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[Intervention Review]

Amnioinfusion for potential or suspected umbilical cord compression in labour

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ABSTRACT

Background

Amnioinfusion aims to prevent or relieve umbilical cord compression during labour by infusing a solution into the uterine cavity.

Objectives

To assess the effects of amnioinfusion for potential or suspected umbilical cord compression on maternal and perinatal outcome .

Search methods

We searched the Cochrane Pregnancy and Childbirth Group's Trials Register (31 October 2011).

Selection criteria

Randomised trials of amnioinfusion compared with no amnioinfusion in women with babies at risk of umbilical cord compression in labour.

Data collection and analysis

The original review had one author only (Justus Hofmeyr (GJH)). For this update, two authors (GJH and T Lawrie) assessed 13 additional trial reports for eligibility and quality. We extracted data and checked for accuracy.

Main results

We have included 19 studies, with all but two studies having fewer than 200 participants. Transcervical amnioinfusion for potential or suspected umbilical cord compression was associated with the following reductions: caesarean section overall (13 trials, 1493 participants; average risk ratio (RR) 0.62, 95% confidence interval (CI) 0.46 to 0.83); fetal heart rate (FHR) decelerations (seven trials, 1006 participants; average RR 0.53, 95% CI 0.38 to 0.74); Apgar score less than seven at five minutes (12 trials, 1804 participants; average RR 0.47, 95% CI 0.30 to 0.72); meconium below the vocal cords (three trials, 674 participants, RR 0.53, 95% CI 0.31 to 0.92); postpartum endometritis (six trials, 767 participants; RR 0.45, 95% CI 0.25 to 0.81) and maternal hospital stay greater than three days (four trials, 1051 participants; average RR 0.45, 95% CI 0.25 to 0.78). Transabdominal amnioinfusion showed similar trends, though numbers studied were small.

Mean cord umbilical artery pH was higher in the amnioinfusion group (seven trials, 855 participants; average mean difference 0.03, 95% CI 0.00 to 0.06) and there was a trend toward fewer neonates with a low cord arterial pH (less than 7.2 or as defined by trial authors) in the amnioinfusion group (eight trials, 972 participants, average RR 0.58, 95% CI 0.29 to 1.14).

Authors' conclusions

The use of amnioinfusion for potential or suspected umbilical cord compression may be of considerable benefit to mother and baby by reducing the occurrence of variable FHR decelerations, improving short-term measures of neonatal outcome, reducing maternal postpartum endometritis and lowering the use of caesarean section, although there were methodological limitations to the trials reviewed here. In addition, the trials are too small to address the possibility of rare but serious maternal adverse effects of amnioinfusion. More research is needed to confirm the findings, assess longer-term measures of fetal outcome, and to assess the impact on caesarean section rates when the diagnosis of fetal distress is more stringent. Trials should assess amnioinfusion in specific clinical situations, such as FHR decelerations, oligohydramnios or prelabour rupture of membranes.

PLAIN LANGUAGE SUMMARY

Amnioinfusion for potential or suspected umbilical cord compression in labour

Infusing fluid into the uterus during labour may reduce fetal heart rate abnormalities and reduce caesarean sections.

Most women have adequate amniotic fluid to protect their baby during pregnancy and labour. Occasionally the volume of amniotic fluid is reduced, and this may cause compression of the umbilical cord. This in turn might lead to intermittent slowing of the baby's heart rate during labour. Infusing fluid into the uterus through a catheter placed through the cervix, or a needle through the abdomen may reduce this problem and the incidence of caesarean section. In addition, it may improve the newborn baby's condition at birth and prevent infection of the womb. The 19 studies reviewed were of average quality, and too small to measure the risk of rare complications for the mother; all but two studies had fewer than 200 participants.

BACKGROUND

Amnioinfusion has been described as a method of preventing or relieving umbilical cord compression during labour (Miyazaki 1983). Saline or Ringers lactate is infused transcervically through a catheter into the uterine cavity, or transabdominally through a 'spinal' needle when membranes are intact. The technique has been used prophylactically in various conditions which are commonly associated with oligohydramnios (reduced volume of amniotic fluid) (Macri 1992), and therapeutically for repetitive variable fetal heart rate (FHR) decelerations during labour. This heart rate abnormality is considered to be due often to umbilical cord compression, particularly when there is oligohydramnios (Gabbe 1976).

There is considerable variability in the diagnosis of oligohydramnios (clinically or with ultrasound), and in the assessment of the severity of variable FHR decelerations on cardiotocography. The use of amnioinfusion for these conditions might therefore vary.

Amnioinfusion with antibiotics has been used to treat established amnionitis (Goodlin 1981), and to prevent infection following premature rupture of membranes (Ogita 1988). Saline amnioinfusion has been used to reduce infection in prolonged rupture of membranes, presumably through dilution or irrigation (Monahan 1995).

Transabdominal amnioinfusion has also been used to facilitate external cephalic version at term (Benifla 1995), and antepartum amnioinfusion has been used for various fetal indications such as to reduce the risk of pulmonary hypoplasia and to improve ultrasound visualisation of fetal anomalies (Gramellini 2003). Reassuring FHR acceleration in response to small-volume amnioinfusion has been described (Wax 2004).

This review deals with amnioinfusion for potential or suspected cord compression in labour. 'Prophylactic versus therapeutic amnioinfusion for oligohydramnios in labour' (Novikova 1996), 'Amnioinfusion for meconium-stained liquor in labour' (Hofmeyr 2010), and 'Amnioinfusion for preterm rupture of membranes' (Hofmeyr 1998) are separate Cochrane reviews in the current edition of *The Cochrane Library*.

OBJECTIVES

To determine, from the best available evidence, the effects of amnioinfusion for potential or suspected umbilical cord compression in labour on FHR characteristics and perinatal and maternal mortality and morbidity.

METHODS

Criteria for considering studies for this review

Types of studies

Clinical trials comparing the effect of amnioinfusion (treatment group) versus no amnioinfusion (control group) for potential or suspected umbilical cord compression in labour, on FHR characteristics, mode of delivery and perinatal and maternal mortality and morbidity; with random allocation to study groups and adequate allocation concealment; where violations

of allocated management and exclusions after allocation were insufficient to materially affect outcomes.

Types of participants

Women whose babies were considered to be at increased risk of, or had FHR patterns suggestive of, umbilical cord compression in labour.

Types of interventions

Amnioinfusion compared with no amnioinfusion. We considered transcervical and transabdominal amnioinfusion separately because there are fundamental differences between the techniques, which may result in different outcomes.

Types of outcome measures

Primary outcomes

Mother

- Caesarean section

Baby

- Abnormal FHR pattern on cardiotocography, e.g. persistent variable decelerations
- Low Apgar score at 5 minutes (< 7 or as defined by trial authors)
- Meconium aspiration syndrome

Secondary outcomes

- Caesarean section for suspected fetal distress
- Instrumental vaginal delivery
- Instrumental vaginal delivery for suspected fetal distress
- Intrapartum maternal T > 38°C
- Postpartum endometritis/puerperal infection
- Rupture of membranes to delivery interval (hours)
- Neonatal admission to intensive/high care
- Meconium below vocal cords
- Maternal hospital stay greater than three days
- Low 1 minute Apgar scores
- Low umbilical cord arterial pH
- Meconium-stained liquor
- Neonatal hospital stay greater than three days
- Umbilical cord prolapse
- Mild or severe birth asphyxia
- Perinatal death
- Neonatal infection

Search methods for identification of studies

Electronic searches

We searched the Cochrane Pregnancy and Childbirth Group's Trials Register by contacting the Trials Search Co-ordinator (31 October 2011).

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. weekly searches of MEDLINE;
3. weekly searches of EMBASE;
4. handsearches of 30 journals and the proceedings of major conferences;
5. weekly current awareness alerts for a further 44 journals plus monthly BioMed Central email alerts.

Details of the search strategies for CENTRAL, MEDLINE and EMBASE, the list of handsearched journals and conference proceedings, and the list of journals reviewed via the current awareness service can be found in the 'Specialized Register' section within the editorial information about the [Cochrane Pregnancy and Childbirth Group](#).

Trials identified through the searching activities described above are each assigned to a review topic (or topics). The Trials Search Co-ordinator searches the register for each review using the topic list rather than keywords.

We did not apply any language restrictions.

Data collection and analysis

For the methods used when assessing the trials identified in the previous version of this review, see [Appendix 1](#).

For this update, we used the following methods when assessing the trials identified by the updated search ([Abdel-Aleem 2005](#); [Gonzalez 2001](#); [McDermot 1998](#); [Mino 1999](#); [Persson-Kjerstadius 1999](#); [Regi 2009](#); [Wang 1997](#); [Rinehart 2000](#)):

Selection of studies

Both authors independently assessed for inclusion all the potential studies identified as a result of the updated search strategy. We resolved any disagreement through discussion.

Data extraction and management

We designed a new form to extract data and, for eligible studies, independently extracted the data using the agreed form. We resolved discrepancies through discussion. We entered data into Review Manager software ([Revman 2011](#)) and checked for accuracy. Where information provided was unclear, we attempted to contact authors of the original reports to provide further details.

Assessment of risk of bias in included studies

For the original review, GJH assessed trials for eligibility. For the 2011 update, both authors independently assessed the risk of bias of the newly identified eligible studies using the criteria outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* ([Higgins 2011](#)). We resolved any disagreement by discussion.

(1) Random sequence generation (checking for possible selection bias)

We describe for each included study the method used to generate the allocation sequence in sufficient detail to allow an assessment of whether it should produce comparable groups.

We assessed the method as:

- low risk of bias (any truly random process, e.g. random number table; computer random number generator);

- high risk of bias (any non-random process, e.g. odd or even date of birth; hospital or clinic record number); or
- unclear risk of bias.

(2) Allocation concealment (checking for possible selection bias)

We describe for each included study the method used to conceal allocation to interventions prior to assignment and assess whether intervention allocation could have been foreseen in advance of, or during recruitment, or changed after assignment.

We assessed the methods as:

- low risk of bias (e.g. telephone or central randomisation; consecutively numbered sealed opaque envelopes);
- high risk of bias (open random allocation; unsealed or non-opaque envelopes, alternation; date of birth);
- unclear risk of bias.

(3) Blinding of participants and personnel (checking for possible performance bias)

We describe for each included study the methods used, if any, to blind study participants and personnel from knowledge of which intervention a participant received. We consider studies to be at low risk of bias if they were blinded, or if we judge that the lack of blinding would be unlikely to affect results. We assessed blinding separately for different outcomes or classes of outcomes.

We assessed the methods as:

- low, high or unclear risk of bias for participants;
- low, high or unclear risk of bias for personnel;
- low, high or unclear risk of bias for outcome assessors.

(4) Incomplete outcome data (checking for possible attrition bias due to the amount, nature and handling of incomplete outcome data)

We describe for each included study, and for each outcome or class of outcomes, the completeness of data including attrition and exclusions from the analysis. We state whether attrition and exclusions were reported and the numbers included in the analysis at each stage (compared with the total randomised participants), reasons for attrition or exclusion where reported, and whether missing data were balanced across groups or were related to outcomes. Where sufficient information is reported, or was supplied by the trial authors, we re-include missing data in the analyses which we undertook.

We assessed methods as:

- low risk of bias (e.g. no missing outcome data; missing outcome data balanced across groups);
- high risk of bias (e.g. numbers or reasons for missing data imbalanced across groups; 'as treated' analysis done with substantial departure of intervention received from that assigned at randomisation);
- unclear risk of bias.

(5) Selective reporting (checking for reporting bias)

We describe for each included study how we investigated the possibility of selective outcome reporting bias and what we found.

We assessed the methods as:

- low risk of bias (where it is clear that all of the study's pre-specified outcomes and all expected outcomes of interest to the review have been reported);
- high risk of bias (where not all the study's pre-specified outcomes have been reported; one or more reported primary outcomes were not pre-specified; outcomes of interest are reported incompletely and so cannot be used; study fails to include results of a key outcome that would have been expected to have been reported);
- unclear risk of bias.

(6) Other bias (checking for bias due to problems not covered by (1) to (5) above)

We describe for each included study any important concerns we have about other possible sources of bias.

We assessed whether each study was free of other problems that could put it at risk of bias:

- low risk of other bias;
- high risk of other bias;
- unclear whether there is risk of other bias.

