Developing a Pilot Model to Predict Successful Vaginal Birth after Caesarean Section for Hong Kong Chinese women

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Objectives: To determine the success rate of vaginal birth after Caesarean section (VBAC) and its associated factors in local Chinese women with one previous Caesarean delivery and to develop nomograms to quantify the probability of a successful VBAC in an individual woman.
Methods: All women with a history of a single previous uncomplicated lower segment Caesarean section who underwent a trial of labour at Princess Margaret Hospital between 1 January 2013 and 30 June 2015 were identified. Their demographic data, obstetrics and medical history, as well as intrapartum events were obtained. Univariate analyses and multivariate logistic regression were performed to identify significant predictors of a successful VBAC.
Results: Of 507 women attempted a VBAC, 406 (80.1%) succeeded. Women who had a successful VBAC were more likely to be younger, taller, and have a history of vaginal delivery or previous VBAC. Women with a previous emergency Caesarean delivery, a non-progressive labour as the indication for previous Caesarean delivery (odds ratio [OR]=0.453, 95% confidence interval [CI], 0.271-0.756), a significantly longer labour in the present pregnancy (OR =0.997, 95% CI, 0.996-0.998), the use of Syntocinon (OR =0.227, 95% CI=0.130-0.395), and epidural analgesia were more likely to have a failed VBAC. Based on these factors, two nomograms (one for antepartum and another for intrapartum) were developed to quantify the probability of a successful VBAC in an individual woman.
Conclusion: The success rate of VBAC in this local Chinese cohort was 80.1%. Non-progressive labour as the indication for previous Caesarean delivery was the most significant antepartum predictor for a failed VBAC, whereas the use of Syntocinon was the most significant intrapartum predictor.
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Keywords: Oxytocin; Pregnancy outcome; Vaginal birth after Cesarean

Introduction

In Princess Margaret Hospital (PMH), the rate of delivery by Caesarean section has increased from 21.5% in 2002 to 26% in 2012. Women with uncomplicated pregnancy who have one previous uncomplicated Caesarean section can be offered either a planned vaginal birth after Caesarean section (VBAC) or an elective repeat Caesarean section (ERCS). The decision to attempt a trial of labour depends on the likelihood of a successful VBAC as the greatest risk of adverse outcome occurs in a trial of VBAC resulted in emergency Caesarean delivery[1].

In the UK, the overall success rate for a planned VBAC is 72 to 75%. Factors associated with a failed VBAC include induced labour, no previous vaginal delivery, body mass index (BMI) >30, and previous Caesarean section for labour dystocia[2-4]. Various predictive models and nomograms have been developed to predict the chance of a successful VBAC according to individual risk assessment[5-7]. The VBAC success rates vary between different studies, and women of white ethnicity have a higher success rate than those of Asian ethnicity[2,4]. In a local cohort study, previous Caesarean section for failure to progress is associated with unsuccessful VBAC among women in whom a double balloon catheter was used for induction of labour[8]. A larger study is required to derive a local VBAC success rate and evaluate various factors that affect the success of VBAC and to predict the likelihood of success.

We aimed to determine the success rate of VBAC and the obstetric and maternal factors associated with the success of VBAC in local Chinese women with one previous Caesarean delivery, and to incorporate these factors into predictive nomograms for easy clinical use. Predictive nomograms can enable obstetricians to quantify VBAC success based on multiple clinical parameters of the pregnant woman.

Methods

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Information System was used to identify births that took place at the Princess Margaret Hospital of Hong Kong (PMH) throughout the study period. The system contains patient demographics, clinical information including antenatal records, obstetric history, labour information, baby information, and diagnosis and procedure for each delivery.

