Predictors of newborn admission after labour induction at term: Bishop score, pre-induction ultrasonography and clinical risk factors

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ABSTRACT

Introduction: Following labour induction at term, 12 percent of neonates can expected to be admitted to the neonatal intensive care unit. We aimed to evaluate the Bishop score, pre-induction ultrasonography (US) assessment of amniotic fluid, foetal weight and cervical length, and pre-induction and intrapartum risk factors as predictors of neonatal admission.

Methods: 152 women at term, scheduled for labour induction, consented to participate in this prospective study. Transabdominal US was performed to obtain foetal biometry and amniotic fluid index, followed by transvaginal US to measure cervical length. US findings were concealed. The Bishop score was obtained at initiation of labour induction. Pre-induction and intrapartum risk factors were also considered in the multivariate logistic regression analysis. All study women received standard care.

Results: On univariate analysis, factors associated with neonatal admission were: gestational age at less than or equal to 40 weeks, labour induction for diabetes mellitus, Bishop score of less than 5 at initiation of labour induction, estimated foetal weight of less than 2.5 kg by US, induction to delivery interval of more than 24 hours, caesarean delivery and umbilical cord blood pH of less than 7.1. Cervical length of greater than 20 mm on transvaginal US (p-value is 0.10) was not significant. After multivariate logistic regression analysis, controlling for the significant variables, only the unfavourable Bishop score (adjusted OR 4.2; 95% CI 1.2-13.8; p-value is 0.02) and caesarean delivery (adjusted OR 3.9; 95% CI 1.1-13.7; p-value is 0.035) were independent predictors of neonatal admission.

Conclusion: The identification of an unfavourable Bishop score as an independent predictor of neonatal admission is useful in the counselling of women who are considering labour induction.

Keywords: Bishop score, caesarean delivery, labour induction, neonatal admission, obstetrical ultrasonography

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INTRODUCTION

Induction of labour occurs in about 20% of term pregnancies,[1] with a neonatal admission to neonatal intensive care unit rate of about 12%.[2] A low amniotic fluid index (AFI) at term labour induction has been shown to be associated with neonatal admission,[2] but low AFI has also been reported to be a poor predictor for neonatal admission in post-date pregnancies.[3] Cervical length by transvaginal ultrasonography (US) prior to labour induction is associated with caesarean delivery,[4] but there is a paucity of data on transvaginal US for cervical length before labour induction and neonatal admission, with no relevant study of predictive value of this parameter highlighted following a PubMed search (www.ncbi.nlm.nih.gov/entrez/query.fcgi) in all languages done on January 19, 2007 using the search parameters, "neonatal admission and cervical length", "transvaginal ultrasonography" or "Bishop score".

Antenatal US for foetal biometry at 36–37 weeks gestation does not affect the neonatal admission rate.[5] However, estimated foetal weight below the fifth percentile by US has been shown to be associated with neonatal admission.[6] There was little data on US estimation of foetal weight and neonatal admission risk in labour induction. A prospective study was performed to determine the utility of pre-induction risk factors, Bishop score, transabdominal US assessment of foetal biometry and AFI, transvaginal US assessment of cervical length and intrapartum risk factors on neonatal admission risk in induction of labour at term, as this information would be helpful in pre-induction counselling.

METHODS

This study was performed in a university hospital conducting about 5,000 deliveries per year. Institution review board approval was granted and written informed

consent was obtained from each woman in the study. Women with a singleton foetus, intact membranes and cephalic presentation at term (37–42 weeks) were recruited when they presented to the induction bay of the delivery suite for labour induction. Recruitment was carried out by the investigators. Women with intrauterine foetal death or known gross foetal anomaly were excluded. Recruitment took place from January 2003 to August 2004. Of 153 women approached, only one woman declined transvaginal US, leaving 152 women for analysis.

Study women were asked to empty their bladder and a transabdominal US was performed to obtain foetal biparietal diameter, head circumference, abdominal circumference and femur length. Estimated foetal weight by US was derived using the formula by Hadlock et al.[7] AFI was obtained by dividing the pregnant uterus into four hypothetical quadrants and measuring the deepest umbilical-cord-free vertical liquor pool in each quadrant and adding up the four measurements to obtain the AFI, as previously described.[8] The AFI was obtained three times in each woman and the mean was used.

