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SYSTEMATIC REVIEW

Prognostic value of the labour admission test and its effectiveness compared with auscultation only: a systematic review

Objective To assess the effectiveness of the labour admission test in preventing adverse outcomes, compared with auscultation only, and to assess the test's prognostic value in predicting adverse outcomes.

Design Systematic review.

Setting Labour wards in hospitals.

Population Pregnant women in labour. Three randomised controlled trials including 11,259 women and 11 observational studies including 5831 women.

Methods Literature searches in Medline, EMBASE, CINAHL, SweMed, The Cochrane Central Register of Controlled Trials, reference lists from identified studies and contact with experts.

Main outcome measures Obstetric interventions (augmentation of labour, continuous electronic fetal monitoring, epidural analgesia, fetal blood sampling and operative deliveries) and neonatal outcomes (perinatal mortality, Apgar score, seizures, resuscitation and admission to neonatal unit).

Results Meta-analyses of the controlled trials found that women randomised to the labour admission test were more likely to have minor obstetric interventions like epidural analgesia [relative risk (RR) 1.2, 95% confidence interval (95% CI) 1.1–1.4], continuous electronic fetal monitoring (RR 1.3, 95% CI 1.2–1.5) and fetal blood sampling (RR 1.3, 95% CI 1.1–1.5) compared with women randomised to auscultation on admission. There were no significant differences in any of the other outcomes. From the observational studies, prognostic value for various outcomes was found to be generally poor. Likelihood ratio (LR) for a positive test was above 10 in 2 of 28 single outcomes and between 5 and 10 in six outcomes.

Conclusions There is no evidence supporting that the labour admission test is beneficial in low risk women.

Introduction

The labour admission test comprises a cardiotocography (CTG) of 20–30 minutes duration carried out on admission to the maternity ward. The labour admission test was introduced as a screening test in early labour to detect compromised fetuses on admission and to select the women in need of continuous fetal electronic monitoring during labour.[1,2] The labour admission test is widely used in the western world. British guidelines published in 2001[3] do not recommend the labour admission test in low risk women, while Swedish guidelines published the same year[4] recommend the test in all women. The British recommendations were based upon three studies,[1,5,6] and the Swedish upon seven studies.[1,2,7–11]

Despite the fact that the labour admission test is widely used, the evidence of its usefulness has never, to our knowledge, been assessed in a systematic review. The aim of the present systematic review was to evaluate if the test improves outcomes for mother and child compared with auscultation only, and to summarise the evidence of the labour admission test in predicting adverse outcomes in labour.

Methods

Literature searches

Computerised searches in MEDLINE (1966–2004), PreMEDLINE (06.09.04), EMBASE (1980–2004), CINAHL (1982–2004), SweMed (1977–2004) and The Cochrane Central Register of Controlled Trials (Cochrane Library, Issue 3, 2004) were conducted in September 2004. The following textwords were used: 'cardiotocogram*', 'ctg', 'cardiotocograph*', 'non-stress test', 'non-stress test*', 'nst', 'labour admission test*' and 'labour admission test*'. In addition, the subject headings from the different databases were added to the search strategy. We also searched the reference lists of all relevant articles and contacted experts in the field to identify unpublished and ongoing studies.

One of the reviewers (EB) first read through titles and abstracts to remove those studies that obviously were not about the labour admission test. Eligible papers were then obtained in full text for further assessment. The quality and eligibility were assessed independently by two reviewers

(EB and LMR). Any disagreement was resolved by conference or by a third reviewer (PØ). Blinding of authors and journals was not done. English, German, Swedish, Danish and Norwegian articles were read by the reviewers; articles in other languages were translated into the Norwegian by medical staff with knowledge of the actual language before assessed. Both observational studies and randomised controlled studies were included.

Selection and assessment of randomised controlled trials

Criteria for selecting randomised controlled trials were as follows. Population: pregnant women in labour. Intervention: labour admission test—CTG of 20–40 minutes duration at admission to a labour ward. Control: auscultation of fetal heart rate on admission. Outcome measures: 'perinatal mortality', 'Apgar score <7 at 5 minutes', 'arterial cord pH <7.05', 'resuscitation of infant', 'admission to neonatal unit', 'thick meconium stained amniotic fluid', 'neonatal seizures', 'operative delivery' (caesarean section, forceps and vacuum), 'caesarean section', 'operative delivery (caesarean section, forceps and vacuum) for fetal distress', 'caesarean section for fetal distress', interventions in labour ('augmentation', 'continuous electronic fetal monitoring', 'fetal blood sampling', 'epidural analgesia') and 'fetal distress' as described by Ingemarsson *et al.*[1] (operative delivery for changed/ominous fetal heart rate changes or Apgar score <7 at 5 minutes after spontaneous delivery).