(7) Overall risk of bias

We made explicit judgements about whether studies were at high risk of bias, according to the criteria given in the *Handbook* (Higgins 2011). With reference to (1) to (6) above, we assessed the likely magnitude and direction of the bias and whether we considered it likely to impact on the findings. When we had concerns about the impact of the level of bias, we undertook sensitivity analyses.

Note: The risk of bias assessment performed for the original review only included points 1) to 3) above, therefore the risk of bias tables for the originally included trials in [Characteristics of included studies](#) may be incomplete. Where details are incomplete we have entered "Unclear: Details not available for the 2011 review update".

Measures of treatment effect

For dichotomous data, we present results as summary risk ratio with 95% confidence intervals. For continuous data we planned to use the mean difference if outcomes were measured in the same way between trials and the standardised mean difference to combine trials that measured the same outcome, but used different methods.

Dealing with missing data

We noted levels of attrition for included studies. We explored the impact of including studies with high levels of missing data in the overall assessment of treatment effect by using sensitivity analysis.

We carried out analyses for all outcomes, as far as possible, on an intention-to-treat basis, i.e. we attempted to include all participants randomised to each group in the analyses, and analysed all participants in the group to which they were allocated, regardless of whether or not they received the allocated intervention. The denominator for each outcome in each trial was the number randomised minus any participants whose outcomes were known to be missing.

Assessment of heterogeneity

We assessed statistical heterogeneity in each meta-analysis using the T^2 , I^2 and Chi^2 statistics. We regarded heterogeneity as substantial if T^2 was greater than zero and either I^2 was greater than 30% or there was a low P value (less than 0.10) in the Chi^2 test for heterogeneity.

Assessment of reporting biases

If there were 10 or more studies in the meta-analysis we investigated reporting biases (such as publication bias) using funnel plots (see [Figure 1](#), [Figure 2](#), [Figure 3](#) and [Figure 4](#)). We assessed funnel plot asymmetry visually, and used formal tests for funnel plot asymmetry. For dichotomous outcomes we used the test proposed by Harbord 2006 and for continuous outcomes we would have used the test proposed by Egger 1997. If we detected asymmetry in any of these tests or by a visual assessment, we performed exploratory analyses to investigate it.

Figure 1. Funnel plot of comparison: 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM), outcome: 1.11 Caesarean section, overall.

Figure 2. Funnel plot of comparison: 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM), outcome: 1.2 Caesarean for suspected fetal distress.

Figure 3. Funnel plot of comparison: 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM), outcome: 1.14 Apgar score < 7 at 1 minute.

Figure 4. Funnel plot of comparison: 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, outcome: 1.12 Apgar score < 7 at 5 minutes.

Data synthesis

We carried out statistical analysis using the Review Manager software (Revman 2011). We used fixed-effect meta-analysis for combining data where it was reasonable to assume that studies were estimating the same underlying treatment effect: i.e. where trials were examining the same intervention, and we judged the trials' populations and methods to be sufficiently similar. If there was clinical heterogeneity sufficient to expect that the underlying treatment effects differed between trials, or if we detected substantial statistical heterogeneity, we used random-effects meta-analysis to produce an overall summary. We treated the random-effects summary as the average range of possible treatment effects and we discussed the clinical implications of treatment effects differing between trials. If the average treatment effect was not clinically meaningful we did not combine trials. Where we used random-effects analyses, we have presented the results as the average treatment effect with its 95% confidence interval, and the estimates of T^2 and I^2 .

Subgroup analysis and investigation of heterogeneity

Where we identified substantial heterogeneity we investigated it using sensitivity analyses. We considered whether an overall effect was clinically meaningful and, if it was, used random-effects analysis to produce it.

We carried out the following subgroup analysis.

1. Amnioinfusion for FHR decelerations (suspected cord compression - therapeutic amnioinfusion)

2. Oligohydramnios without FHR decelerations (prophylactic amnioinfusion)
3. Mixed or other indications, e.g. prelabour rupture of the membranes at term or preterm

Sensitivity analysis

We performed sensitivity analyses where there was a risk of bias associated with the quality of some of the included trials, e.g. Persson-Kjerstadius 1999 and where there was substantial heterogeneity.

RESULTS

Description of studies

See [Characteristics of included studies](#).

We have included 19 studies: 13 from the original review and six from the updated search. One newly identified report contributed no data (Gonzalez 2001). All except two (Abdel-Aleem 2005; Schrimmer 1991) had 200 or fewer participants. The primary author of the Owen 1990 trial provided additional unpublished data for inclusion in this review.

Two trials were stopped before reaching their planned sample size because preliminary results produced significant differences between the groups (Regi 2009; Vergani 1996).

Risk of bias in included studies

See 'Risk of Bias' tables in [Characteristics of included studies](#) and [Figure 5](#) and [Figure 6](#).

Figure 5. Risk of bias graph: review authors' judgments about each risk of bias item presented as percentages across all included studies.

Figure 6. Risk of bias summary: review authors' judgements about each risk of bias item for each included study.

Participants of 10 studies were 'randomised' or 'randomly allocated' to groups with no further details provided (Busowski 1995; Chauhan 1992; Gonzalez 2001; MacGregor 1991; Miyazaki 1985; Nageotte 1985; Owen 1990; Persson-Kjerstadius 1999; Puertas 2001; Wu 1989) and nine studies used random number tables or computer-generated randomisation (Abdel-Aleem 2005; Amin 2003; Mino 1999; Monahan 1995a; Nageotte 1991; Regi 2009; Schrimmer 1991; Strong 1990; Vergani 1996). Wang 1997 used coin-tossing for the first of each pair of women to randomise participants.

Ten studies performed group allocation by sealed envelopes (Abdel-Aleem 2005; Amin 2003; Chauhan 1992; Miyazaki 1985; Monahan 1995a; Nageotte 1991; Owen 1990; Persson-Kjerstadius 1999; Regi 2009; Strong 1990). One group (Schrimmer 1991) used 'computer' randomisation and sealed envelopes in a ratio of 3:2.

Nageotte 1985 recorded five withdrawals after randomisation and Regi 2009 recorded two. We have excluded results from women who declined participation in Chauhan 1992 and were used as a comparison group from this review.

The interpretation of FHR response to amnioinfusion in some studies may have been subject to bias as tracings were often not stated to have been assessed 'blind' (Abdel-Aleem 2005; Chauhan 1992; Mino 1999; Miyazaki 1985; Persson-Kjerstadius 1999; Wang 1997). Apgar score assessments may also have been subject to bias.

In one study (Owen 1990) the allocations were imbalanced (43 experimental versus 57 control women, of whom 22 and 36 respectively were multiparous), and the estimated gestational age of women with oligohydramnios/suspected impaired fetal growth in the amnioinfusion group was significantly less than that of the

control group. Personal communication with the primary author has established that the enrolment discrepancy was in part a chance imbalance in the randomisation, and in part the result of exclusion of a few women allocated to the experimental group who, for technical reasons, did not actually receive amnioinfusion.

The study by [Persson-Kjerstadius 1999](#) also had imbalanced group sizes (52 controls versus 60 in the study group). Missing mode of delivery data could have altered results for this outcome (4/60 in the amnioinfusion group); however on sensitivity analysis, review results were not significantly affected by these missing data and so we have retained these data in the meta-analysis. In this study, data on neonatal outcome were tabled without denominators, and for "ominous fetal heart rate patterns", as percentages, and so the latter were unusable. Attempts to contact the authors for additional information were unsuccessful.

In one study ([Nageotte 1991](#)), three women in each group received the non-allocated management, but analysis was according to 'intention to treat'.

After unsuccessful attempts to contact authors of a trial conducted in Spain ([Mino 1999](#)), we considered five reports to pertain to the same trial at different stages of enrolment ([Mino 1997a](#); [Mino 1997b](#); [Mino 1998](#); [Puertas 1997](#)). Two reports published as abstracts ([Gonzalez 2001](#); [Puertas 2001](#)) had no usable data as results were presented as percentages only.

The overall methodological quality of the trials reviewed was thus not ideal.

For data analysis, we have applied a random-effects model where substantial heterogeneity existed on meta-analysis (20 out of 31 outcomes in the comparison 'Transcervical amnioinfusion'). We have expressed results for these outcomes as the 'average' effect.

We performed funnel plots on four outcomes: [Analysis 1.1](#), [Analysis 1.2](#), [Analysis 1.11](#) and [Analysis 1.12](#). We were satisfied that the first three outcomes were free from reporting bias. The asymmetry in [Figure 4](#) ([Analysis 1.12](#)) is discussed below in [Effects of interventions](#).

Effects of interventions

There was significant heterogeneity for several outcomes, for which we have used a random-effects model.

Mode of delivery

The incidence of caesarean section (primary outcome) was significantly reduced (13 trials, 1493 women; average risk ratio (RR) 0.62, 95% confidence interval (CI) 0.46 to 0.83; ([Analysis 1.1](#))). This reduction was due to a reduction in the sub-groups oligohydramnios (average RR 0.60 95%CI 0.42 to 0.85) and mixed group (average RR 0.48, 95%CI 0.27 to 0.86). There was no difference in the one trial in the FHR deceleration group which reported this outcome.

The effect was most marked for caesarean section performed for suspected fetal distress (12 trials, 1588 women; average RR 0.46; 95% CI 0.31 to 0.68 ([Analysis 1.2](#))), which was reduced in all three groups. The magnitude of the reduction was less for FHR decelerations than for the other two sub-groups (test for subgroup differences: $P = 0.02$). Since the diagnosis of fetal distress may be

subject to reporting bias, the latter result should be interpreted with caution: the use of scalp blood pH measurement was not used to confirm all diagnoses of fetal distress, therefore it is possible that the difference in caesarean sections for fetal distress is due to the difference in the rate of variable FHR decelerations, which do not necessarily denote fetal distress. Another possible explanation is that attending staff may have been reassured that problems relating to oligohydramnios had been attended to by means of amnioinfusion, and therefore less likely to opt for caesarean section for fetal distress.

Likewise, the results for the outcome 'forceps or vacuum for fetal distress' may be subject to bias (four trials, 665 women; RR 0.58, 95% CI 0.39 to 0.85 ([Analysis 1.3](#))). The incidence of forceps or vacuum assisted delivery overall was not significantly different between groups (five trials, 705 women; RR 0.85, 95% CI 0.64 to 1.12 ([Analysis 1.4](#))).

Fetal/neonatal outcome

Persistent variable FHR decelerations (primary outcome) were significantly less frequent in the amnioinfusion group (seven trials, 1006 participants; average RR 0.53, 95% CI 0.38 to 0.74 ([Analysis 1.5](#))). This effect was slightly greater in the FHR deceleration subgroup (three trials, 682 participants; 0.44, 95% CI 0.24 to 0.80) than in the oligohydramnios (3 trials, 131 participants, average RR 0.54 95% CI 0.30 to 0.99) or mixed indication group (one trial, 193 participants; RR 0.81, 95% CI 0.71 to 0.93). The test for subgroup differences was not significant: ($P = 0.07$).

Mean cord umbilical artery pH was higher in the amnioinfusion group compared with the control group (seven trials, 855 participants; average mean difference (MD) 0.03, 95% CI 0.00 to 0.06 (random-effects) or MD 0.03, 95% CI 0.02-0.04, (fixed-effect) ([Analysis 1.18](#))) and there was a trend toward fewer neonates with a lower cord arterial pH (less than 7.2 or as defined by trial authors) in the amnioinfusion group (eight trials, 972 participants, average RR 0.58, 95% CI 0.29 to 1.14 ([Analysis 1.14](#))).

Neonates with Apgar scores less than seven at one minute were significantly fewer in the amnioinfusion group versus the controls (10 trials, 1628 participants; average RR 0.47, 95% CI 0.29 to 0.77 ([Analysis 1.11](#))): this effect was significant overall and for the oligohydramnios subgroup only (six trials, 746 participants; 0.27, 95% CI 0.18 to 0.39) (test for subgroup differences: $P = 0.03$). The results for neonatal Apgar scores less than seven at five minutes (primary outcome) were similar to the one-minute assessment (12 trials, 1804 participants; average RR 0.47, 95% CI 0.30 to 0.72 ([Analysis 1.12](#))). Since the Apgar assessment was rarely stated by investigators as blind, this result may be subject to some observer bias. In addition asymmetry in the funnel plot suggests the possibility of publication bias ([Figure 4](#)).