Immediately following the transabdominal US, transvaginal US was performed. The sagittal image of the entire cervical canal for measurement was acquired ultrasonographically, as previously described.[9] Measurement of cervical length was made from the internal os to external os in a straight line.[10] The cervical length was obtained from three different images in each woman, and the shortest length was used for analysis.[11] Funnelling was defined as a funnel shape appearance at the internal cervical os due to its dilation. Ultrasonographical findings were concealed from providers. US was performed by investigators with at least one year experience with obstetrical and gynaecological US, using a 3.5 MHz curvilinear transabdominal probe and a 6 MHz transvaginal probe fitted to either a Toshiba™ Eccocee or Toshiba™ Capasee machine (Toshiba Medical Imaging, Tokyo, Japan).

The method of induction of labour was decided at the initial vaginal examination on the induction bay, at which time the Bishop score was also obtained. Induction was either by administration of dinoprostone (3 mg) pessary placement or amniotomy. The start of labour induction was taken as time of insertion of the first dinoprostone pessary or of amniotomy. Universal electronic foetal heart rate monitoring was carried out. In our institution, dinoprostone pessary was used for labour induction if the Bishop score was unfavourable (< 5), and amniotomy was usually performed when the cervix was ≥ 3 cm dilated and the presenting part was low. In women with unfavourable Bishop scores, following dinoprostone pessary insertion, the woman was assessed after six hours, and depending on the cervical dilatation and presence of contractions, a further dinosprostone pessary might be inserted or amniotomy performed. A maximum of two doses of dinoprostone per day was allowed. The women were routinely assessed again after another six hours and if the cervix dilation remained unfavourable, women with non-urgent indications were usually allowed to rest overnight and the process was repeated the following morning. Following amniotomy for labour induction, oxytocin was usually started within two hours, if contractions were inadequate.

Once in established labour, vaginal assessment was usually done every four hours initially, unless otherwise indicated. Oxytocin was started for labour augmentation when labour progress fell below the two-hour delay action line in the partogram. Once started, oxytocin infusion was continued to delivery unless otherwise indicated. Pre-induction, intrapartum and delivery variables collected included mode of induction, requirement for epidural analgesia, presence of meconium in the liquor, induction to delivery interval, abnormal cardiotocograph, caesarean delivery, five-minute Apgar score and umbilical cord pH.

The cardiotocograph was defined as abnormal if at least two of the following features were present in the last hour prior to birth: (a) absence of foetal heart rate accelerations; (b) tachycardia (> 160 beats per minute); (c) reduced foetal heart rate baseline variability (< 5 beats per minute); and (d) late, variable or prolonged decelerations. We defined low Bishop score as a score < 5, and long cervix as length on transvaginal US > 20 mm after analysing the receiver-operator characteristic curve of these parameters on neonatal admission. Low AFI is defined as AFI ≤ 5 and short stature as height < 1.5 m. Neonatal admission was defined as admission to a newborn care facility, typically to a special care nursery or neonatal intensive care unit, but admission might be to a paediatric ward, if the aforementioned facilities were fully utilised with stay duration of at least one day.

Data was entered into the Statistical Package for Social Sciences version 11.5 (SPSS Inc, Chicago, IL, USA), and GraphPad Instat software (GraphPad Software Inc, San Diego, CA, USA) was also used for data analysis. SISA software (Quantitative Skills, Hilversum, Netherlands) was used to perform Fisher's exact test with larger than 2 × 2 datasets. The Kolmogorov-Smirnov test was used to check for normal distribution. The *t*-test was used to analyse the mean, the Mann-Whitney U-test for non-parametric data, Fisher's exact test for categorical datasets (up to 2 × 5), relative risk (RR) and its 95% confidence interval (CI) were calculated using the GraphPad Instat programme. A receiver operator characteristic curve was used to determine the best cut-off to use for Bishop score and cervical length for neonatal admission as outcome. Multivariate logistic regression analysis was performed

Table I. Characteristics, pregnancy and neonatal outcomes of 152 study women undergoing labour induction.