For assessing the quality of the studies, the CONSORT statement quality criteria were used.[12] The overall quality of every study was assessed as good, moderate or poor. The assessments were done independently by two of the authors (EB and LMR).

Selection and assessment of observational studies

Criteria for selecting observational studies were as follows: Population: pregnant women in labour. Test: the labour admission test—CTG of 20–40 minutes duration at admission to the labour ward. Outcome measures: 'Apgar score <7 at 5 minutes', 'arterial cord pH <7.05', 'resuscitation of infant', 'admission to neonatal unit', 'thick meconium stained amniotic fluid', 'operative delivery (caesarean section, forceps and vacuum) for fetal distress', 'caesarean section for fetal distress' and 'fetal distress' as described by Ingemarsson *et al.*[1] (operative delivery for changed/ominous fetal heart rate changes or Apgar score <7 at 5 minutes after spontaneous delivery). Data: sufficient data to construct 2 × 2 contingency tables of the labour admission test for each pregnancy outcome. For assessing the quality of the studies, the QUADAS tool was used.[13] The assessments were done independently by two of the authors (EB and LMR).

Data extraction and analysis of randomised controlled trials

The data were extracted from each study and entered into 2 × 2 tables independently by two of the reviewers (EB and LMR). The participants were classified according to the presence of an outcome measure in intervention and control group. Authors were contacted in order to get additional information about the studies when needed. The raw data for each outcome measure were pooled together for the meta-analysis. Relative risks (RRs) with 95% confidence intervals (95% CIs) were calculated for each outcome measure.[14]

Forest plots of RRs with CIs for each outcome measure from each study were produced to get a visual impression of heterogeneity. To quantify inconsistency, the I^2 statistic was calculated. This test describes the percentage of the variability in effect estimates that occurs due to heterogeneity rather than chance. A value greater than 50% may be considered as substantial heterogeneity.[15] The computer programme RevMan[16] was used for calculations.

Data extraction and analysis of observational studies

Data were extracted from each study and entered into 2 × 2 contingency tables independently by two of the reviewers (EB and LMR). The participants were classified according to the result of the labour admission test and to the presence or absence of an outcome measure. Authors were contacted in order to get additional information about the studies when needed.

Sensitivity, specificity, positive predictive value, negative predictive value and likelihood ratios (LRs) with 95% CIs were calculated. If any of the values in a table was zero, by convention 0.5 was added to each cell to avoid computational problems. A positive LR greater than 10 or negative LR less than 0.1 can provide convincing diagnostic evidence. A positive LR above 5 or negative LR below 0.2 is supposed to give strong diagnostic evidence, although this depends on the pre-test probability and to the context to which they are applied.[17]

The Spearman's rank correlation coefficient between true positive rate (sensitivity) and false-positive rate (1-specificity) was calculated. The computer programmes CIDT[18] and CIA[19] were used for calculations.

Results

Literature searches

The computerised searches initially generated 3761 titles. After reading all titles and abstracts, 3743 were excluded because they were obviously not about the labour admission test. Eighteen titles were identified by the electronic search,[1,5,20–35] five by hand searching the reference lists[6,10,36–38] and two by personal field knowledge.[39,40]

Twenty-five studies (3 randomised controlled and 22 observational studies) were left for further assessment (Fig. 1). In one study,[21] the labour admission tests were assessed by midwives and physicians-in-charge and by two independent experts. We considered independent expert assessment most appropriate, and by toss-of-the coin expert 2 was chosen. In another study[24] where the labour admission tests were assessed by midwives and physicians-in-charge and by one independent expert, the expert assessment was chosen.

Randomised controlled trials

Three randomised controlled trials were included and no studies were excluded. One study was from Ireland[27] and two were from Scotland.[31,39] The three studies included totally 11,259 women, all were low risk. The characteristics of the included studies are presented in Table 1. There were no disagreements between the two reviewers in assessing the study qualities. One study fulfilled all quality criteria and was assessed as good,[27] the two other studies were assessed as moderate[33,39] (Table 2).

The plotted RRs depicted heterogeneity in some of the outcome measures (Table 3). The I^2 statistic for heterogeneity was above 50% for three outcome measures: 'operative delivery', 'augmentation' and 'continuous electronic fetal monitoring'. In all other outcome measures, I^2 was 0% or could not be calculated because only one study provided data. Because of substantial heterogeneity, the random effect model[15] was used for the meta-analysis.