Women who had delivered at PMH between 1 January 2013 and 30 June 2015 with a coding of 'previous Caesarean section' or 'previous uterine scar' were identified. The maternal antenatal records, hospital electronic records (e-PR), written records throughout the whole antepartum, intrapartum, and postpartum periods, neonatal birth records and neonatal e-PR were reviewed by the main investigator. Women who had a vertex singleton pregnancy with a gestational age of 24 weeks or above and a history of one previous uncomplicated lower segment Caesarean section were included. Those who had contraindications for VBAC including a history of more than one previous lower segment Caesarean section, previous classical Caesarean section, previous uterine rupture, previous complicated uterine scar, or previous non-Caesarean section scar were excluded. Women with indications for an ERCS or emergency Caesarean section before the onset of labour, women who refused a VBAC, or those who were non-Chinese were also excluded.

A successful VBAC was defined as vaginal delivery following an attempted VBAC including normal spontaneous delivery and instrumental delivery. Demographic data, obstetrics and medical history, as well as intrapartum events were obtained. Maternal demographics included age, maternal height, pre-pregnancy or first visit body mass index (BMI) and parity. Obstetric history included the indication for previous Caesarean section, type of previous Caesarean section (elective or emergency), birth weight of previous baby delivered by Caesarean, time since last Caesarean delivery, and history of previous vaginal delivery. Medical history and intrapartum information included birth weight of the current delivery, sex of the baby, gestational age at delivery, duration of the first stage of labour, maternal pre-existing conditions (asthma, autoimmune disease, chronic hypertension, diabetes, renal disease, seizure disorder), conditions of current pregnancy (gestational diabetes, gestational hypertension, pre-eclampsia or eclampsia), use of Syntocinon for induction or augmentation, and use of epidural analgesia. Previous non-progressive labour was defined as labour dystocia, failed induction of labour or cephalopelvic disproportion as the indication for previous Caesarean delivery.

The labour of women who underwent VBAC was managed according to the department protocol with continuous fetal heart monitoring and regular maternal monitoring. There was no restriction in choice of labour pain relief methods unless otherwise contra-indicated. Assessment of labour progress and intrapartum management was the same as for normal vaginal delivery. The decision to use Syntocinon for augmentation or induction was made by a senior obstetrician with adequate counselling to the patient about the associated risks, including scar rupture.

Statistical analyses were performed using PASW Statistics 18, Release Version 18.0.0 (SPSS, Inc., Chicago [IL], US). For categorical data, Chi-square test and Fisher's exact test were used. For continuous data with a highly skewed distribution, a non-parametric test (i.e. Mann-Whitney *U* test) was used. The level of statistical significance was set at 0.05.

Significant variables as potential predictors were entered into a logistic regression model to determine the predictors for the success of VBAC. Multivariate logistic regression analysis (forward elimination procedure) was performed by including variables with a significance level of $p<0.2$ using univariate analysis. Various significant antepartum and intrapartum factors were used to develop

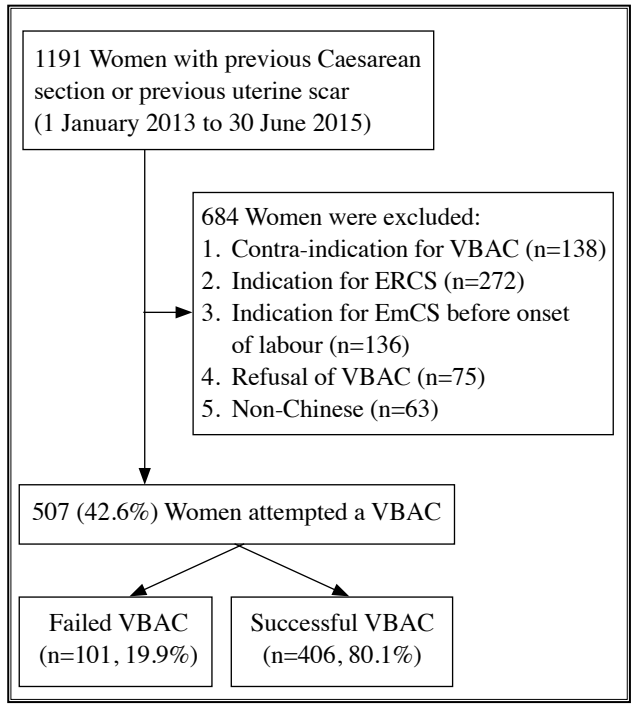

Figure 1. Selection of cohort
Abbreviations: EmCS = emergency Caesarean section; ERCS = elective repeated Caesarean section; VBAC = vaginal birth after Caesarean section