Characteristic or outcome	No. (%)*	Median [IQR]*
Age (years)	30.5 ± 4.8	
≥ 35	27 (17.8)	
Parity	1.1 ± 1.2	1 [2]
Nullipara	65 (42.8)	
Ethnicity		
Malay	96 (63.2)	
Chinese	23 (15.1)	
Indian	31 (20.4)	
Other	2 (1.3)	
Height (cm)	156 ± 6	
Short stature (< 150)	22 (14.5)	
Gestational age (weeks)	39.9 ± 1.3	40 [3]
> 40	73 (48.0)	
Indication for labour induction†		
Prolonged pregnancy (≥ 41 weeks)	65 (34.2)	
Diabetes mellitus	50 (26.3)	
Hypertension	22 (11.6)	
Non-reassuring foetal status‡	38 (20.0)	
Others	15 (7.9)	
Bishop score		5 [3]
< 5	50 (32.9)	
Amniotic fluid index	10.1 ± 4.5	
≤ 5	17 (11.2)	
Transvaginal US		
Cervical length (mm)	23 ± 9	
Funnelling at internal cervical os	35 (23.0)	
Estimated foetal weight (kg)	3.1 ± 0.4	
< 2.5	14 (9.2)	
2.5–4	135 (88.8)	
> 4	3 (2.0)	
Mode of labour induction		
Vaginal dinoprostone	120 (78.9)	
Amniotomy	32 (21.1)	
Epidural analgesia in labour	38 (25.0)	
Meconium-stained liquor	7 (4.6)	
Non-reassuring cardiotocograph in labour	22 (14.5)	
Induction delivery interval (hours)	17.7 ± 14.4	12.6 [17.2]
> 12	78 (51.3)	
> 24	41 (27.0)	
Mode of delivery		
Caesarean section	35 (23.0)	
Instrumental vaginal	14 (9.2)	
Spontaneous vaginal	103 (67.8)	
Indication for caesarean delivery		
Non-reassuring foetal status	17 (48.6)	
Failure to progress	17 (48.6)	
Intrapartum haemorrhage	1 (2.9)	
Birth weight (kg)	3.20 ± 0.45	
< 2.5	9 (5.9)	
2.5–4	140 (92.1)	
> 4	3 (2)	
Apgar score at 5 minutes	9.9 ± 0.5	10 [0]
< 7	1 (0.7)	
Cord pH	7.31 ± 0.08	7.32 [0.09]
< 7.1	2 (1.3)	
Neonatal admission	21 (13.8)	
Indication for neonatal admission		
Suspected hypoglycaemia	12 (57.1)	
Tachypnoea	5 (23.8)	
Observation	2 (9.5)	
Birth asphyxia	1 (4.8)	
Congenital anomaly	1 (4.8)	
Duration of neonatal ward stay (days)	2.4 ± 2.8 n = 21	1 [1.5]

*Where applicable, data is expressed as mean ± standard deviation; or where data was non-parametric, median [interquartile range (IQR)]. All figures are rounded to one decimal place.

†Total indications 190 for 152 study women, as 36 women had two recorded indications and one woman had three indications for labour induction.

‡Includes oligohydramnios, reduced foetal movement, small for gestational age, non-reassuring cardiotocograph and non-reassuring umbilical artery Doppler profile.

using all variables with crude $p < 0.05$. $p < 0.05$ was taken as a significant level and all tests used two-tailed results.

RESULTS

The characteristics and outcome profiles of the 152 study women are listed in Table I. The overall neonatal admission rate was 13.8%. The median stay in the neonatal nursery was one day (interquartile range [IQR] 1.5 days). There was one early neonatal death which occurred in a neonate who was delivered by spontaneous vaginal delivery to a 27-year-old multipara woman with insulin-dependent diabetes mellitus. The infant was delivered at 38 weeks gestation with a birth weight of 3.9 kg, Apgar score of 9 at five minutes, umbilical cord pH of 7.35, following an induction to delivery interval of ten hours. The infant had pulmonary haemorrhage and succumbed in the neonatal intensive care unit within 24 hours of birth. No other neonate required mechanical ventilation.

There were 50 inductions for patients with diabetes mellitus in pregnancy, and these neonates accounted for 11 of the 21 neonatal admissions, including nine of the 12 admissions for suspected neonatal hypoglycaemia. Receiver operator characteristic curve indicated that the best cut-off for predictors of neonatal admission were cervical length of > 20 mm (area under the curve = 0.645; p = 0.031; sensitivity 76.2%, specificity 43.5%, positive predictive value 17.8% and negative predictive value 91.9%) and Bishop score of < 5 (area under the curve = 0.721; p = 0.001; sensitivity 66.7%, specificity 72.5%, positive predictive value 28.0% and negative predictive value 93.1%).

Gestational age was confirmed by US in 131 (86.2%) women, supported by compatible symphysis-fundal height before 24 weeks gestation in another 15 (9.9%) women, but four (2.6%) women attended late for antenatal care and their gestational age was based on maternal menstrual dates. The distribution for parity, gestational age, Bishop score, duration of neonatal admission and induction to delivery interval were found to be non-parametric. Data for these variables were primarily displayed as median (IQR), and Mann-Whitney U-test was used to assess the difference for these variables among women whose infants were admitted or not admitted to a neonatal unit.