Women randomised to the labour admission test had more often minor obstetric interventions like epidural analgesia (RR 1.2, 95% CI 1.1–1.4), continuous electronic fetal monitoring (RR 1.3, 95% CI 1.2–1.5) and fetal blood sampling (RR 1.3, 95% CI 1.1–1.5) in labour than women randomised to auscultation on admission. There were trends towards more operative deliveries, operative deliveries for fetal distress and caesarean sections among the women randomised to the labour admission test, although these differences did not reach statistical significance (Table 3). There were no significant differences in augmentation of labour between the two groups, or in any of the neonatal outcomes (Table 3).

Observational studies

Of the 22 studies identified, 1 was excluded because it was not about the labour admission test,[5] 6 because the study population and/or outcome measures were not relevant and could not be transformed or recoded,[6,26,29,36,37,40] 1 because of double publication,[20] 1 because data could not be entered into 2 × 2 tables[22] and 2 because of poor study quality.[30,32] Of the 11 observational studies included, 3 were from Singapore,[1,23,28] 3 from Great Britain,[24,25,34] 4 from USA[10,11,35,38] and 1 from Norway.[21] Eight studies contained mixed populations[10,11,21,23,28,34,35,38] and three contained low risk populations.[1,24,25] The 11 studies included totally 5831 women. Characteristics of included studies are presented in Table 1. Agreement between EB and LMR in

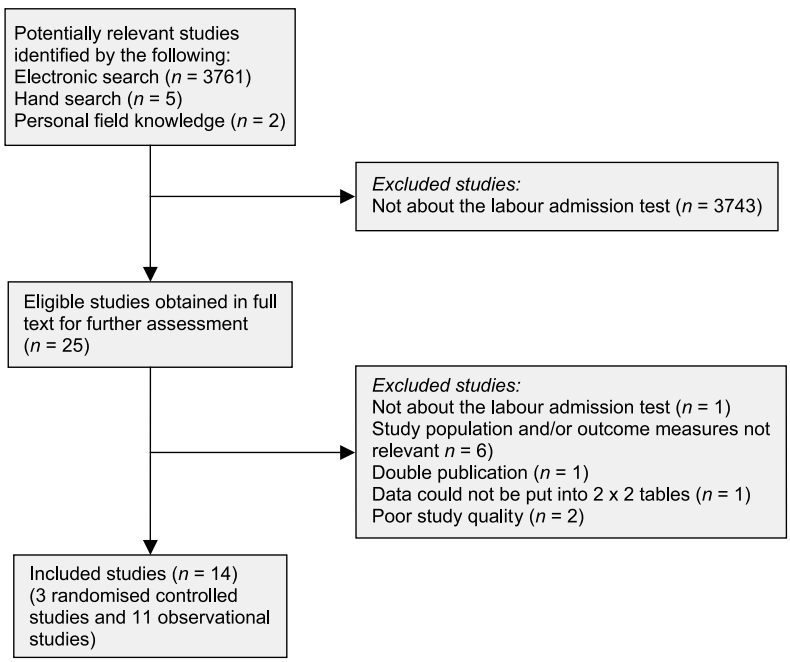

Fig. 1. Selection process of eligible studies from all identified studies.

Table 1. Characteristics of included studies.

Randomised controlled studies

Study	Setting/study population	Number included, intervention/ control groups	Intervention	Control	Fetal heart rate abnormalities, Intervention (%)/ control (%)	Outcome measures used in review
Cheyne *et al.*[39]	Midwives Birth Unit, Glasgow Royal Maternity Hospital, Glasgow, UK/Low risk	312 148/164	20 minutes CTG at admission	Auscultation using a hand-held Doppler device during and immediately following a contraction for minimum 60 seconds	Not described/ not described	Operative delivery,[a] caesarean section, augmentation, epidural, continuous EFM, fetal blood sampling, Apgar score <7 at 5 minutes, admission to neonatal unit
Impey *et al.*[27]	National Maternity Hospital, Dublin, Ireland/Low risk	8580 4298/4282	20 minutes CTG at admission	Auscultation immediately after early amniotomy on diagnosis of labour	1360 (32.0)/ not described	Operative delivery,[a] operative delivery for FD,[a] caesarean section, caesarean section for FD, augmentation, continuous EFM, fetal blood sampling, resuscitation of infant, neonatal seizures, Apgar score <7 at 5 minutes, admission to neonatal unit
Mires *et al.*[31]	Ninewells Medical Hospital, Dundee, UK/Low risk	2367 1186/1181	20 minutes CTG at admission	Auscultation using a hand-held Doppler device during and immediately after at least one contraction	255 (21.5)/ 42 (3.6)	Operative delivery,[a] caesarean section, augmentation, epidural, continuous EFM, fetal blood sampling, resuscitation of infant, Apgar score <7 at 5 minutes, admission to neonatal unit

