	Intermittent CTG n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Lund 1994	196/2029	164/2015		100.0	1.19 [0.97, 1.45]
Total (95% CI)	2029	2015		100.0	1.19 [0.97, 1.45]
Total events: 196 (Continuous CTG), 164 (Intermittent CTG)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.70 p=0.09					

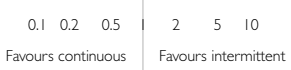
Analysis 05.08. Comparison 05 Continuous CTG versus intermittent CTG, Outcome 08 Epidural analgesia

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 05 Continuous CTG versus intermittent CTG

Outcome: 08 Epidural analgesia

Study	Continuous CTG n/N	Intermittent CTG n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Lund 1994	369/2029	347/2015		100.0	1.06 [0.92, 1.21]
Total (95% CI)	2029	2015		100.0	1.06 [0.92, 1.21]
Total events: 369 (Continuous CTG), 347 (Intermittent CTG)					
Test for heterogeneity: not applicable					
Test for overall effect z=0.80 p=0.4					

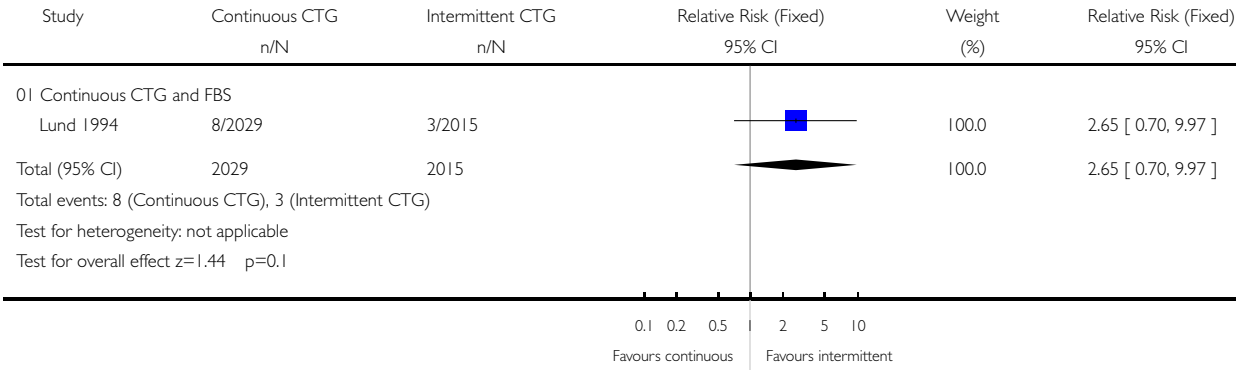


Analysis 05.20. Comparison 05 Continuous CTG versus intermittent CTG, Outcome 20 Apgar score < 7 at 5 minutes

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 05 Continuous CTG versus intermittent CTG

Outcome: 20 Apgar score < 7 at 5 minutes

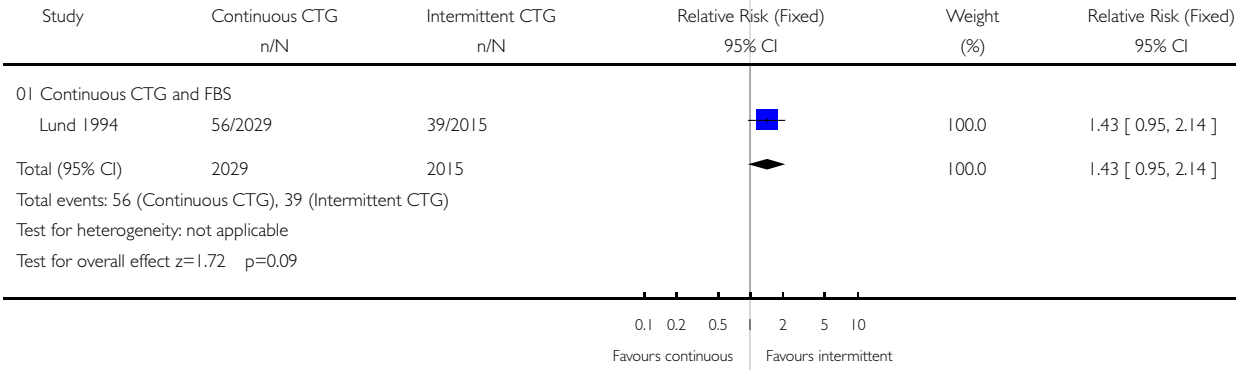


Analysis 05.22. Comparison 05 Continuous CTG versus intermittent CTG, Outcome 22 Cord blood acidosis