The frequency of meconium below the vocal cords was halved in the amnioinfusion group (three trials, 674 participants, average RR 0.53, 95% CI 0.31 to 0.92 ([Analysis 1.21](#))) but there was no significant difference in the occurrence of meconium aspiration syndrome (primary outcome) (two trials, 514 participants; RR 0.14, 95% CI 0.01 to 2.75 ([Analysis 1.19](#))).

The outcome 'mild' or 'severe' birth asphyxia was reported in one study only (118 participants, RR 0.32, 95% CI 0.15 to 0.70 ([Analysis 1.13](#))).

Umbilical cord prolapse occurred in two out of 677 women (seven trials), both of whom were receiving amnioinfusion. In both cases the babies were born in poor condition. Very large studies will be required to determine whether there is an increase in this rare outcome with amnioinfusion.

Perinatal death was also a rare event occurring in two amnioinfusion cases and five control cases (nine trials, 1022 participants; RR 0.47, 95% CI 0.12 to 1.79 ([Analysis 1.16](#))).

There was no significant difference between groups in the rates of neonatal sepsis.

There was a trend towards fewer neonatal admissions to an intensive care or high risk nursery in the average amnioinfusion group (five trials, 958 participants; average RR 0.74, 95% CI 0.49 to 1.10 ([Analysis 1.20](#))).

Neonatal hospital stay more than three days was significantly reduced in one but not the other trial which reported this outcome ([Analysis 1.23](#)).

Maternal outcome

Postpartum endometritis/puerperal infection was reduced only in the mixed indication sub-group (two trials, 161 participants; average RR 0.20, 95% CI 0.05 to 0.88; [Analysis 1.17](#)). This outcome may be subject to bias as few studies reported assessor blinding. In addition, it may be secondary to the reduced rate of caesarean section with amnioinfusion, as may the shorter maternal hospital stay (four trials, 1051 participants; average RR 0.45, 95% CI 0.25 to 0.78 ([Analysis 1.22](#))).

Other outcomes

There was no significant difference between groups with regard to the time from rupture of membranes to delivery ([Analysis 1.9](#)).

The results of the two trials of transabdominal amnioinfusion are very similar to those of the trials of transcervical amnioinfusion but numbers of participants are small. There was a reduction in suspicious/ominous FHR patterns (one trial, 70 participants; RR 0.13, 95% CI 0.03 to 0.52 ([Analysis 2.1](#))) and caesarean section for fetal distress (two trials, 110 participants; RR 0.20, 95% CI 0.05 to 0.74 ([Analysis 2.3](#))). The trends to reduced caesarean sections overall and improved fetal outcomes did not reach statistical significance.

DISCUSSION

The results of the trials reviewed are generally consistent, except for the results of the study of [Chauhan 1992](#). The lack of positive outcomes in the latter trial may be the result of the small numbers studied or the fact that amnioinfusion was administered on one occasion only.

The evidence available from these trials suggests that amnioinfusion for potential (oligohydramnios) or suspected umbilical cord compression (FHR decelerations) reduces the occurrence of variable FHR decelerations and improves short-term neonatal outcomes, namely Apgar scores and umbilical artery pH.

In addition, of considerable importance is the large reduction in caesarean sections, which is accounted for by a reduction in operations performed for 'fetal distress'. As no mention is made of

fetal scalp blood sampling in any of the studies, this diagnosis may have been based on FHR patterns alone. Extrapolation of the results as a guide to clinical practice should therefore be limited to clinical situations in which caesarean sections are commonly performed for abnormal FHR patterns alone.

The decrease in puerperal infection appears to be a maternal benefit of amnioinfusion. This effect may be secondary to the lower rate of caesarean section following amnioinfusion as may the significantly shorter length of hospital stay.

The trials reviewed are too small to address the possibility of rare but serious maternal side effects of amnioinfusion. Several case reports have been published of cardiac failure or amniotic fluid embolism following amnioinfusion, though a causal relationship has not been established ([Dibble 1992](#); [Dragich 1991](#); [Hofmeyr 1996](#); [Maher 1994](#); [Wegnelius 1996](#); [Wenstrom 1994](#)). The benefits shown in the trials reviewed need to be weighed against the theoretical small risk of serious maternal complications. Extrapolation from the Cochrane review of amnioinfusion for meconium-stained liquor, which included one large trial, is reassuring in that no increase in maternal death or severe morbidity was found ([Hofmeyr 2010](#)). Larger trials are needed to address the risk-benefit ratio of amnioinfusion for oligohydramnios or FHR decelerations conclusively.

The trials reviewed are also too small to assess the possibility of rare fetal complications, such as umbilical cord prolapse.

Trials in this review include the use of amnioinfusion both prophylactically for situations such as oligohydramnios, or therapeutically for FHR decelerations. The limited evidence available suggests that there is no advantage to using amnioinfusion prophylactically as opposed to therapeutically (see Cochrane review by [Novikova 1996](#)).

The trials of transabdominal amnioinfusion, though small, suggest that similar results are achieved as with transcervical amnioinfusion. The risk of transabdominal insertion of a needle into the amniotic cavity needs to be weighed against several theoretical advantages of the transabdominal route in women with intact membranes: the membranes do not need to be ruptured to perform amnioinfusion; there is no ongoing leakage of amniotic fluid, so that a single infusion is likely to be effective for several hours; and the discomfort, inconvenience and possible risks of an indwelling intrauterine catheter are avoided.

The results should be interpreted with caution because of the methodological shortcomings mentioned, and the small numbers in the individual studies. The latter limitation raises the possibility of publication bias. It is worth noting that in the review of amnioinfusion for meconium stained liquor, positive results from a number of small trials were not borne out by a large, multicentre trial ([Hofmeyr 2010](#)).

AUTHORS' CONCLUSIONS

Implications for practice

In settings in which fetal scalp blood sampling is not used to confirm fetal distress, the use of amnioinfusion for potential or suspected umbilical cord compression may be of considerable benefit to the mother and baby, though the methodological limitations of the trials reviewed here need to be kept in mind. Amnioinfusion may

also be useful both for oligohydramnios and for repeated variable decelerations in settings where fetal blood sampling reveals no imminent indication for caesarean section, by decreasing the risk of meconium below the cords and fetal acidosis.

Implications for research

Larger randomised studies are needed to assess the effect of amnioinfusion for oligohydramnios or FHR decelerations on neonatal well-being, and on the rate of caesarean sections, where fetal scalp blood sampling is used to confirm the diagnosis of fetal distress. Trials should assess amnioinfusion in specific clinical situations, such as FHR decelerations, oligohydramnios or prelabour rupture of membranes.

The use of transabdominal amnioinfusion deserves further research. In particular, a large trial in women with intact membranes comparing transabdominal amnioinfusion with artificial rupture of membranes and transcervical amnioinfusion may help to define possible risks associated with the presence of an indwelling intrauterine catheter.

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REFERENCES

References to studies included in this review

Abdel-Aleem 2005 {published data only}

Abdel-Aleem H, Amin AF, Shokry M, Radwan RA. Therapeutic amnioinfusion for intrapartum fetal distress using a pediatric feeding tube. *International Journal of Gynecology & Obstetrics* 2005;**90**(2):94-8.

Amin 2003 {published data only}

Amin AF, Mohammed MS, Sayed GH, Abdel-Razik S. Prophylactic transcervical amnioinfusion in laboring women with oligohydramnios. *International Journal of Gynecology & Obstetrics* 2003;**81**:183-9.

Busowski 1995 {published data only}

Busowski J, Pendergraft JS, Parsons M, O'Brien W. Transabdominal amnioinfusion prior to induction of labor. *American Journal of Obstetrics and Gynecology* 1995;**172**:287.

Chauhan 1992 {published data only}

Chauhan SP, Rutherford SE, Hess LW, Morrison JC. Prophylactic intrapartum amnioinfusion for patients with oligohydramnios. A prospective randomized study. *Journal of Reproductive Medicine* 1992;**37**(9):817-20.

Gonzalez 2001 {published data only}

Gonzalez R, Malde J, Carrillo MP, Sancho-Minano J, Garrote A, Munoz A, et al. The use of amnioinfusion in preterm deliveries. Preliminary results. *Journal of Perinatal Medicine* 2001;**29 Suppl 1**(Pt 2):629.

MacGregor 1991 {published data only}

MacGregor SN, Banzhaf WC, Silver RK, Depp R. A prospective, randomized evaluation of intrapartum amnioinfusion. *Journal of Reproductive Medicine* 1991;**36**:69-73.

Mino 1999 {published data only}

Mino M, Puertas A, Carrillo MP, Santiago JC, Herruzo AJ, Miranda JA. Influence of amnioinfusion on variable or prolonged decelerations: a randomised study. *Acta Obstetrica et Gynecologica Scandinavica* 1997;**76**(167):95.

Mino M, Puertas A, Herruzo AJ, Miranda JA. Amnioinfusion in labor induction of term pregnancies with premature rupture of the membranes and low amniotic fluid. *International Journal of Gynecology & Obstetrics* 1998;**61**:135-40.

* Mino M, Puertas A, Miranda JA, Herruzo AJ. Amnioinfusion in term labor with low amniotic fluid due to rupture of membranes: a new indication. *European Journal of Obstetrics & Gynecology and Reproductive Biology* 1999;**82**:29-34.

Mino M, Puertas A, Mozas J, Carrillo Badillo MP, Rodríguez Oliver A, Miranda JA. A modification of the amniotic fluid index after amnioinfusion for infants with early rupture of membranes [Modificación del índice de líquido amniótico tras amnioinfusión en gestantes con rotura prematura de membranas a término]. *Acta Ginecológica* 1997;**54**(1):11-4.

Puertas A, Mino M, Carrillo MP, Mozas J, Herruzo AJ, Miranda JA. Influence of amnioinfusion on neonatal acid-base state: a randomized study. *Acta Obstetrica et Gynecologica Scandinavica* 1997;**76 Suppl**(167:1):94.

Miyazaki 1985 {published data only}

Miyazaki FS, Nevarez F. Saline amnioinfusion for relief of repetitive variable decelerations: a prospective randomized study. *American Journal of Obstetrics and Gynecology* 1985;**153**:301-6.

Nageotte 1985 {published data only}

Nageotte MP, Freeman RK, Garite TJ, Dorchester W. Prophylactic intrapartum amnioinfusion in patients with preterm premature rupture of membranes. *American Journal of Obstetrics and Gynecology* 1985;**153**:557-62.

Nageotte 1991 {published data only}

Nageotte MP, Bertucci L, Towers CV, Lagrew DC, Mondanlau H. Prophylactic amnioinfusion in pregnancies complicated by oligohydramnios or thick meconium: a prospective study. Proceedings of 9th Annual Meeting of the Society of Perinatal Obstetricians; 1989 February 1-4; New Orleans, Louisiana. 1989:78.

Nageotte MP, Bertucci L, Towers CV, Lagrew DL, Modanlou H. Prophylactic amnioinfusion in pregnancies complicated by oligohydramnios: a prospective study. *Obstetrics & Gynecology* 1991;**77**:677-80.

Owen 1990 {published data only}

Owen J, Henson BV, Hauth JC. A prospective randomized study of saline amnioinfusion. Proceedings of 9th Annual Meeting of the Society of Perinatal Obstetricians; 1989 February 1-4; New Orleans, Louisiana, USA. 1989:440.

* Owen J, Henson BV, Hauth JC. A prospective randomized study of saline solution amnioinfusion. *American Journal of Obstetrics and Gynecology* 1990;**162**:1146-9.

Persson-Kjerstadius 1999 {published data only}

Persson-Kjerstadius N, Forsgren H, Westgren M. Intrapartum amnioinfusion in women with oligohydramnios A prospective randomized trial. *Acta Obstetrica et Gynecologica Scandinavica* 1999;**78**(2):116-9.

Puertas 2001 {published data only}

Puertas A, Munoz A, Mozas J, Carrillo MP, Perez B, Gozalez R, Fernandez M, Miranda JA. Value of intrapartum transcervical amnioinfusion in pregnancies with oligohydramnios and integral ovular membranes. *Journal of Perinatal Medicine* 2001;**29 Suppl 1**:632.

Regi 2009 {published and unpublished data}

Regi A, Alexander N, Jose R, Lionel J, Varghese L, Peedicayil A. Amnioinfusion for relief of recurrent severe and moderate variable decelerations in labor. *Journal of Reproductive Medicine* 2009;**54**(5):295-302.