Observational studies

Study	Setting/study population	Number included	Assessments done by	Test assessment method	Number with non-reactive tests (%)	Outcome measures used in review
Blix *et al.*[21]	Hammerfest Hospital, Hammerfest, Norway/Mixed (735 low risk, 110 high risk)	845	Independent observer	Reactive/ equivocal/ ominous	139 (16.4)[b]	Apgar score <7 at 5 minutes, admission to neonatal unit, operative delivery for FD,[a] caesarean section for FD, fetal distress[c]
Chua *et al.*[23]	National University Hospital, Singapore/ Mixed (unclearly described)	1092	Not described	Reactive/ equivocal/ ominous	71 (6.5)[b]	Apgar score <7 at 5 minutes, resuscitation of infant,[d] admission to neonatal unit, operative delivery for FD[b]
Ducey *et al.*[10]	Winthrop University Hospital, New York, USA/Mixed (unclearly described)	405	Not described	Normal/ abnormal	24 (5.9)	Caesarean section for FD
Elimian *et al.*[35]	University Hospital at Stony Brook, NY, USA/Mixed (unclearly described)	426	Independent observer	Normal/ non-reassuring	25 (5.9)	Apgar score <7 at 5 minutes, admission to neonatal unit, caesarean section for FD

Table 1. (*continued*)

Observational studies						
Study	Setting/study population	Number included	Assessments done by	Test assessment method	Number with non-reactive tests (%)	Outcome measures used in review
Farrell *et al.*[24]	Ninewells Medical Hospital, Dundee, UK/Low risk	231	Independent observer	Normal/ abnormal	26 (11.3)	Apgar score <7 at 5 minutes, admission to neonatal unit
Farrell *et al.*[25]	Ninewells Medical Hospital, Dundee, UK/Low risk	182	Not described	Normal/ abnormal	12 (6.6)	Apgar score <7 at 5 minutes, resuscitation of infant, admission to neonatal unit, operative delivery for FD[a]
Ingemarsson *et al.*[1]	Kandang Kerbau Hospital, Singapore/ Low risk	1041	Independent observer	Reactive/ equivocal/ ominous	59 (5.7)[b]	Operative delivery for FD,[a] caesarean section for FD, fetal distress[c]
Ingemarsson *et al.*[28]	Kandang Kerbau Hospital, Singapore/ Mixed (unclearly described)	766	Independent observer	Reactive/ equivocal/ ominous	58 (7.6)[b]	Fetal distress[c]
Sarno *et al.*[38]	Women's Hospital, Los Angeles County, California, USA/Mixed (unclearly described)	109	Not described	Normal/ abnormal	21 (19.3)	Apgar score <7 at 5 minutes, caesarean section for FD
Sarno *et al.*[11]	Women's Hospital, Los Angeles County, California, USA/Mixed (unclearly described)	400	Independent observer	Normal/ abnormal	90 (22.5)	Apgar score <7 at 5 minutes, caesarean section for FD
Somerset *et al.*[34]	Princess Anne Hospital, Southampton, UK/Mixed (unclearly described)	334	Not described	Reactive/ equivocal/ ominous	41 (12.3)[b]	Caesarean section for FD

FD = fetal distress.
[a] Caesarean section, vacuum and forceps deliveries.
[b] Cutoff equivocal test.
[c] Fetal distress according to Ingemarsson *et al.*[1] (see text).
[d] Assisted ventilation.

first assessment was weighted kappa 0.7 (95% CI 0.4–1.0). There were only minor disagreements between the two reviewers; the instances of disagreement were results of oversights and were easily resolved by consensus. The assessed qualities of the included studies are presented in Table 2.

The Spearman's rank correlation was low (<0.5) in most cases and there was heterogeneity between the studies. Some of the outcome measures had very few observations, three or less.