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 05 Continuous CTG versus intermittent CTG

Outcome: 22 Cord blood acidosis



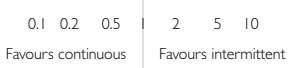
Analysis 05.23. Comparison 05 Continuous CTG versus intermittent CTG, Outcome 23 Neonatal ICU admissions

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 05 Continuous CTG versus intermittent CTG

Outcome: 23 Neonatal ICU admissions

Study	Continuous CTG n/N	Intermittent CTG n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 Continuous CTG and FBS					
Lund 1994	58/2029	43/2015		100.0	1.34 [0.91, 1.98]
Total (95% CI)	2029	2015		100.0	1.34 [0.91, 1.98]
Total events: 58 (Continuous CTG), 43 (Intermittent CTG)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.47 p=0.1					



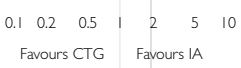
Analysis 06.01. Comparison 06 Continuous CTG versus IA (high quality versus rest), Outcome 01 Caesarean section

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 06 Continuous CTG versus IA (high quality versus rest)

Outcome: 01 Caesarean section

Study	CTG n/N	Auscultation n/N	Relative Risk (Random) 95% CI	Weight (%)	Relative Risk (Random) 95% CI
01 High-quality trials					
Dublin 1985	158/6474	144/6490		15.2	1.10 [0.88, 1.37]
Melbourne 1976	39/175	24/175		11.0	1.63 [1.02, 2.58]
Subtotal (95% CI)	6649	6665		26.2	1.27 [0.88, 1.83]
Total events: 197 (CTG), 168 (Auscultation)					
Test for heterogeneity chi-square=2.22 df=1 p=0.14 I^2 =54.9%					
Test for overall effect z=1.26 p=0.2					
02 Not high-quality trials					
Athens 1993	71/746	59/682		13.4	1.10 [0.79, 1.53]
Copenhagen 1985	28/482	18/487		9.2	1.57 [0.88, 2.80]
Denver 1976	40/242	16/241		9.6	2.49 [1.43, 4.32]
Denver 1979	67/459	13/231		9.2	2.59 [1.46, 4.60]
Melbourne 1981	18/445	10/482		6.8	1.95 [0.91, 4.18]
Pakistan 1989	35/100	12/100		8.9	2.92 [1.61, 5.28]
Seattle 1987	19/122	19/124		9.1	1.02 [0.57, 1.82]