Schrimmer 1991 {published data only}

Schrimmer DB, Macri CJ, Paul RH. Prophylactic amnioinfusion as a treatment for oligohydramnios in laboring patients: a prospective, randomized trial. *American Journal of Obstetrics and Gynecology* 1991;**164**:305.

Schrimmer DB, Macri CJ, Paul RH. Prophylactic amnioinfusion as a treatment for oligohydramnios in labouring patients: a prospective, randomized trial. *American Journal of Obstetrics and Gynecology* 1991;**165**:972-5.

Strong 1990 {published data only}

Strong TH, Hetzler G, Sarno AP, Paul RH. Prophylactic intrapartum amnioinfusion: a randomized clinical trial. *American Journal of Obstetrics and Gynecology* 1990;**162**:1370-5.

Vergani 1996 {published data only}

Vergani P, Ceruti P, Strobelt N, Locatelli A, D'Oria P, Mariani S. Transabdominal amnioinfusion in oligohydramnios at term before induction of labor with intact membranes: a randomized clinical trial. *American Journal of Obstetrics and Gynecology* 1996;**175**:465-70.

Wang 1997 {published data only}

Wang CC, Rogers MS. Lipid peroxidation in cord blood: a randomised sequential pairs study of prophylactic saline amnioinfusion for intrapartum oligohydramnios. *British Journal of Obstetrics and Gynaecology* 1997;**104**(10):1145-51.

Wu 1989 {published data only}

Wu BT. Intrapartum amnioinfusion in patients with oligohydramnios. *Chung Hua Fu Chan Ko Tsa Chih* 1989;**24**:2-4.

References to studies excluded from this review
McDermot 1998 {published data only}

McDermott TM, Parilla BV. Amnioinfusion as a therapy to reduce post partum endometriosis after chorioamnionitis. *American Journal of Obstetrics and Gynecology* 1998;**178**(1):S212.

McEvoy 1991 {published data only}

* McEvoy C, Sardesai S, Macri C, Paul R, Durand M. Neonatal pulmonary mechanics and oxygenation after prophylactic amnioinfusion in labor: a randomized clinical trial. *Pediatrics* 1995;**95**:688-92.

McEvoy C, Sardesai S, Macri C, Paul R, Durand M. Neonatal pulmonary mechanics and oxygenation following prophylactic amnioinfusion in labour: a randomized clinical trial. *Pediatric Research* 1991;**29**:226A.

Monahan 1995 {published data only}

Monahan E, Katz VL, Cox RL. Amnioinfusion for preventing puerperal infection. A prospective study. *Journal of Reproductive Medicine* 1995;**40**:721-3.

Muse 1997 {published data only}

Muse K, Cooke R, Milligan D. Cold amnioinfusion does not induce the neonatal thyrotropin surge in utero. *Fertility and Sterility* 1997;**Suppl**:S77-S78.

Pressman 1996 {published data only}

Pressman EK, Blakemore KJ. A prospective randomised trial of two solutions for intrapartum amnioinfusion: effects on fetal electrolytes, osmolality, and acid base status. *American Journal of Obstetrics and Gynecology* 1996;**175**:945-9.

Rinehart 2000 {published data only}

Rinehart BK, Terrone DA, Barrow JH, Isler CM, Barrilleaux PS, Roberts WE. Randomized trial of intermittent or continuous amnioinfusion for variable decelerations. *Obstetrics & Gynecology* 2000;**96**(4):571-4.

Washburne 1996 {published data only}

* Washburne JF, Chauhan SP, Magann EF, Rhodes PG, Naef RW, Morrison JC. Neonatal electrolyte response to amnioinfusion with lactated Ringer's solution vs. normal saline. *Journal of Reproductive Medicine* 1996;**41**:741-4.

Washburne JF, Chauhan SP, Magann EF, Rhodes PH, Wilkins PW, Morrison JC. Newborn electrolyte responses to amnioinfusion with lactated ringer's vs normal saline: a randomized prospective study. *American Journal of Obstetrics and Gynecology* 1994;**170**:376.

Additional references
Alderson 2004

Alderson P, Green S, Higgins JPT, editors. Cochrane Reviewers' Handbook 4.2.2 [updated March 2004]. In: Review Manager (RevMan) [Computer program]. Oxford, England: The Cochrane Collaboration, 2004.

Benifla 1995

Benifla JL, Goffinet F, Bascou V, Darai E, Proust A, Madelenat P. Transabdominal amnioinfusion facilitates external version manoeuvre after initial failure. *Journal de Gynecologie, Obstetrique et Biologie de la Reproduction (Paris)* 1995;**24**:319-22.

Dibble 1992

Dibble LA, Elliot JP. Possible amniotic fluid embolism associated with amnioinfusion. *Journal of Maternal-Fetal Medicine* 1992;**1**:263-6.

Dragich 1991

Dragich DA, Ross AF, Chestnut DH, Wenstrom KD. Respiratory failure associated with amnioinfusion during labor. *Anesthesia & Analgesia* 1991;**72**:549-51.

Egger 1997

Egger M, Smith GD, Schneider M, Minder C. Bias in meta-analysis detected by a simple, graphical test. *BMJ* 1997;**315**:629-34.

Gabbe 1976

Gabbe SG, Ettinger BB, Freeman RK, Martin CB. Umbilical cord compression associated with amniotomy: laboratory observations. *American Journal of Obstetrics and Gynecology* 1976;**126**:353-5.

Goodlin 1981

Goodlin RC. Intra-amniotic antibiotic infusions. *American Journal of Obstetrics and Gynecology* 1981;**139**:975.

Gramellini 2003

Gramellini D, Fieni S, Kaihura C, Piantelli G, Verrotti C. Antepartum amnioinfusion: a review. *Journal of Maternal-Fetal & Neonatal Medicine* 2003;**14**:291-6.

Harbord 2006

Harbord RM, Egger M, Sterne JA. A modified test for small-study effects in meta-analyses of controlled trials with binary endpoints. *Statistics in Medicine* 2006;**25**:3443-57.

Higgins 2011

Higgins JPT, Green S, editors. Cochrane Handbook for Systematic Reviews of Interventions Version 5.1.0 [updated March 2011]. The Cochrane Collaboration, 2011. Available from www.cochrane-handbook.org.

Hofmeyr 1998

Hofmeyr GJ. Amnioinfusion for preterm rupture of membranes. *Cochrane Database of Systematic Reviews* 1998, Issue 1. [DOI: [10.1002/14651858.CD000942](https://doi.org/10.1002/14651858.CD000942)]

Hofmeyr 2010

Hofmeyr GJ, Xu H. Amnioinfusion for meconium-stained liquor in labour. *Cochrane Database of Systematic Reviews* 2010, Issue 1. [DOI: [10.1002/14651858.CD000014.pub3](https://doi.org/10.1002/14651858.CD000014.pub3)]

Macri 1992

Macri CJ, Schrimmer DB, Leung A, Greenspoon JS, Paul RH. Prophylactic amnioinfusion improves outcome of pregnancy complicated by thick meconium and oligohydramnios. *American Journal of Obstetrics and Gynecology* 1992;**167**(1):117-21.

Maher 1994

Maher JE, Wenstrom KD, Hauth JC, Meis BJ. Amniotic fluid embolism after saline amnioinfusion: two cases and review of the literature. *Obstetrics & Gynecology* 1994;**83**:851-4.

Mino 1997a

Mino M, Puertas A, Mozas J, Carrillo Badillo MP, Rodríguez Oliver A, Miranda JA. A modification of the amniotic fluid index after aminioinfusion for infants with early rupture of membranes [Modificación del índice de líquido amniótico tras amnioinfusión en gestantes con rotura prematura de membranas a término]. *Acta Ginecológica* 1997;**54**(1):11-4.

Mino 1997b

Mino M, Puertas A, Carrillo MP, Santiago JC, Herruzo AJ, Miranda JA. Influence of amnioinfusion on variable or prolonged decelerations: a randomised study. *Acta Obstetrica et Gynecologica Scandinavica* 1997;**76**(167):95.

Mino 1998

Mino M, Puertas A, Herruzo AJ, Miranda JA. Amnioinfusion in labor induction of term pregnancies with premature rupture of the membranes and low amniotic fluid. *International Journal of Gynecology & Obstetrics* 1998;**61**:135-40.

Miyazaki 1983

Miyazaki FS, Taylor NA. Saline amnioinfusion for relief of prolonged variable decelerations. *American Journal of Obstetrics and Gynecology* 1983;**146**:670-8.

Novikova 1996

Novikova N, Hofmeyr GJ, Essilfie-Appiah G. Prophylactic versus therapeutic amnioinfusion for oligohydramnios in labour. *Cochrane Database of Systematic Reviews* 1996, Issue 1. [DOI: [10.1002/14651858.CD000176](https://doi.org/10.1002/14651858.CD000176)]

Ogita 1988

Ogita S, Imanaka M, Matsumoto M, Oka T, Sugawa T. Transcervical amnioinfusion of antibiotics: a basic study for managing premature rupture of membranes. *American Journal of Obstetrics and Gynecology* 1988;**158**:23-7.

Puertas 1997

Puertas A, Mino M, Carrillo MP, Mozas J, Herruzo AJ, Miranda JA. Influence of amnioinfusion on neonatal acid-base state: a randomized study. *Acta Obstetrica et Gynecologica Scandinavica* 1997;**76** Suppl(167:1):94.

RevMan 2003 [Computer program]

The Cochrane Collaboration. Review Manager (RevMan). Version 4.2 for Windows. Oxford, England: The Cochrane Collaboration, 2003.

Revman 2011 [Computer program]

The Nordic Cochrane Centre, The Cochrane Collaboration. Review Manager (RevMan). Version 5.1. Copenhagen: The Nordic Cochrane Centre, The Cochrane Collaboration, 2011.

Wax 2004

Wax JR, Flaherty N, Pinette MG, Blackstone J, Cartin A. Small-volume amnioinfusion: a potential stimulus of intrapartum fetal heart rate accelerations. *American Journal of Obstetrics and Gynecology* 2004;**190**:380-2.

Wegnelius 1996

Wegnelius G, Bergstrom M, Ahlbom L, Thomassen P. A case report of life-threatening pulmonary edema. *European Journal of Obstetrics & Gynecology and Reproductive Biology* 1996;**65**(2):237-9.

Wenstrom 1994

Wenstrom KD, Andrews WW, Maher JE. Prevalence, protocols and complications associated with amnioinfusion. *American Journal of Obstetrics and Gynecology* 1994;**170**:341.

References to other published versions of this review

Hofmeyr 1995

Hofmeyr GJ. Amnioinfusion in intrapartum umbilical cord compression (potential, or diagnosed by electronic fetal monitoring). [revised 24 March 1993]. In: Enkin MW, Keirse MJNC, Renfrew MJ, Neilson JP, Crowther C (eds.) *Pregnancy and Childbirth Module*. In: The Cochrane Pregnancy and Childbirth Database [database on disk and CDROM]. The Cochrane Collaboration; Issue 2, Oxford: Update Software; 1995.

Hofmeyr 1996

Hofmeyr GJ, Gulmezoglu AM, Nidodem VC, de Jager M.
Amnioinfusion. *European Journal of Obstetrics & Gynecology and Reproductive Biology* 1996;**64**:159-65.

* Indicates the major publication for the study

CHARACTERISTICS OF STUDIES
Characteristics of included studies [ordered by study ID]

Abdel-Aleem 2005

Methods	Randomised trial conducted in Egypt. Randomisation by a random number table; allocation concealment by sealed opaque envelopes. Intention-to-treat analysis.
Participants	438 women in labour with fetal distress diagnosed on a FHR tracing. Inclusion criteria: single fetus, vertex presentation, gestational age > 37 weeks, cervical dilatation < 5 cm. Exclusion criteria: vaginal bleeding, fetal anomalies, uterine scars, uterine anomalies, malpresentation, intrauterine growth retardation, maternal temperature higher than 38C, grand multiparity (> 5) and severe pre-eclampsia.
Interventions	Amnioinfusion with a 1000 ml warmed NS solution via a paediatric feeding tube vs no amnioinfusion. (A bolus of 500 ml was infused over 30 minutes followed by another 500 ml over 15-20 min.) If the FHR pattern did not become reassuring after the first 200 ml, a CS was performed; if the FHR pattern was corrected the infusion was completed.
Outcomes	Neonatal Apgars, meconium, admission to NICU, mode of delivery, maternal fever, hospital stay longer than 3 days, maternal complications.
Notes	Fetal blood gas monitoring not available in this hospital setting, otherwise a high-quality trial.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number table.
Allocation concealment (selection bias)	Low risk	Sealed opaque envelopes.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No missing data.
Selective reporting (reporting bias)	Low risk	Intention-to-treat analysis. All outcomes reported.
Other bias	Low risk	A good quality trial.