The interaction of US findings, clinical profile, intrapartum and delivery risk factors and neonatal admission are shown in Table II. Taking only pre-induction factors into account, on univariate analysis, gestation > 40 weeks (RR 0.34; 95% CI 0.13-0.88; p = 0.019), labour induction for diabetes mellitus in pregnancy (RR 2.2; 95% CI 1.0–4.9; p = 0.048), estimated foetal weight < 2.5 kg (RR 3.1; 95% CI 1.3–7.1; p = 0.027) and Bishop score < 5 (RR 4.1; 95% CI 1.8–9.5; p < 0.001) were significantly associated with neonatal admission. Transvaginal US cervical length of > 20 mm (p = 0.10) was not a significant predictor. Following adjusted analysis of these pre-induction variables, only unfavourable Bishop scores (adjusted odds-ratio [AOR] 4.4; 95% CI 1.5–13.6; p = 0.009) were independently associated with neonatal admission.

On univariate analysis of induction, intrapartum and delivery variables, prolonged induction to delivery interval > 24 hours (RR 3.0; 95% CI 1.4–6.5; p = 0.008), caesarean delivery (RR 3.7; 95% CI 1.7–7.9; p = 0.001) and cord pH < 7.1 (RR 8.5; 95% CI 5.4–13.3; p = 0.016) were associated with neonatal admission. On multivariate logistic regression analysis, taking into account all variables that were collected in this study with crude p < 0.05, only Bishop scores < 5 (AOR 4.2; 95% CI 1.2–13.8; p = 0.02) and caesarean deliveries (AOR 3.9; 95%CI 1.1–13.7; p = 0.035) were independently associated with neonatal admission. Induction indicated by diabetes mellitus in pregnancy (adjusted p = 0.076) was not a significant independent risk factor for neonatal admission, despite the fact that the majority of neonatal admissions were for suspected neonatal hypoglycaemia, but this was a borderline result.

DISCUSSION

The role of US findings as a predictor for adverse perinatal outcome at labour induction at term remained unsettled. The admission rate to a neonatal nursery of 13.8% in our study (32.9% of the woman in our study had labour induction indicated by diabetes mellitus) was relatively low compared to a reported neonatal admission rate of 61%–71% reported in a recent randomised trial on the management of mild to moderately severe gestational diabetes mellitus.[12] The low neonatal admission rate of 22% among women induced for diabetes mellitus is likely due to the fact that our study was of term labour inductions with mature foetuses. Our overall admission rate was broadly similar to the 11.6% reported by Alchalabi et al,[2] but only1.1% of their labour inductions were for women with diabetes mellitus.

An unfavourable Bishop score is associated with caesarean delivery at labour induction and also spontaneous labour.[13] We have demonstrated an independent association between Bishop score < 5 and neonatal admission. This is a useful finding as the Bishop score is a widely-used tool in assessing favourability for labour induction, and this finding be helpful during counselling of women who are considering labour induction. The independent association between unplanned or emergency caesarean delivery and neonatal admission was plausible and expected,[14] as these deliveries were often associated with prolonged induction to delivery interval, or abnormal cardiotocography. Low estimated foetal weight was not associated with neonatal admission in our study of term labour induction. This finding is compatible with that of

Table II. US and clinical profile and neonatal admission in 152 study women.