Except for a few single study outcomes, the predictive values of the labour admission test were poor. Sensitivity varied between 5% and 83% in the 28 single outcomes and was above 50% in four outcomes ('Apgar score <7 at 5 minutes' in Chua *et al.*,[23] 'caesarean section for fetal distress' in Ducey *et al.*,[10] Sarno *et al.* (1989)[38] and Sarno *et al.* (1990).[11] This means that more than 50% of adverse outcomes were predicted by the labour admission test. Positive predictive values were between 1% and 28% except in one outcome (75% in 'caesarean section for fetal distress' in Ducey *et al.*[10]). The consequence of this is that the majority of those testing positive were false positives. Specificity was between 78% and 98%, indicating that the test could pick out the majority of those not having the adverse outcome. Negative predictive value was between 89% and 99%, indicating that among the women testing negative, very few had the adverse outcome. LRs for a positive test were above 10 in only two outcomes ('Apgar score <7 at 5 minutes' in Chua *et al.*[23] and 'caesarean section for fetal distress' in Ducey *et al.*[10]) and between 5 and 10 in six outcomes ('admission to neonatal unit' in Chua *et al.*,[23] 'operative delivery for fetal distress' in Chua *et al.*,[23] 'caesarean section for fetal distress' in Ingemarsson *et al.*[1] and Sarno *et al.*[38] and 'fetal distress' in Ingemarsson *et al.*[28] In one outcome, the LR for a negative test was 0.2 ('caesarean section for fetal distress' in Sarno *et al.*,[38] but in all other outcomes it was only between 0.4 and 1.0 (Table 4). When the LR is close to 1, it means that a negative test result is as likely from a woman with the adverse outcome as from a woman without the adverse outcome, rendering it a useless test.

Table 2. Quality of included studies assessed by CONSORT[12] and QUADAS[13].

Randomised controlled studies	Inclusion and exclusion criteria clearly described	Participant flow clearly described	Intervention and control groups comparable at baseline	Concealed allocation procedure	Intervention clearly described	Intervention in control group clearly described	Blinded data analysis	Deviations from the protocol described	Study quality
Cheyne *et al.*[39]	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Moderate
Impey *et al.*[27]	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Good
Mires *et al.*[31]	Yes	Yes	Unclear	Yes	Yes	Yes	Yes	Yes	Moderate
Observational studies	Spectrum of patients representative?	Selection criteria clearly described	24 hours or less from test until delivery	Blinding of observer(s) from target condition when interpreting test	Blinding of test result when defining target condition	Were uninterpretable test results reported?	Test described in sufficient detail to permit replication	Clear definition of positive test result	Study quality
Blix *et al.*[21]	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes	Moderate
Chua *et al.*[23]	Yes	No	Unclear	Unclear	No	Unclear	Yes	Yes	Moderate
Ducey *et al.*[10]	Yes	Yes	Yes	Unclear	Unclear	Unclear	No	Yes	Moderate
Elimian *et al.*[35]	Yes	Yes	Unclear	Yes	Yes	Unclear	Yes	Yes	Moderate
Farrell *et al.*[24]	No	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Moderate
Farrell *et al.*[25]	No	Yes	Unclear	Unclear	Unclear	Unclear	Yes	Yes	Moderate
Ingemarsson *et al.*[1]	No	Yes	Yes	Yes	Yes	Unclear	Yes	Yes	Moderate
Ingemarsson *et al.*[28]	Yes	Yes	Yes	Yes	Yes	Unclear	No	Yes	Moderate
Sarno *et al.*[38]	Yes	No	Unclear	Unclear	Unclear	Yes	No	Yes	Moderate
Sarno *et al.*[11]	No	Yes	Unclear	Unclear	Unclear	Unclear	No	Yes	Moderate
Somerset *et al.*[34]	Yes	Yes	No	Unclear	Unclear	Unclear	No	Yes	Moderate

Discussion

In the randomised controlled trials, the labour admission test led to more obstetric interventions with no benefits for the newborn. In the observational studies, the predictive values were generally low. The computerised literature searches were broad; of 3699 citations only 19 were relevant. In spite of the broad search, we found seven citations by hand searching reference lists and by personal field knowledge.

Of the observational studies, Ducey *et al.*[10] had the best results—highest predictive values and an LR for a positive test of almost 35 for the outcome measure 'caesarean section for fetal distress'. Chua *et al.*[23] also had higher predictive values than the other diagnostic studies (Table 4). We could not find any methodological reasons why these studies had better prognostic properties than the other studies.

A problem that arose when interpreting the results from the observational studies was that none of the outcome measures was logical gold standards. The Apgar score is presumably quite objective, but because interventions are done to prevent mortality and morbidity, very few newborns (at least in the western world) are born with low Apgar scores. The other outcome measures ('resuscitation of infant', 'admission to neonatal unit', 'operative delivery for fetal distress', 'caesarean section for fetal distress' and 'fetal distress' as defined by Ingemarsson *et al.*[1]) are to a larger extent subjective and will differ between different institutions and single observers. Also, the labour admission test itself can influence the prevalence of some of the outcomes for which it is screening (e.g. operative deliveries).