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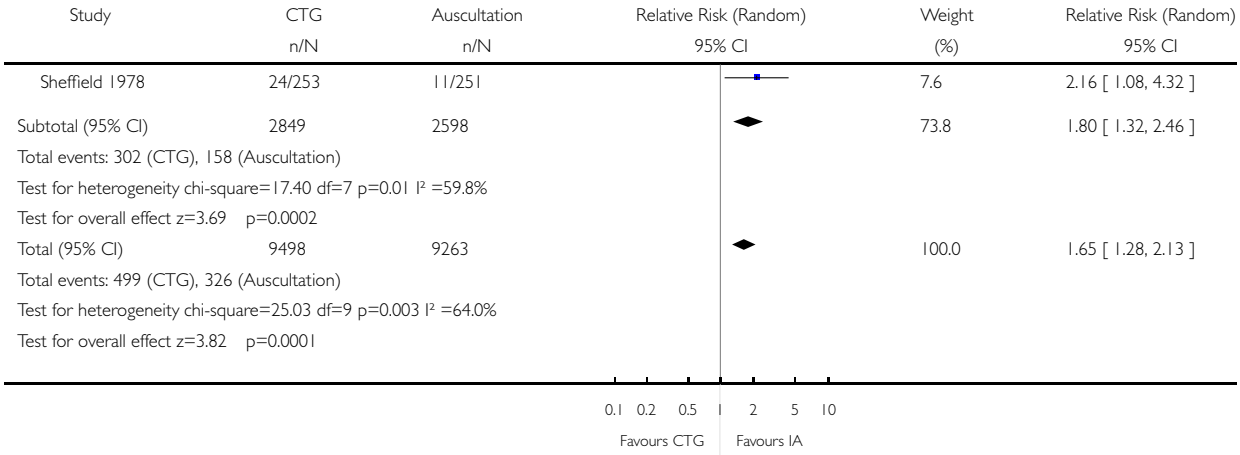
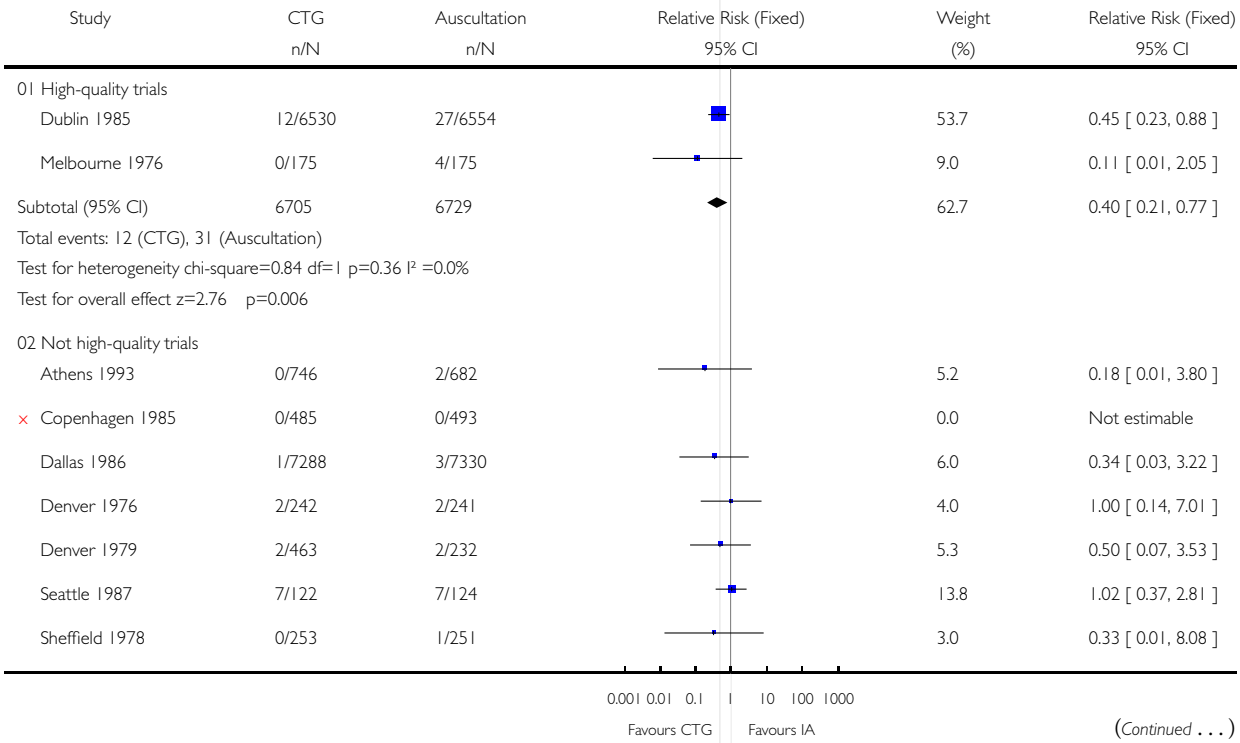


Analysis 06.02. Comparison 06 Continuous CTG versus IA (high quality versus rest), Outcome 02 Neonatal seizures

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 06 Continuous CTG versus IA (high quality versus rest)