Profile	Neonatal admission No (%)*		Crude p-value; [RR] (95% CI)	Adjusted p-value† ; [AOR] (95% CI)
	Yes n = 21	No n = 131		
Age (years)	31.5 ± 4.6	30.3 ± 4.9	0.30	
≥ 35	4 (19.0)	23 (17.6)	1.0	
Parity	0 [1]	1 [2]	0.27	
Nullipara	12 (57.1)	53 (40.5)	0.16	
Ethnicity				
Malay	14 (66.7)	82 (62.6)	0.81	
Chinese	2 (9.5)	21 (16.0)		
Indian	5 (23.8)	26 (19.8)		
Other	0 (0)	2 (1.5)		
Height (cm)	157 ± 6	156 ± 6	0.48	
< 150	2 (9.5)	20 (15.3)	0.74	
Gestational age (weeks)	38 [2.5]	40 [2]	< 0.001	
> 40	5 (23.8)	68 (51.9)	0.019; [0.34] (0.13–0.88)	0.16
Indication for induction‡				
≥ 41 weeks	5 (18.5)	60 (36.8)	0.066	
Diabetes mellitus	11 (40.7)	39 (23.9)		
Hypertension	6 (22.2)	16 (9.8)		
Non-reassuring foetal status§	4 (14.8)	34 (20.9)		
Others	1 (3.7)	14 (8.6)		
Induction for diabetes mellitus				
Yes	11 (52.4)	39 (29.8)	0.048; [2.2](1.0–4.9)	0.076
No	10 (47.6)	92 (70.2)		
Bishop score	4 [2]	5 [3]	0.001	
< 5	14 (66.7)	36 (27.5)	< 0.001; [4.1] (1.8–9.5)	0.02; [4.2] (1.2–13.8)
Amniotic fluid index	9.9 ± 4.7	10.1 ± 4.9	0.83	
≤ 5	2 (9.5)	17 (13.0)	1.0	
Transvaginal US				
Cervical length (mm)	27.0 ± 8.5	22.0 ± 9.3	0.023	
Length > 20	14 (66.7)	56 (42.7)	0.10	
No cervical funnelling	19 (90.5)	98 (74.8)	0.16	
Estimated foetal weight (kg)	3.0 ± 0.6	3.1 ± 0.4	0.22	
< 2.5	5 (23.8)	9 (6.9)	0.027	0.43
Mode of labour induction				
Vaginal dinoprostone	20 (95.2)	100 (76.3)	0.079	
Amniotomy	1 (4.8)	31 (23.7)		
Epidural analgesia in labour	7 (33.3)	31 (23.7)	0.42	
Meconium-stained liquor	2 (9.5)	5 (3.8)	0.23	
Non-reassuring cardiotocograph in labour	6 (28.6)	16 (12.2)	0.086	
Induction delivery interval (hors)	29 [25.3]	11.0 [15.3]	0.007	
> 24	11 (52.4)	30 (22.9)	0.008; [3.0] (1.4–6.5)	0.069
Caesarean delivery	11 (52.4)	24 (18.3)	0.001; [3.7] (1.7–7.9)	0.035; [3.9] (1.1–13.7)
Birth weight (kg)	3.1 ± 0.6	3.2 ± 0.4	0.33	
< 2.5	2 (9.5)	7 (5.3)	0.36	
Apgar score at five minutes	10 [0]	10 [1]	< 0.001	
< 7	1 (4.8)	0 (0)	0.14	
Cord pH	7.30 [0.11]	7.32 [0.07]	0.10	
< 7.1	2 (10.5)	0 (0)	0.016; [8.5] (5.4–13.3)	1.0
	n = 19	n = 128		

*Where applicable, data is expressed as mean ± standard deviation; or for non-parametric variables, as median [interquartile range (IQR)]. All figures are rounded to one decimal place.

RR: relative risk; AOR: adjusted odds ratio; CI: confidence interval

† Adjusted p-value is shown where covariate (crude $p < 0.05$) was incorporated into the model for multivariate logistic regression analysis, and AOR is shown where adjusted $p < 0.05$.

‡ Indications total 190 as 37 women had two recorded indications for labour induction and one woman had three indications listed.

§ Includes oligohydramnios, reduced foetal movement, small for gestational age, non-reassuring cardiotocograph and non-reassuring umbilical artery Doppler.

recent studies, which have shown no association between estimated foetal weight and another surrogate for poor perinatal outcome, i.e. caesarean delivery.[4,15,16]

Low AFI was also not associated with neonatal admission, which was unsurprising given that the majority of neonatal admissions were for suspected hypoglycaemia (66.7% of suspected hypoglycaemia admissions came from pregnancies complicated by diabetes mellitus in pregnancy). The mean ± standard deviation AFI for women whose labour induction was indicated by diabetes mellitus, compared to women with other indications for labour induction, was 11.7 ± 4.7 vs. 9.3 ± 4.2 ($p = 0.003$). We did not find an association between low AFI and neonatal admission, in contrast to findings by Alchalabi et al,[2] but as previously mentioned, their study group comprised very few labour inductions indicated by diabetes mellitus in pregnancy (1.1% vs. 32.9%) and a higher proportion of AFI ≤ 5 (36.7% vs. 11.2%), compared to our study group. However, even when we considered only the 102 labour inductions not indicated by diabetes mellitus, when comparing AFI ≤ 5 vs. AFI > 5, neonatal admission rates were 7.7% vs. 10.1% admission, respectively, and low AFI was still not associated with neonatal admission ($p = 1.0$).

Long cervix (> 20 mm length) was not associated with neonatal admission on univariate analysis ($p = 0.1$), and if we included cervix > 20 mm into a multivariate logistic regression model of pre-induction variables after controlling for Bishop score, gestational age and labour induction indicated by diabetes mellitus, a long cervix on transvaginal US also failed to show an association (adjusted $p = 0.41$). An unfavourable Bishop score (< 5) appears to be a useful and independent predictor of neonatal admission in a mixed group of women undergoing labour induction at term, but further studies are needed to confirm this finding.

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