The randomised controlled trial is a better study design for assessing the usefulness of the labour admission test; it can show if there are differences in outcomes between women screened with the labour admission test and those not screened. The meta-analysis showed that there were more obstetric interventions in the labour admission test group than in the control group. The reason for this may be explained by the great proportion of abnormal labour admission tests in two of the studies.[27,31] In the smallest study,[39] the proportion was not described. An abnormal labour admission test is usually followed by continuous electronic fetal monitoring, this can again lead to unnecessary obstetric interventions. A meta-analysis of nine randomised controlled trials including more than 18,500 women compared continuous electronic fetal monitoring with intermittent auscultation in labour.[41] There were significantly more caesarean sections and operative vaginal deliveries, and a reduction of neonatal seizures in the electronic fetal monitoring group. However, the long term impact of the reduction of neonatal seizures is not clear.[41]

In Mires *et al.*,[31] 21.5% of the admission traces in the intervention group were considered abnormal while 3.6% in the control group had fetal heart rate abnormalities at auscultation. Impey *et al.*[27] found 32% abnormal traces on admission. The labour unit staff in both studies did the

Table 3. Outcome events and meta-analysis for randomised controlled studies.

	Outcome events, *n/n*		RR (95% CI)
	Labour admission test	Auscultation at admission	
Operative delivery[a]			
Cheyne *et al.*[39]	23/148	30/164	0.9 (0.5–1.4)
Impey *et al.*[27]	673/4298	634/4282	1.1 (1.0–1.2)
Mires *et al.*[31]	313/1186	247/1181	1.3 (1.1–1.5)
Total	1009/5632	911/5627	1.1 (1.0–1.3)
Test for heterogeneity: $I^2 = 59.9\%$			
Operative delivery for fetal distress[a]			
Impey *et al.*[27]	308/4298	273/4282	1.1 (1.0–1.3)
Test for heterogeneity: not applicable			
Caesarean section			
Cheyne *et al.*[39]	11/148	9/164	1.4 (0.6–3.2)
Impey *et al.*[27]	180/4298	158/4282	1.1 (0.9–1.4)
Mires *et al.*[31]	61/1186	43/1181	1.4 (1.0–2.1)
Total	252/5632	210/5627	1.2 (1.0–1.4)
Test for heterogeneity: $I^2 = 0\%$			
Caesarean section for fetal distress			
Impey *et al.*[27]	57/4298	50/4282	1.1 (0.8–1.7)
Test for heterogeneity: not applicable			
Augmentation			
Cheyne *et al.*[39]	28/148	29/164	1.1 (0.7–1.7)
Impey *et al.*[27]	1637/4298	1629/4282	1.0 (1.0–1.1)
Mires *et al.*[31]	246/1183	202/1175	1.2 (1.0–1.4)
Total	1911/5629	1860/5621	1.1 (0.9–1.2)
Test for heterogeneity: $I^2 = 55.6\%$			
Epidural			
Cheyne *et al.*[39]	26/148	22/164	1.3 (0.8–2.2)
Mires *et al.*[31]	325/1186	261/1181	1.2 (1.1–1.4)
Total	351/1334	283/1345	1.2 (1.1–1.4)
Test for heterogeneity: $I^2 = 0\%$			
Continuous EFM			
Cheyne *et al.*[b,39]	7/148	5/164	1.6 (0.5–4.8)
Impey *et al.*[27]	2511/4298	1802/4282	1.4 (1.3–1.5)
Mires *et al.*[31]	672/1186	551/1178	1.2 (1.1–1.3)
Total	3190/5632	2358/5624	1.3 (1.2–1.5)
Test for heterogeneity: $I^2 = 77.6\%$			
Fetal blood sampling			
Cheyne *et al.*[39]	6/148	8/164	0.8 (0.3–2.3)
Impey *et al.*[27]	457/4298	349/4282	1.3 (1.1–1.5)
Mires *et al.*[31]	96/1186	76/1181	1.3 (0.9–1.7)
Total	559/5632	433/5627	1.3 (1.1–1.5)
Test for heterogeneity: $I^2 = 0\%$			
Perinatal mortality			
Cheyne *et al.*[39]	0/148	0/164	Not estimable
Impey *et al.*[c,27]	0/4298	1/4282	0.3 (0.0–8.2)
Mires *et al.*[31]	2/1186	1/1181	2.0 (0.2–21.9)
Total	2/5632	2/5627	1.1 (0.2–7.1)
Test for heterogeneity: $I^2 = 0\%$			
Resuscitation of infant			
Impey *et al.*[d,27]	8/4298	13/4282	0.6 (0.3–1.5)
Mires *et al.*[e,31]	5/1185	4/1178	1.2 (0.3–4.6)
Total	13/5483	17/5460	0.8 (0.4–1.6)
Test for heterogeneity: $I^2 = 0\%$			
Neonatal seizures			
Impey *et al.*[27]	11/4298	14/4282	0.8 (0.4–1.7)
Test for heterogeneity: not applicable			
Apgar score <7 at 5 minutes			
Cheyne *et al.*[39]	0/148	2/164	0.2 (0.0–4.6)
Impey *et al.*[27]	17/4298	11/4282	1.5 (0.7–3.3)
Mires *et al.*[31]	25/1181	18/1171	1.4 (0.8–2.5)
Total	42/5627	31/5617	1.4 (0.9–2.2)
Test for heterogeneity: $I^2 = 0\%$			
Admission to neonatal unit			
Cheyne *et al.*[39]	1/148	3/164	0.4 (0.0–3.5)
Impey *et al.*[27]	203/4298	197/4282	1.0 (0.8–1.2)
Mires *et al.*[31]	46/1185	45/1175	1.0 (0.7–1.5)
Total	250/5631	245/5621	1.0 (0.9–1.2)
Test for heterogeneity: $I^2 = 0\%$			