Amin 2003

Methods	Computer-generated random sequence in sequentially numbered opaque sealed envelopes.
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Amin 2003 (Continued)

Participants	Women in early labour (cervix < 4 cm); 37 or more weeks' gestation; 4-quadrant AFI < 5 cm; membranes intact or ruptured; singleton term gestation; vertex presentation; normal FHR pattern. Exclusion criteria: vaginal bleeding; fetal congenital anomalies; fever; symmetrical fetal growth impairment; grand multiparity; uterine anomalies or scars; severe pre-eclampsia; estimated fetal weight < 1500 g; meconium-stained amniotic fluid.
Interventions	Transcervical amnioinfusion of 500 ml normal saline at 37 degrees centigrade over 30 minutes then 500 ml by gravity infusion, then re-evaluation of AFI vs routine care. Continuous FHR monitoring in both groups.
Outcomes	160/182 women gave consent. There were no exclusions after enrolment. Baseline data were similar between groups. Mean AFI in the amnioinfusion group increased from 3.2 (SD 1.3) to 11.8 (1.5) after amnioinfusion. Outcomes: abnormal FHR patterns; caesarean section; Apgar scores; meconium below cords; umbilical artery pH; need for intensive care admission; maternal hypertonus; pyrexia and hospital stay.
Notes	February 2000 to September 2001, Assuit University Hospital.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated random sequence.
Allocation concealment (selection bias)	Low risk	Sequentially numbered opaque sealed envelopes.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Low risk	No post-randomisation exclusions.
Selective reporting (reporting bias)	Low risk	Baseline data similar. Outcomes pre-specified.
Other bias	Low risk	A good quality trial.

Busowski 1995

Methods	'Prospectively randomised', method not specified.
Participants	Inclusion criteria: decreased amniotic fluid prior to induction of labour. Exclusion criteria: chorioamnionitis; fetal distress; non-vertex presentation; vaginal bleeding.
Interventions	Transabdominal amnioinfusion prior to induction of labour with 250 ml normal saline over 20 minutes under ultrasound guidance using a 22 gauge needle (n = 16), compared with no amnioinfusion (n = 15).
Outcomes	Caesarean section for fetal distress; cord pH < 7.20; 5-minute Apgar scores < 7. Data on caesarean section rates overall have been requested from the authors.
Notes	Considered separately from transcervical amnioinfusion as is a fundamentally different procedure.

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

Busowski 1995 (Continued)

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	High risk	Inadequate.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Authors contacted for clarity.
Selective reporting (reporting bias)	Unclear risk	Overall caesarean section rates not reported.
Other bias	Unclear risk	Details not available for 2011 review.

Chauhan 1992

Methods	Randomisation using sealed envelopes drawn from a box.
Participants	Inclusion criteria: women in labour; gestational age 37 or more weeks; AFI 5 cm or less; no FHR tracing abnormalities. Exclusion criteria: multiple pregnancy; ruptured membranes; late FHR decelerations; variable decelerations; non-reactive FHR patterns; chorioamnionitis; thick meconium; inability to place fetal scalp lead and the intrauterine pressure catheter at the time of artificial amniotomy.
Interventions	Amnioinfusion with 250 ml normal saline at room temperature, followed if necessary by repeat infusions of 100 ml until an AFI of 5 cm or more achieved (n = 21), compared with control group (n = 17).
Outcomes	Recurrent (5 or more) moderate or severe variable decelerations or bradycardia; caesarean section for fetal distress; caesarean section overall; intrauterine resuscitation with terbutaline; Apgar score < 7 at 1 minute; Apgar score < 7 at 5 minutes; umbilical arterial pH < 7.2; perinatal death.
Notes	An additional 15 women who refused participation were included as a comparison group. As they were not subject to random allocation, their results have not been included in this review. The interpretation of FHR response to the amnioinfusion may have been subject to bias as tracings were not stated to have been assessed 'blind'.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Sealed envelopes drawn from a box.
Blinding (performance bias and detection bias)	Unclear risk	Assessor blinding not described.

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

Chauhan 1992 (Continued)

All outcomes

Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Details not available for 2011 review.
Selective reporting (reporting bias)	Unclear risk	Details not available for 2011 review.
Other bias	Unclear risk	An additional 15 women who refused participation were included as a comparison group. As they were not subject to random allocation, their results have not been included in this review.

Gonzalez 2001

Methods	"Randomly assigned", no other details.
Participants	44 women in preterm labour (spontaneous or induced) with premature rupture of membranes.
Interventions	Amnioinfusion (24) vs no amnioinfusion (20).
Outcomes	Mode of delivery, FHR patterns.
Notes	Abstract only, results presented as percentages only and so no usable data from this report. More fetal distress reported in control group (15% vs 4%).

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomly assigned", no other details.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	not described.
Selective reporting (reporting bias)	Unclear risk	Results reported as percentages only.
Other bias	Unclear risk	Unclear.

MacGregor 1991

Methods	'Randomized', method not given.
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MacGregor 1991 (Continued)

Participants	Inclusion criteria: oligohydramnios (no amniotic fluid pocket measuring > 1 x 1 cm on ultrasound examination); singleton pregnancy; > 26 weeks' gestation (11/35 were < 35 weeks); cephalic presentation; cervical dilatation < 8 cm; no suspicion of intra-amniotic infection; no vaginal bleeding; no FHR pattern necessitating urgent delivery.
Interventions	Amnioinfusion during labour with Ringer's solution warmed to 37 degrees centigrade at 10 ml per minute for 1 hour and continued if variable decelerations persisted until decelerations ceased or 800 ml had been infused, followed by infusion at 3 ml per minute till delivery (n = 19), compared with control group (n = 16).
Outcomes	Persistent variable decelerations; umbilical cord prolapse; caesarean section for suspected fetal distress; caesarean section overall; perinatal death; postpartum endometritis; umbilical arterial pH < 7.20.
Notes	All but 1 case of postpartum endometritis followed caesarean section. Maternal age higher in the amnioinfusion group (26.4 vs 23.1 years).

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Not described.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Details not available for 2011 review update.
Selective reporting (reporting bias)	Unclear risk	Details not available for 2011 review update.
Other bias	Unclear risk	Details not available for 2011 review update.

Mino 1999

Methods	Randomisation by random number table. Allocation concealment not described.
Participants	200 women with prelabour rupture of membranes at term for induction of labour with oxytocin. Included if AFI < 10 cm and 'normal fluid volume had been observed the week before' PROM. Excluded if multiple pregnancy, vaginal bleeding, fetal or uterine anomalies, non-vertex presentation, fetal distress, and MSL, maternal viral infection.
Interventions	Amnioinfusion in early labour (600 ml warm normal saline over 1 hour; AFI repeated, if < 15 cm, amnioinfusion was continued at 180 ml/hour until full dilatation achieved or uterine baseline activity reached 20 mmHg) vs no amnioinfusion.
Outcomes	Not clearly pre-specified. Fetal umbilical artery pH at delivery, neonatal acidosis, Apgar scores, mode of delivery, pathological FHR patterns, maternal and neonatal infection-related data.

Mino 1999 (Continued)

Notes We have grouped the 1997 and 1998 Minô reports together with this trial as they seem to be earlier reports of the same trial. We were unfortunately unsuccessful in our attempts to contact the authors for clarity.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation by random number table.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Adequate.
Selective reporting (reporting bias)	Unclear risk	See below.
Other bias	Unclear risk	Four other reports (Mino 1997a ; Mino 1997b ; Mino 1998 ; Puertas 1997) seem to be of the same trial and yet there are no references in the 1999 article to the other reports.

Miyazaki 1985

Methods	Allocation by sealed envelopes.
Participants	Women with variable FHR decelerations during labour. Exclusions included severely abnormal FHR tracings, advanced labour, labour ward too busy and non-participation in the study of some attending staff.
Interventions	Amnioinfusion during labour with normal saline until decelerations resolved plus 250 ml (maximum 800 ml) and repeated if necessary (n = 49), compared with control group (n = 47).
Outcomes	Persistent variable decelerations; umbilical cord prolapse; caesarean section for suspected fetal distress; Apgar score < 7 at 1 minute; Apgar score < 7 at 5 minutes; perinatal death.
Notes	FHR tracings not stated to have been assessed 'blind'.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Randomised."
Allocation concealment (selection bias)	Low risk	Sealed envelopes.

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

Miyazaki 1985 (Continued)

Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Details not available for 2011 review update
Selective reporting (reporting bias)	Low risk	All pre-specified outcomes reported.
Other bias	Unclear risk	Details not available for 2011 review update.

Nageotte 1985

Methods	'Random' allocation (method not specified).
Participants	Women with clinically confirmed spontaneous prelabour rupture of the membranes at 26 to 35 weeks' gestation, ultrasound-diagnosed oligohydramnios, vertex presentation and no fetal anomaly or distress.
Interventions	Intrapartum amnioinfusion with normal saline warmed to 37 degrees centigrade at 10 ml per minute for 1 hour (repeated if large fluid loss occurred subsequently), followed by infusion at 3 ml per minute (n = 29), compared with control group (n = 32). All participants had intrauterine pressure catheter inserted as early in labour as possible.
Outcomes	Caesarean section for suspected fetal distress; caesarean section, overall; perinatal death; postpartum endometritis; Apgar score < 7 at 1 minute; incidence of variable decelerations in first and second stage labour; umbilical arterial pH.
Notes	There were 5 withdrawals after randomisation, for apparently legitimate reasons.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"Random allocation."
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	There were 5 withdrawals after randomisation, for apparently legitimate reasons.
Selective reporting (reporting bias)	Unclear risk	Details not available for 2011 review update.
Other bias	Unclear risk	Details not available for 2011 review update.

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

Nageotte 1991

Methods	Allocation by random number table using sealed envelopes.
Participants	Inclusion criteria: postdates pregnancy (42 or more weeks), or suspected impaired fetal growth (clinical impression confirmed by poor growth on ultrasound measurements and estimated fetal weight below the 10th percentile for gestational age), plus oligohydramnios (AFI < 8 cm). Exclusion criteria: previous classical caesarean section; non-vertex presentation; placenta praevia.
Interventions	Comparison between warmed saline (93-96 degrees Fahrenheit) group, room temperature saline (68-72 degrees Fahrenheit) group (together n = 50), and control group (n = 26). Amnioinfusion rate was 10 ml per minute for 1 hour, then 3 ml per minute until delivery, briefly stopped every 30 minutes to evaluate resting tone.
Outcomes	Meconium-stained amniotic fluid; umbilical cord prolapse; ruptured membranes to delivery interval; maximum maternal temperature intrapartum; variable FHR decelerations per hour in first and second stage of labour; caesarean section for suspected fetal distress; caesarean section overall; Apgar score < 7 at 5 minutes; umbilical artery pH; perinatal death; meconium below the cords; meconium aspiration syndrome.
Notes	3 women in the control group received amnioinfusion and 3 in the amnioinfusion groups did not, but analysis was in the original groups according to intention to treat. The maternal and neonatal temperatures given are for the control and the warmed saline group. The room temperature saline group temperatures were identical to the control group. For all other analyses, the 2 amnioinfusion groups are grouped together.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Random number table.
Allocation concealment (selection bias)	Low risk	Sealed envelopes.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Details not available for 2011 review update.
Selective reporting (reporting bias)	Low risk	3 women in the control group received amnioinfusion and 3 in the amnioinfusion groups did not, but analysis was in the original groups according to intention to treat.
Other bias	Low risk	Details not available for 2011 review update.

Owen 1990

Methods	Randomly allocated using sealed envelopes.
Participants	Women in spontaneous labour or due for induction of labour with no previous positive contraction stress test, with 1 of the following: postdates (at least 42 weeks) (5 amnioinfusion and 6 control); recur-

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

Owen 1990 (Continued)

rent mild to moderate variable decelerations in labour unresponsive to maternal position change, hydration and oxygen therapy (13 and 20); preterm labour (before 37 weeks) (11 and 18); or oligohydramnios and/or suspected impaired fetal growth (14 and 13).