Outcome: 02 Neonatal seizures



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Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
Subtotal (95% CI)	9599	9353		37.3	0.66 [0.33, 1.33]
Total events: 12 (CTG), 17 (Auscultation)					
Test for heterogeneity chi-square=2.15 df=5 p=0.83 I^2 =0.0%					
Test for overall effect z=1.16 p=0.2					
Total (95% CI)	16304	16082		100.0	0.50 [0.31, 0.80]
Total events: 24 (CTG), 48 (Auscultation)					
Test for heterogeneity chi-square=4.10 df=7 p=0.77 I^2 =0.0%					
Test for overall effect z=2.89 p=0.004					

Analysis 07.01. Comparison 07 Continuous CTG versus IA (high risk versus low risk), Outcome 01 Caesarean section

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 07 Continuous CTG versus IA (high risk versus low risk)

Outcome: 01 Caesarean section

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 high risk					
Denver 1976	40/242	16/241		16.4	2.49 [1.43, 4.32]
Denver 1979	67/459	13/231		17.7	2.59 [1.46, 4.60]
Melbourne 1976	39/175	24/175		24.5	1.63 [1.02, 2.58]
Pakistan 1989	35/100	12/100		12.3	2.92 [1.61, 5.28]
Seattle 1987	19/122	19/124		19.3	1.02 [0.57, 1.82]
Subtotal (95% CI)	1098	871		90.2	2.02 [1.58, 2.57]
Total events: 200 (CTG), 84 (Auscultation)					
Test for heterogeneity chi-square=8.90 df=4 p=0.06 I^2 =55.0%					
Test for overall effect z=5.68 p<0.00001					
02 low risk					
Melbourne 1981	18/445	10/482		9.8	1.95 [0.91, 4.18]
Subtotal (95% CI)	445	482		9.8	1.95 [0.91, 4.18]
Total events: 18 (CTG), 10 (Auscultation)					
Test for heterogeneity: not applicable					
Test for overall effect z=1.72 p=0.09					
Total (95% CI)	1543	1353		100.0	2.01 [1.60, 2.53]
Total events: 218 (CTG), 94 (Auscultation)					
Test for heterogeneity chi-square=8.89 df=5 p=0.11 I^2 =43.8%					
Test for overall effect z=5.93 p<0.00001					

Analysis 07.02. Comparison 07 Continuous CTG versus IA (high risk versus low risk), Outcome 02 Neonatal seizures

Review: Continuous cardiotocography (CTG) as a form of electronic fetal monitoring (EFM) for fetal assessment during labour

Comparison: 07 Continuous CTG versus IA (high risk versus low risk)

Outcome: 02 Neonatal seizures

Study	CTG n/N	Auscultation n/N	Relative Risk (Fixed) 95% CI	Weight (%)	Relative Risk (Fixed) 95% CI
01 high risk					
Denver 1976	2/242	2/241		4.4	1.00 [0.14, 7.01]
Denver 1979	2/463	2/232		5.8	0.50 [0.07, 3.53]
Dublin 1985	5/1492	8/1539		17.1	0.64 [0.21, 1.97]
Melbourne 1976	0/175	4/175		9.8	0.11 [0.01, 2.05]
Seattle 1987	7/122	7/124		15.1	1.02 [0.37, 2.81]
Subtotal (95% CI)	2494	2311		52.1	0.67 [0.36, 1.24]
Total events: 16 (CTG), 23 (Auscultation)					
Test for heterogeneity chi-square=2.36 df=4 p=0.67 I² =0.0%					
Test for overall effect z=1.28 p=0.2					
02 low risk					
Dallas 1986	1/7288	3/7330		6.5	0.34 [0.03, 3.22]
Dublin 1985	7/5038	19/5015		41.4	0.37 [0.15, 0.87]
Subtotal (95% CI)	12326	12345		47.9	0.36 [0.16, 0.81]
Total events: 8 (CTG), 22 (Auscultation)					
Test for heterogeneity chi-square=0.01 df=1 p=0.94 I² =0.0%					
Test for overall effect z=2.46 p=0.01					
Total (95% CI)	14820	14656		100.0	0.52 [0.32, 0.85]
Total events: 24 (CTG), 45 (Auscultation)					
Test for heterogeneity chi-square=4.08 df=6 p=0.67 I² =0.0%					
Test for overall effect z=2.62 p=0.009