[a] Caesarean section, vacuum and forceps.
[b] More than 75% of the time in delivery unit.
[c] Intrapartum or early (within seven days) death of an infant without a major congenital abnormality.
[d] Administration of mechanical ventilation for more than 15 minutes.
[e] Need for intermittent positive pressure ventilation at resuscitation.

assessments. In a Scottish study[24] with only low risk women included, and the assessments done by the labour unit staff, the proportion of abnormal labour admission tests, was 14.7%. In a Norwegian study[20] with a mixed population, the proportion was 5.3%. At Lund University Hospital, Sweden, the proportion of non-reactive labour admission test is 2.9% (Ingemar Ingemarsson, personal communication). Mires *et al.*[31] did not describe the criteria for assessing the labour admission test. Impey *et al.*[27] classified the labour admission test normal if the baseline fetal heart rate was 110–160 bpm, variability was as more than 5 per minutes, decelerations were absent and if there were more than one acceleration in 20 minutes. If the criteria were not met, the CTG was continued until delivery. These criteria are stricter than in the study by Ingemarsson *et al.*[1] who assessed the test as reactive if there were two accelerations (more than 15 beats, more than 15 seconds) in 10–20 minutes or if there were no accelerations but normal baseline and variability.

The study of Impey *et al.*[27] was performed at Dublin National Maternity Hospital where labour in nulliparous women was managed actively. Among other things, amniotomy was performed upon admission (mean cervical dilatation at rupture of membranes was less than 2 cm) and one-to-one midwifery care. Only those with clear amniotic fluid were

Table 4. Outcome events and LRs for observational studies.