Interventions	Amnioinfusion during labour with saline warmed to 37 degrees Centigrade at 10 ml per minute for 1 hour, then 3 ml per minute (n = 43), was compared with a control group (n = 57). All women had intrauterine pressure transducers. Amnioinfusion was performed through a second intrauterine catheter.
Outcomes	Umbilical cord prolapse; caesarean section for suspected fetal distress; caesarean section overall; forceps or vacuum for suspected fetal distress; Apgar score < 7 at 5 minutes; cord arterial pH < 7.2; perinatal death; postpartum endometritis; admission to high-risk nursery. The 4-quadrant AFI in 31 cases increased from mean 9.8 cm (SD 3.8) to 14.7 (3.7) after amnioinfusion.
Notes	The treatments were not blinded. There was an unexplained imbalance between the treatment and control group, and within the various enrolment categories which might have influenced results. For example, in the amnioinfusion group there were relatively fewer women enrolled for variable decelerations and preterm labour. Personal communication with the first author revealed that the discrepancies were partly due to chance and partly due to withdrawal of a few women from the amnioinfusion group who for technical reasons did not receive amnioinfusion. These withdrawals may have affected the results.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	"randomly allocated."
Allocation concealment (selection bias)	Low risk	Sealed envelopes.
Blinding (performance bias and detection bias) All outcomes	High risk	The treatments were not blinded.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Unpublished data provided by author.
Selective reporting (reporting bias)	Unclear risk	Withdrawals due to technical reasons may have affected results.
Other bias	Low risk	No other bias noted.

Persson-Kjerstadius 1999

Methods	Randomised trial conducted in Sweden between Sept 1994 and March 1996. Sealed envelopes were used for allocation; envelopes were used in sequential 'random order'; randomisation code not disclosed to participants or study coordinator; no post-randomisation exclusions. Sample size not specified.
Participants	112 women at term in labour or who were to be induced, with an AFI of < 5 cm on ultrasound. Excluded if placenta praevia, maternal fever or multiple pregnancy.

Persson-Kjerstadius 1999 (Continued)

Interventions	Amnioinfusion during labour (500 ml normal saline at 37°C infused over 30 min, ultrasound repeated 1 hour after infusion - if repeat AFI < 8 another 250 ml infused) vs no amnioinfusion.
Outcomes	FHR abnormalities, mode of delivery, Apgar score, pH in umbilical artery blood and NICU admission.
Notes	Imbalance in group size with 60 in study group vs 52 in the control group. Missing data: 4/60 in study group not reported on for mode of delivery. Some outcomes reported as percentages (abnormal FHR patterns) and total number of subjects for each outcome not always stated. Umbilical artery pH data presented as means without SD. Authors were contacted but were unable to clarify these issues.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Sealed envelopes drawn at random out of a mixed box.
Allocation concealment (selection bias)	Low risk	Sealed envelopes.
Blinding (performance bias and detection bias) All outcomes	High risk	Participant and investigator blinding not possible due to intervention. Blinding of assessor of FHR patterns not described.
Incomplete outcome data (attrition bias) All outcomes	High risk	Missing data: 4/60 in study group not reported on for mode of delivery. This could affect the findings related to caesarean section rate and/or vacuum extraction. It is not clear whether missing data is due to bias.
Selective reporting (reporting bias)	Unclear risk	All outcomes reported but denominators and SDs missing.
Other bias	High risk	Imbalance in group size, some outcomes reported as percentages (denominators absent) and four cases missing. Moderate risk of bias.

Puertas 2001

Methods	'Randomised clinical assay.'
Participants	Women in labour, intact membranes and oligohydramnios (AFI < 8).
Interventions	Intrapartum transcervical amnioinfusion during labour vs no amnioinfusion; continuous monitoring of FHR, fetal oxygen saturation and intrauterine pressure.
Outcomes	Interventions for fetal distress; neonatal acid-base status.
Notes	University Hospital, Granada. Data not included yet as only percentages given in the abstract.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	'Randomised.'

Puertas 2001 (Continued)

Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Data presented as percentages.
Selective reporting (reporting bias)	Unclear risk	Data presented as percentages.
Other bias	Unclear risk	Onyl brief information provided (abstract).

Regi 2009

Methods	Randomised controlled trial conducted in India between October 2003 and September 2004; computer-generated random number table used and allocation concealed via sequential sealed opaque envelopes. Diagnosis of fetal distress made by 2 clinicians.
Participants	150 pregnant women > 34 weeks' gestation with the presence of severe repetitive variable decelerations in active labour. Exclusion criteria: variable decelerations with poor variability or delayed recovery, baseline bradycardia or tachycardia, repetitive late decelerations, Grade II and III MSL, previous caesarean section, and the presence of a contraindication to vaginal delivery.
Interventions	Amnioinfusion during labour (500 ml warmed normal saline over 30 minutes then a continuous infusion of 3 ml/minutes until delivery) vs no amnioinfusion.
Outcomes	FHR patterns, neonatal Apgars, mode of delivery, fetal distress, duration of labour, ROM to delivery interval, umbilical artery pH, length of hospital stay.
Notes	Sample size estimated to be 400 but study was discontinued after 150 participants due to a significant relief of variable decelerations in the amnioinfusion group. Baseline characteristics were similar between groups. Attempts to contact authors for unpublished data were unsuccessful.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	Computer-generated random number table.
Allocation concealment (selection bias)	Low risk	Sequential sealed opaque envelopes.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not possible.
Incomplete outcome data (attrition bias)	Unclear risk	Two post-randomisation exclusions after not receiving the intervention.

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

Regi 2009 (Continued)

All outcomes

Selective reporting (reporting bias)	Low risk	All expected outcomes reported.
Other bias	Low risk	A good quality trial.

Schrimmer 1991

Methods	Computer randomisation with treatment: non-treatment ratio of 3:2, using sealed envelopes.
Participants	Inclusion criteria: women in labour or admitted for induction of labour, with oligohydramnios (4-quadrant AFI < 5 cm); singleton vertex presentation; normal FHR baseline and variability. Exclusion criteria: moderate or severe variable decelerations; late decelerations; vaginal bleeding; fetal anomalies; chorioamnionitis.
Interventions	Amnioinfusion of 500 ml saline warmed to 37 degrees centigrade infused by gravity over 20-30 minutes (15 to 25 ml per minute), followed by repeat ultrasound examination after initial infusion and hourly, and reinfusion of 500 ml if AFI < 5 cm, 250 ml if AFI > 5 and < 10 cm (n = 175), compared with control group (n = 130). Women in both groups had intrauterine pressure transducers inserted.
Outcomes	Increase in AFI after 500 ml infusion (mean 8.4, SD 1.4 cm); amnionitis (amnioinfusion 18/175 vs control 9/130); caesarean section for suspected fetal distress; caesarean section overall; forceps or vacuum for suspected fetal distress; forceps or vacuum delivery overall; Apgar score < 7 at 1 minute; Apgar score < 7 at 5 minutes; cord arterial pH < 7.2; perinatal death; postpartum endometritis; maternal hospital stay > 3 days; neonatal hospital stay > 3 days.
Notes	Los Angeles, California, USA. August 1989 to September 1990. 85 subjects from this study are included in the report of Macri 1992 (Paul RH, personal communication). (See Cochrane review ' Hofmeyr 2010 ').

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer randomisation.
Allocation concealment (selection bias)	Low risk	Sealed envelopes.
Blinding (performance bias and detection bias) All outcomes	High risk	Study not blinded, but research procedures carried out by researchers not involved in clinical care and clinical decisions.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low attrition.
Selective reporting (reporting bias)	Low risk	All expected outcomes reported.
Other bias	Unclear risk	Discrepancy between the number of caesarean sections in the amnioinfusion group ascribed to fetal distress, between the preliminary report and the final report (24/171 vs 14/175).

Strong 1990

Methods	Randomised permuted block technique (n = 6) allocation using sealed envelopes.
Participants	Inclusion criteria: labouring women with oligohydramnios (AFI < 5 cm); singleton vertex presentation; 4 cm or less cervical dilatation; 37 or more weeks gestation; normal baseline FHR variability; estimated fetal weight > 2500 g. Exclusion criteria: late FHR decelerations; moderate or severe variable decelerations; vaginal bleeding; chorioamnionitis; meconium-stained amniotic fluid; fetal anomalies; uterine anomalies.
Interventions	Amnioinfusion during labour of 250 ml saline warmed to 37 degrees centigrade at 10 to 20 ml per minute, repeated until an AFI of 8 cm was reached and if the AFI fell below 8 cm on subsequent hourly ultrasound examinations (n = 30), compared with control group (n = 30).
Outcomes	Persistent variable decelerations; meconium-stained amniotic fluid; umbilical cord prolapse; caesarean section for suspected fetal distress; caesarean section overall; forceps or vacuum for suspected fetal distress; forceps or vacuum delivery overall; Apgar score < 7 at 1 minute; Apgar score < 7 at 5 minutes; umbilical cord arterial pH < 7.20; neonatal sepsis; perinatal death; rupture of membranes to delivery interval; intrapartum maternal temperature > 38 degrees centigrade.
Notes	The rupture of membranes to delivery interval was longer in the amnioinfusion group (mean 16.8, SD 12.1 hours) than the control group (10.1, 6.5), and this difference persisted for vaginal deliveries (data not given). This result is difficult to interpret as the incidence of ruptured membranes at admission in the amnioinfusion group was 15/30 compared with 8/30 in the control group. The longer duration of ruptured membranes may thus have been related to a chance difference in the groups rather than an effect of amnioinfusion. The same may apply to the excess of maternal pyrexia in the amnioinfusion group.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Block randomisation.
Allocation concealment (selection bias)	Low risk	Sealed envelopes.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low attrition.
Selective reporting (reporting bias)	Low risk	All expected outcomes reported.
Other bias	Unclear risk	Baseline imbalance in groups with regard to the incidence of ruptured membranes at enrolment might have affected some outcomes.

Vergani 1996

Methods	Allocation by a 'computer generated randomisation table'. Not specified whether next allocation concealed prior to enrolment.
Participants	Non-labouring primiparous women at term with ultrasonographic diagnosis of oligohydramnios (largest amniotic fluid pocket < 2 x 2 cm on perpendicular planes); singleton gestation; vertex presentation; gestational age 37+ weeks; ultrasound estimated fetal weight 2500 g+; reactive non-stress test; cervical Bishop score 6 or less; intact membranes. Exclusion criteria: maternal indications leading to an elective caesarean section.
Interventions	Transabdominal amnioinfusion before labour under ultrasonographic guidance: normal saline 500 ml at 37 degrees centigrade infused through a 20-gauge spinal needle at 30 ml per minute. Sulbactam-ampicillin 3 gm given intravenously (n = 39). Compared with no amnioinfusion (n = 40). Labour induction within 1-4 hours of randomisation: for Bishop score 4 or less, intracervical prostaglandin E2 0.5 mg, repeated 3 times 6-hourly; for Bishop score 5-6 intravaginal prostaglandin E2 1.5 mg, repeated twice at 8 hour intervals. Membranes were ruptured when Bishop score was > 6 or all the doses of prostaglandins had been given, and oxytocin infusion started after 2 hours if not in labour.
Outcomes	Apgar score at 5 minutes; umbilical artery pH; meconium-stained amniotic fluid; maternal infectious morbidity; neonatal complications.
Notes	Power calculation required 114 participants in each group to show a 75% reduction in caesarean section for fetal distress. The study was suspended when an interim analysis showed that significance had been reached (total 79 participants). Spontaneous onset of labour occurred in 5 women after amnioinfusion.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Computer-generated.
Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Not described.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Low attrition.
Selective reporting (reporting bias)	Low risk	All expected outcomes reported.
Other bias	Low risk	No other bias noted.

Wang 1997

Methods	Randomised trial; randomisation performed sequentially in pairs by tossing a coin for the first woman in the pair.
Participants	92 women with singleton term pregnancy, cephalic presentation, no MSL, with oligohydramnios (AFI ≤ 5 cm), normal FHR pattern 30 minutes after amniotomy.