	Outcome events, *n/n*		LR	
	Positive test	Negative test	Positive test	Negative test
Operative delivery for fetal distress[a]				
Blix *et al.*[b,21]	14/139	31/706	2.0 (1.3–3.2)	0.8 (0.7–1.0)
Chua *et al.*[b,23]	20/71	44/1021	6.3 (4.0–9.9)	0.7 (0.6–0.9)
Farrell *et al.*[25]	3/12	13/170	3.5 (1.0–11.5)	0.9 (0.7–1.1)
Ingemarsson *et al.*[b,1]	5/59	29/982	2.7 (1.2–6.4)	0.9 (0.8–1.0)
Caesarean section for fetal distress				
Blix *et al.*[b,21]	10/139	13/706	2.8 (1.7–4.5)	0.7 (0.5–1.0)
Ducey *et al.*[10]	18/24	14/381	35.0 (14.9–81.9)	0.5 (0.3–0.7)
Elimian *et al.*[35]	8/25	19/401	7.0 (3.3–14.6)	0.7 (0.6–0.9)
Ingemarsson *et al.*[b,1]	5/59	13/982	5.3 (2.4–11.6)	0.8 (0.6–1.0)
Sarno *et al.*[38]	5/21	1/88	5.4 (3.0–9.5)	0.2 (0.0–1.2)
Sarno *et al.*[11]	16/90	8/310	3.4 (2.4–4.8)	0.4 (0.2–0.7)
Somerset *et al.*[b,34]	6/41	10/293	3.4 (1.7–6.9)	0.7 (0.5–1.0)
Apgar score <7 at 5 minutes				
Blix *et al.*[b,21]	2/139	5/706	1.8 (0.5–5.7)	0.9 (0.5–1.4)
Chua *et al.*[b,23]	10/71	6/1021	11.0 (7.0–17.3)	0.4 (0.2–0.8)
Elimian *et al.*[35]	0/25	3/401	2.1 (0.2–28.6)	0.9 (0.6–1.4)
Farrell *et al.*[24]	0/26	2/205	1.5 (0.1–18.6)	0.9 (0.6–1.6)
Farrell *et al.*[25]	0/12	1/170	3.6 (0.3–42.6)	0.8 (0.4–1.8)
Sarno *et al.*[38]	0/21	1/88	1.3 (0.1–14.4)	0.9 (0.4–2.1)
Sarno *et al.*[11]	3/90	7/310	1.4 (0.5–3.5)	0.9 (0.6–1.4)
Fetal distress[c]				
Blix *et al.*[b,21]	15/139	35/706	1.9 (1.2–3.0)	0.8 (0.7–1.0)
Ingemarsson *et al.*[b,1]	9/59	13/982	8.3 (4.7–14.8)	0.6 (0.4–0.9)
Ingemarsson *et al.*[b,28]	8/58	14/708	5.4 (2.9–10.0)	0.7 (0.5–0.9)
Resuscitation of infant				
Chua *et al.*[b,d,23]	12/71	32/1021	4.8 (2.8–8.3)	0.8 (0.6–0.9)
Farrell *et al.*[25]	1/12	18/170	0.8 (0.1–5.7)	1.0 (0.9–1.1)
Admission to neonatal unit				
Blix *et al.*[b,28]	11/139	17/705	2.5 (1.5–4.1)	0.7 (0.5–1.0)
Chua *et al.*[b,23]	19/71	42/1021	6.2 (3.9–9.8)	0.7 (0.6–0.9)
Elimian *et al.*[35]	3/25	30/401	1.6 (0.5–5.1)	1.0 (0.9–1.1)
Farrell *et al.*[24]	3/26	4/205	4.2 (1.6–10.8)	0.6 (0.3–1.2)
Farrell *et al.*[25]	0/12	2/170	2.4 (0.2–32.1)	0.9 (0.5–1.5)

[a] Caesarean section, vacuum and forceps deliveries.
[b] Cutoff equivocal test.
[c] Fetal distress according to Ingemarsson *et al.*,[1] see text.
[d] Assisted ventilation; 95% CIs in parentheses.

included in the study. A systematic review[42] found that early amniotomy was associated with a non-significant trend towards increase in the risk of a caesarean section. Another systematic review[43] found that women who had continuous one-to-one intrapartum care were less likely to have operative deliveries than women who did not have continuous support. Many delivery units do not rupture the membranes as routine in early labour and do not provide one-to-one midwifery care. The results from Impey *et al.*[27] may therefore not be valid in other settings.

The high proportion of labour admission tests considered abnormal by Mires *et al.*[31] and Impey *et al.*[27] is probably the reason that so many women in the intervention group had continuous electronic fetal monitoring; which again led to increased obstetric interventions. Despite this, there was no improvement in neonatal outcomes. In low risk women, serious adverse outcomes occur infrequently. In the three randomised controlled studies[27,31,39] including only low risk women, the perinatal mortality rate was 0.3/1000, and the proportion of newborns that were resuscitated was 0.2%. The proportion of newborns with an Apgar score <7 at 5 minutes was 0.6%. Consequently, our meta-analysis may be underpowered to detect differences in these outcomes. In order to be able to detect a difference in Apgar scores less than 7 at 5 minutes in this population, a sample size of more than 16,000 is required. As a consequence of this assumption, an underpowered study like ours might lead to type II errors, where possible effects might be overseen due to low power.

If a randomised controlled trial was determined in a unit where a small proportion of the labour admission tests were considered abnormal, we would maybe not find a similar increase in obstetric interventions in low risk women. It could be argued that the high specificities and negative predictive values support using the labour admission test to recognise a reactive fetal heart rate in order to decide subsequent mode of monitoring. There is, however, no reason to believe that the neonatal outcomes would improve.

The British[3] and Swedish guidelines[4] were made before the three randomised controlled studies[27,31,39] on the labour admission test were published. Both guidelines included observational studies only, and they ended up with different recommendations on the use of the labour admission test. The present study arrived at the same conclusions as the British guidelines.[3]

Conclusions

There is no evidence supporting that the labour admission test is beneficial in low risk women. The test performs poorly in preventing adverse outcomes and is a poor predictor of these adverse outcomes. In settings where a high proportion of the tests are assessed as abnormal, the labour admission test leads to more obstetric interventions without improving the neonatal outcomes. There is scarce scientific evidence to recommend the labour admission test as screening for adverse outcomes in high risk women.

Future research should emphasise the most appropriate method of fetal surveillance in high risk labours.

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Conflict of interest

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