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

Wang 1997 (Continued)

Interventions	Amnioinfusion during labour (1 litre normal saline at room temp infused over 30 min, repeated if AFI remained ≤ 5 cm on ultrasound 30 minutes later) vs no amnioinfusion.
Outcomes	Fetal arterial lipid peroxidase levels, neonatal arterial pH and base excess, mode of delivery.
Notes	Investigators excluded 7 participants in each group after randomisation where the blood specimens were considered questionable i.e. the specimens could not be definitely identified as arterial (primary outcomes were biochemical), leaving 39 participants in each group. Continuous data presented as mean [range] without SDs so not usable for this review.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Randomisation in pairs by coin-tossing.
Allocation concealment (selection bias)	Unclear risk	Once first participant's group was allocated, was second patient's allocation revealed?
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Partial blinding as investigators were not involved in the clinical decision making or interpreting of FHR tracings.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	7 post-randomisation exclusions in each group due to "questionable blood samples" - samples that could not be definitely identified as arterial.
Selective reporting (reporting bias)	Low risk	6 patients in the study group did not receive amnioinfusion due to rapid delivery but were analysed by intention-to-treat.
Other bias	Low risk	No other potential bias noted.

Wu 1989

Methods	'Randomized'. Method not specified.
Participants	Hospitalised women in labour, full-term or post-term, vertex presentation, amniotic area ≥ 2 cm on ultrasound or < 100 ml obtained at rupture of membranes.
Interventions	Amnioinfusion during labour with normal saline warmed to 37 degrees centigrade, 500 ml at 15-20 ml per minute followed by slow or intermittent infusion (n = 60), compared with controls (n = 58).
Outcomes	'Mild or severe birth asphyxia'; caesarean section for suspected fetal distress; caesarean section overall; perinatal death; postpartum endometritis.
Notes	'Postpartum morbidity' interpreted as postpartum endometritis.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	'Randomised.'

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

Wu 1989 (Continued)

Allocation concealment (selection bias)	Unclear risk	Not described.
Blinding (performance bias and detection bias) All outcomes	Unclear risk	Details not available for the 2011 review update.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Details not available for the 2011 review update.
Selective reporting (reporting bias)	Unclear risk	Details not available for the 2011 review update.
Other bias	Unclear risk	Details not available for the 2011 review update.

AFI: amniotic fluid index

CS: caesarean section

FHR: fetal heart rate

icu: intensive care unit

MSL: meconium-stained liquor

NICU: neonatal intensive care unit

NS: normal saline

ROM: rupture of membranes

SD: standard deviation

vs: versus

Characteristics of excluded studies [ordered by study ID]

Study	Reason for exclusion
McDermot 1998	This randomised trial compares amnioinfusion with no amnioinfusion for 34 women with chorioamnionitis in labour, on subsequent postpartum endometritis. Results found 3/16 women in the study group and 2/16 women in the control group had postpartum endometritis; 1 neonatal infection occurred in the study group and none in the control group.
McEvoy 1991	No difference was found in pulmonary mechanics or oxygen saturation in a subset of 18 neonates born to mothers who had been enrolled in a randomised trial of amnioinfusion for oligohydramnios at their institution. They do not state how the subset of 18 infants studied was derived from the larger trial. In a subsequent publication by the same authors in 1995, results of 42 infants, presumably from the same study, are given. No significant differences in pulmonary mechanics or oxygenation were found between infants whose mothers had received amnioinfusion (n = 22) or the controls (n = 20). The study is excluded because, without information on how the subset of infants studied was derived from the larger trial, it is not possible to be sure that selection bias was excluded. It is also not stated whether the subset was derived from the larger study from the same unit included in this review (Schrimmer 1991).
Monahan 1995	This RCT studies amnioinfusion for preventing puerperal infection not cord compression.
Muse 1997	Randomised comparison of the effect of cold versus body temperature amnioinfusion on fetal TSH levels. The difference (13.12 SD 5.02 versus 7.67 SD 0.75 respectively) was not statistically significant, but the numbers studied were small (total n = 13).
Pressman 1996	No randomised comparison with a control group.

Amnioinfusion for potential or suspected umbilical cord compression in labour (Review)

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Study	Reason for exclusion
	<p>39 women receiving amnioinfusion were randomised by sequential sealed envelopes to receive lactated Ringer's solution plus 5 ml/L physiologic glucose (n = 18) or normal saline (n = 21). Infusates were warmed to 39 degrees centigrade and 500 ml infused over 30 minutes, followed by a continuous infusion at 200 ml/hour.</p> <p>The groups were not well matched for nulliparity (Ringer's 22% vs saline 52%). There were no differences in neonatal electrolyte or acid-base status. There were no statistically significant differences in length of labour (10.9 (SD 8.9) vs 12.1 (5.4) hours); length of ruptured membranes (7.7 (9.4) vs 9.8 (5.1) hours); caesarean sections (39% vs 33%); operative deliveries (55% vs 36%); chorioamnionitis (5.6 vs 19%); postpartum endometritis (17% vs 19%); or Apgar scores < 7 at 5 minutes (5.5 vs 4.8%).</p>
Rinehart 2000	<p>Randomised trial comparing continuous amnioinfusion with bolus amnioinfusion for repeated variable decelerations in labour. There were 35 in bolus group and 30 in continuous group. No significant difference in any of the neonatal outcome variables between groups (except for increased cost with continuous infusion).</p>
Washburne 1996	<p>No randomised comparison of amnioinfusion with control group.</p> <p>67 women receiving amnioinfusion were randomised by computer-generated cards in sealed envelopes to receive lactated Ringer's solution (n = 30) or normal saline (n = 37). Warmed solution was infused in 500 ml increments to a volume of 500-1500 ml.</p> <p>There were no statistically significant differences with respect to amnioinfusion to delivery time (Ringer's lactate 3.9 hours (SD 2.5) vs saline 5.9 hours (3.6)); or maternal or neonatal electrolyte levels.</p>

SD: standard deviation
TSH: thyroid stimulating hormone
vs: versus

DATA AND ANALYSES

Comparison 1. Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Caesarean section, overall	13	1493	Risk Ratio (M-H, Random, 95% CI)	0.62 [0.46, 0.83]
1.1 Fetal heart rate (FHR) decelerations	1	150	Risk Ratio (M-H, Random, 95% CI)	1.04 [0.69, 1.56]
1.2 Oligohydramnios	9	982	Risk Ratio (M-H, Random, 95% CI)	0.60 [0.42, 0.85]
1.3 Mixed or other indications	3	361	Risk Ratio (M-H, Random, 95% CI)	0.48 [0.27, 0.86]
2 Caesarean for suspected fetal distress	12	1588	Risk Ratio (M-H, Random, 95% CI)	0.46 [0.31, 0.68]
2.1 FHR decelerations	3	683	Risk Ratio (M-H, Random, 95% CI)	0.70 [0.60, 0.82]
2.2 Oligohydramnios	7	744	Risk Ratio (M-H, Random, 95% CI)	0.33 [0.17, 0.64]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
2.3 Mixed or other indications	2	161	Risk Ratio (M-H, Random, 95% CI)	0.24 [0.07, 0.79]
3 Forceps/vacuum-suspected fetal distress	4	665	Risk Ratio (M-H, Fixed, 95% CI)	0.58 [0.39, 0.85]
3.1 Oligohydramnios	2	365	Risk Ratio (M-H, Fixed, 95% CI)	0.36 [0.15, 0.86]
3.2 Mixed or other indications	2	300	Risk Ratio (M-H, Fixed, 95% CI)	0.68 [0.44, 1.05]
4 Forceps or vacuum delivery, overall	5	705	Risk Ratio (M-H, Fixed, 95% CI)	0.85 [0.64, 1.12]
4.1 FHR decelerations	1	150	Risk Ratio (M-H, Fixed, 95% CI)	0.95 [0.55, 1.63]
4.2 Oligohydramnios	4	555	Risk Ratio (M-H, Fixed, 95% CI)	0.81 [0.58, 1.13]
5 Persistent variable decelerations	7	1006	Risk Ratio (M-H, Random, 95% CI)	0.53 [0.38, 0.74]
5.1 FHR decelerations	3	682	Risk Ratio (M-H, Random, 95% CI)	0.44 [0.24, 0.80]
5.2 Oligohydramnios	3	131	Risk Ratio (M-H, Random, 95% CI)	0.54 [0.30, 0.99]
5.3 Mixed or other indications	1	193	Risk Ratio (M-H, Random, 95% CI)	0.81 [0.71, 0.93]
6 Variable FHR decelerations during second stage of labour	1	20	Risk Ratio (M-H, Fixed, 95% CI)	0.78 [0.49, 1.23]
7 Meconium-stained amniotic fluid	4	362	Risk Ratio (M-H, Random, 95% CI)	0.67 [0.34, 1.33]
7.1 FHR decelerations	1	148	Risk Ratio (M-H, Random, 95% CI)	1.16 [0.47, 2.83]
7.2 Oligohydramnios	3	214	Risk Ratio (M-H, Random, 95% CI)	0.48 [0.16, 1.42]
8 Umbilical cord prolapse	7	677	Risk Ratio (M-H, Fixed, 95% CI)	2.94 [0.31, 27.63]
8.1 FHR decelerations	2	246	Risk Ratio (M-H, Fixed, 95% CI)	2.88 [0.12, 68.98]
8.2 Oligohydramnios	5	431	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.13, 70.83]
9 Rupture of membranes to delivery interval (hours)	4	484	Mean Difference (IV, Random, 95% CI)	1.89 [-0.13, 3.91]
9.1 FHR decelerations	1	148	Mean Difference (IV, Random, 95% CI)	1.62 [-1.10, 4.34]
9.2 Oligohydramnios	2	136	Mean Difference (IV, Random, 95% CI)	3.62 [-1.27, 8.51]
9.3 Mixed or other indications	1	200	Mean Difference (IV, Random, 95% CI)	-0.51 [-4.44, 3.42]
10 Intrapartum maternal temperature > 38°C	4	846	Risk Ratio (M-H, Fixed, 95% CI)	1.55 [0.85, 2.82]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
10.1 FHR decelerations	2	586	Risk Ratio (M-H, Fixed, 95% CI)	1.37 [0.70, 2.71]
10.2 Oligohydramnios	1	60	Risk Ratio (M-H, Fixed, 95% CI)	3.0 [0.66, 13.69]
10.3 Mixed or other indications	1	200	Risk Ratio (M-H, Fixed, 95% CI)	1.0 [0.06, 15.77]
11 Apgar score < 7 at 1 minute	10	1628	Risk Ratio (M-H, Random, 95% CI)	0.47 [0.29, 0.77]
11.1 FHR decelerations	3	682	Risk Ratio (M-H, Random, 95% CI)	0.78 [0.32, 1.92]
11.2 Oligohydramnios	6	746	Risk Ratio (M-H, Random, 95% CI)	0.27 [0.18, 0.39]
11.3 Mixed or other indications	1	200	Risk Ratio (M-H, Random, 95% CI)	2.0 [0.18, 21.71]
12 Apgar score < 7 at 5 minutes	12	1804	Risk Ratio (M-H, Random, 95% CI)	0.47 [0.30, 0.72]
12.1 FHR decelerations	3	682	Risk Ratio (M-H, Random, 95% CI)	0.47 [0.16, 1.38]
12.2 Oligohydramnios	7	822	Risk Ratio (M-H, Random, 95% CI)	0.51 [0.27, 0.96]
12.3 Mixed or other indications	2	300	Risk Ratio (M-H, Random, 95% CI)	1.33 [0.09, 20.60]
13 'Mild' or 'severe' birth asphyxia	1	118	Risk Ratio (M-H, Fixed, 95% CI)	0.32 [0.15, 0.70]
14 Low cord arterial pH (< 7.2 or as defined by trial authors)	8	972	Risk Ratio (M-H, Random, 95% CI)	0.58 [0.29, 1.14]
14.1 Oligohydramnios	6	678	Risk Ratio (M-H, Random, 95% CI)	0.39 [0.19, 0.81]
14.2 Mixed or other indications	2	294	Risk Ratio (M-H, Random, 95% CI)	1.02 [0.35, 2.99]
15 Neonatal sepsis	2	208	Risk Ratio (M-H, Fixed, 95% CI)	5.08 [0.61, 42.63]
16 Perinatal death	9	1022	Risk Ratio (M-H, Fixed, 95% CI)	0.47 [0.12, 1.79]
16.1 FHR decelerations	2	534	Risk Ratio (M-H, Fixed, 95% CI)	0.33 [0.01, 8.14]
16.2 Oligohydramnios	5	327	Risk Ratio (M-H, Fixed, 95% CI)	0.48 [0.07, 3.29]
16.3 Mixed or other indications	2	161	Risk Ratio (M-H, Fixed, 95% CI)	0.55 [0.05, 5.77]
17 Postpartum endometritis	6	767	Risk Ratio (M-H, Random, 95% CI)	0.47 [0.21, 1.06]
17.1 FHR decelerations	1	148	Risk Ratio (M-H, Random, 95% CI)	0.0 [0.0, 0.0]
17.2 Oligohydramnios	3	458	Risk Ratio (M-H, Random, 95% CI)	0.64 [0.24, 1.72]
17.3 Mixed or other indications	2	161	Risk Ratio (M-H, Random, 95% CI)	0.20 [0.05, 0.88]
18 Umbilical cord arterial pH	7	855	Mean Difference (IV, Fixed, 95% CI)	0.03 [0.02, 0.04]
18.1 Oligohydramnios	4	494	Mean Difference (IV, Fixed, 95% CI)	0.03 [0.02, 0.05]

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
18.2 Mixed or other indications	3	361	Mean Difference (IV, Fixed, 95% CI)	0.03 [0.02, 0.05]
19 Meconium aspiration syndrome	2	514	Risk Ratio (M-H, Fixed, 95% CI)	0.14 [0.01, 2.75]
20 Admission to ICU/high-care nursery	5	958	Risk Ratio (M-H, Random, 95% CI)	0.74 [0.49, 1.10]
20.1 FHR decelerations	2	586	Risk Ratio (M-H, Random, 95% CI)	0.65 [0.32, 1.31]
20.2 Oligohydramnios	2	272	Risk Ratio (M-H, Random, 95% CI)	0.99 [0.57, 1.72]
20.3 Mixed and other indications	1	100	Risk Ratio (M-H, Random, 95% CI)	0.44 [0.15, 1.28]
21 Meconium below vocal cords	3	674	Risk Ratio (M-H, Fixed, 95% CI)	0.53 [0.31, 0.92]
22 Maternal hospital stay > 3 days	4	1051	Risk Ratio (M-H, Random, 95% CI)	0.45 [0.25, 0.78]
22.1 FHR decelerations	2	586	Risk Ratio (M-H, Random, 95% CI)	0.49 [0.17, 1.40]
22.2 Oligohydramnios	2	465	Risk Ratio (M-H, Random, 95% CI)	0.42 [0.28, 0.64]
23 Neonatal hospital stay > 3 days	2	453	Risk Ratio (M-H, Random, 95% CI)	0.61 [0.26, 1.42]

Analysis 1.1. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 1 Caesarean section, overall.

Analysis 1.2. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 2 Caesarean for suspected fetal distress.

Analysis 1.3. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 3 Forceps/vacuum-suspected fetal distress.

Analysis 1.4. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 4 Forceps or vacuum delivery, overall.

Analysis 1.5. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 5 Persistent variable decelerations.

Analysis 1.6. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 6 Variable FHR decelerations during second stage of labour.

Analysis 1.7. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 7 Meconium-stained amniotic fluid.

Analysis 1.8. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 8 Umbilical cord prolapse.

Analysis 1.9. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 9 Rupture of membranes to delivery interval (hours).

Analysis 1.10. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 10 Intrapartum maternal temperature > 38°C.

Analysis 1.11. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 11 Apgar score < 7 at 1 minute.

Analysis 1.12. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 12 Apgar score < 7 at 5 minutes.

Analysis 1.13. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 13 'Mild' or 'severe' birth asphyxia.

Analysis 1.14. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 14 Low cord arterial pH (< 7.2 or as defined by trial authors).

Analysis 1.15. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 15 Neonatal sepsis.

Analysis 1.16. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 16 Perinatal death.

Analysis 1.17. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 17 Postpartum endometritis.

Analysis 1.18. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 18 Umbilical cord arterial pH.

Analysis 1.19. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 19 Meconium aspiration syndrome.

Analysis 1.20. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 20 Admission to ICU/high-care nursery.

Analysis 1.21. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 21 Meconium below vocal cords.

Analysis 1.22. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 22 Maternal hospital stay > 3 days.

Analysis 1.23. Comparison 1 Transcervical amnioinfusion for intrapartum umbilical cord compression (potential, or diagnosed by EFM)*, Outcome 23 Neonatal hospital stay > 3 days.

Comparison 2. Transabdominal amnioinfusion for cord compression (potential, or diagnosed by fetal heart rate monitor)

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Suspicious/ominous fetal heart rate pattern	1	70	Risk Ratio (M-H, Fixed, 95% CI)	0.13 [0.03, 0.52]
2 Meconium-stained liquor	1	79	Risk Ratio (M-H, Fixed, 95% CI)	1.37 [0.52, 3.58]
3 Caesarean for suspected fetal distress	2	110	Risk Ratio (M-H, Fixed, 95% CI)	0.20 [0.05, 0.74]
4 Caesarean section, overall	1	79	Risk Ratio (M-H, Fixed, 95% CI)	0.43 [0.17, 1.10]
5 Forceps/vacuum delivery, overall	1	79	Risk Ratio (M-H, Fixed, 95% CI)	0.0 [0.0, 0.0]
6 Apgar score < 7 at 5 minutes	2	110	Risk Ratio (M-H, Fixed, 95% CI)	0.64 [0.18, 2.31]
7 Low cord pH (< 7.20 or as defined by trialists)	2	75	Risk Ratio (M-H, Fixed, 95% CI)	0.20 [0.04, 1.06]

Analysis 2.1. Comparison 2 Transabdominal amnioinfusion for cord compression (potential, or diagnosed by fetal heart rate monitor), Outcome 1 Suspicious/ominous fetal heart rate pattern.

Analysis 2.2. Comparison 2 Transabdominal amnioinfusion for cord compression (potential, or diagnosed by fetal heart rate monitor), Outcome 2 Meconium-stained liquor.

Analysis 2.3. Comparison 2 Transabdominal amnioinfusion for cord compression (potential, or diagnosed by fetal heart rate monitor), Outcome 3 Caesarean for suspected fetal distress.

Analysis 2.4. Comparison 2 Transabdominal amnioinfusion for cord compression (potential, or diagnosed by fetal heart rate monitor), Outcome 4 Caesarean section, overall.

Analysis 2.5. Comparison 2 Transabdominal amnioinfusion for cord compression (potential, or diagnosed by fetal heart rate monitor), Outcome 5 Forceps/vacuum delivery, overall.

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Total (95% CI)	39	40			Not estimable
Total events: 0 (Treatment), 0 (Control)					
Heterogeneity: Not applicable					
Test for overall effect: Not applicable					
			Treatment 0.1 0.2 0.5 1 2 5 10 Control		

Analysis 2.6. Comparison 2 Transabdominal amnioinfusion for cord compression (potential, or diagnosed by fetal heart rate monitor), Outcome 6 Apgar score < 7 at 5 minutes.

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Busowski 1995	0/16	1/15		28.13%	0.31[0.01,7.15]
Vergani 1996	3/39	4/40		71.87%	0.77[0.18,3.22]
Total (95% CI)	55	55		100%	0.64[0.18,2.31]
Total events: 3 (Treatment), 5 (Control)					
Heterogeneity: Tau ² =0; Chi ² =0.26, df=1 (P=0.61); I ² =0%					
Test for overall effect: Z=0.68 (P=0.5)					
			Treatment 0.01 0.1 1 10 100 Control		

Analysis 2.7. Comparison 2 Transabdominal amnioinfusion for cord compression (potential, or diagnosed by fetal heart rate monitor), Outcome 7 Low cord pH (< 7.20 or as defined by trialists).

Study or subgroup	Treatment n/N	Control n/N	Risk Ratio M-H, Fixed, 95% CI	Weight	Risk Ratio M-H, Fixed, 95% CI
Busowski 1995	0/16	3/15		47.41%	0.13[0.01,2.4]
Vergani 1996	1/22	4/22		52.59%	0.25[0.03,2.06]
Total (95% CI)	38	37		100%	0.2[0.04,1.06]
Total events: 1 (Treatment), 7 (Control)					
Heterogeneity: Tau ² =0; Chi ² =0.12, df=1 (P=0.73); I ² =0%					
Test for overall effect: Z=1.89 (P=0.06)					
			Treatment 0.001 0.1 1 10 1000 Control		

APPENDICES

Appendix 1. Methods used to assess trials included in previous versions of this review

The following methods were used to assess [Amin 2003](#), [Busowski 1995](#), [Chauhan 1992](#), [MacGregor 1991](#), [Miyazaki 1985](#), [Monahan 1995a](#), [Nageotte 1985](#), [Nageotte 1991](#), [Owen 1990](#), [Puertas 2001](#), [Schrimmer 1991](#), [Strong 1990](#), [Vergani 1996](#), [Wu 1989](#), [McEvoy 1991](#), [Muse 1997](#), [Pressman 1996](#), [Washburne 1996](#). Trials under consideration were evaluated for methodological quality and appropriateness for inclusion according to the prespecified selection criteria, without consideration of their results. The risk of bias assessment was based on randomisation, allocation concealment and blinding. Individual outcome data were included in the analysis if they met the prespecified criteria in 'Types of outcome measures'. Included trial data were processed as described in [Alderson 2004](#).

Data were extracted from the sources and entered onto the Review Manager computer software ([RevMan 2003](#)), checked for accuracy, and analysed as above using the RevMan software. For dichotomous data, relative risks and 95% confidence intervals were calculated, and in the absence of heterogeneity, results were pooled using a fixed effects model.

WHAT'S NEW

Date	Event	Description
29 November 2011	New search has been performed	Six newly identified trials included (Abdel-Aleem 2005 ; Gonzalez 2001 ; Mino 1999 ; Persson-Kjerstadius 1999 ; Regi 2009 ; Wang 1997) and one new trial excluded (Rinehart 2000). Two trials previously awaiting classification (McDermot 1998 ; Washburne 1996) now excluded. The comparison of amnioinfusion for suspected amnionitis removed from the review.
9 March 2011	New citation required but conclusions have not changed	A new co-author helped to prepare this update.

HISTORY

Protocol first published: Issue 2, 1996

Review first published: Issue 2, 1996

Date	Event	Description
30 September 2010	New search has been performed	New search conducted in September 2010 identified 13 new reports/trials for classification: Abdel-Aleem 2005 , Gonzalez 2001 , Mino 1997a , Mino 1997b , Mino 1998 , Miño 1999 , Persson-Kjerstadius 1999 , Puertas 1997 , Regi 2009 , Wang 1997 , McDermot 1998 , Rinehart 2000 , Washburne 1994 .
2 July 2010	Amended	Contact details edited.
30 October 2008	Amended	Converted to new review format.
1 November 2004	New search has been performed	Search updated. One new trial identified which has been included (Amin 2003). The title has changed from 'Amnioinfusion for umbilical cord compression in labour' to 'Amnioinfusion for potential or suspected umbilical cord compression in labour'.
19 October 1997	New search has been performed	Search updated.
19 October 1997	New citation required but conclusions have not changed	Substantive amendment

CONTRIBUTIONS OF AUTHORS

GJ Hofmeyr prepared the original review. For the update, Tess Lawrie and GJ Hofmeyr assessed trials, performed data extraction and contributed to the text. GJ Hofmeyr maintains the review.

DECLARATIONS OF INTEREST

None known.

SOURCES OF SUPPORT

Internal sources

- University of the Witwatersrand, South Africa.

External sources

- South African Medical Research Council, South Africa.
- UNDP/UNFPA/WHO/World Bank (HRP), Switzerland.

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

The original review included a comparison of amnioinfusion for suspected versus potential chorioamnionitis. During the update process, we decided that this topic requires a separate review and removed this comparison from the review. In response to reviewer recommendations, the sub-groups were redefined to be more clinically relevant, and all outcomes were analysed in these sub-groups. In keeping with current systematic review methodology, the number of primary outcomes was reduced.

INDEX TERMS

Medical Subject Headings (MeSH)

*Heart Rate, Fetal; *Umbilical Cord; Amnion; Cesarean Section [statistics & numerical data]; Constriction, Pathologic [therapy]; Endometritis [prevention & control]; Fetal Distress [*therapy]; Injections [methods]; Meconium; Oligohydramnios [*therapy]; Randomized Controlled Trials as Topic

MeSH check words

Female; Humans; Pregnancy