predictive models, and nomograms were generated to represent the models. Nomograms were developed using R 3.0.3 (Package "rms"; https://www.r-project.org/).

This study was approved by the Kowloon West Cluster Research Ethics Committee.

Results

A total of 1191 women delivered at PMH between 1 January 2010 and 30 June 2015 with a coding of 'previous Caesarean section' or 'previous uterine scar' (Figure 1). Among them, 684 women were excluded due to contra-indication for VBAC (n=138), indication for an ERCS (n=272), indication for an emergency Caesarean section before the onset of labour (n=136), refusal of VBAC (n=75), and non-Chinese ethnicity (n=63). The remaining 507 (42.6%) women underwent a VBAC and were included. Among them, 406 (80.1%) achieved a successful VBAC, whereas 101 (19.9%) failed a trial of labour. Of the 406 women, 338 (83.3%) had normal vaginal delivery and 68 (16.7%) required instrumental delivery (vacuum extraction or forceps delivery). The indications for instrumental delivery were prolonged second stage of labour (36.8%), fetal distress (60.3%), and others (2.9%). Of the 101 women who failed a trial of labour, 59 (58.4%) had a repeat Caesarean section for failure to progress, 17 (16.8%) for failed induction of labour, 19 (18.8%) for fetal distress, and six (6%) for other indications.

Table 1. Maternal characteristics of women undergoing vaginal birth after Caesarean section (VBAC)*

	Failed VBAC (n=101)	Successful VBAC (n=406)	OR (95% CI)	p Value
Age at delivery (years)	34.0 (31.0-36.0)	33.0 (30.0-36.0)	0.938 (0.891-0.987)	0.019
Maternal height (cm)	156.0 (153.0-160.0)	158.0 (155.0-162.0)	1.065 (1.021-1.112)	0.007
Body mass index (pre-pregnancy or first visit) [kg/m^2]	21.4 (20.0-23.7)	21.1 (19.3-23.1)	0.952 (0.89-1.019)	0.209
Pre-existing disease†				0.662
No	99 (98)	400 (98.5)	1	
Yes	2 (2)	6 (1.5)	0.743 (0.148-3.735)	
Birth interval (years)	4.0 (3.0-7.0)	4.0 (2.0-6.0)	0.961 (0.903-1.024)	0.24
Type of previous LSCS				0.006
Emergency	80 (83.3)	252 (69.2)	0.45 (0.252-0.805)	
Elective	16 (16.7)	112 (30.8)	1	
Indication for previous Caesarean				0.008
Previous non-progressive labour‡	50 (49.5)	123 (30.8)	0.417 (0.198-0.88)	
Fetal distress	10 (9.9)	59 (14.8)	1	
Malpresentation	13 (12.9)	90 (22.5)	1.173 (0.483-2.85)	
Placenta praevia / abruption	4 (4.0)	20 (5.0)	0.847 (0.239-3.004)	
Others	24 (23.8)	108 (27.0)	0.763 (0.342-1.703)	
Previous preterm Caesarean				0.515
No	91 (90.1)	373 (92.1)	1	
Yes	10 (9.9)	32 (7.9)	0.781 (0.37-1.646)	
Previous vaginal delivery				0.013
No	94 (93.1)	338 (83.3)	1	
Yes	7 (6.9)	68 (16.7)	2.702 (1.201-6.078)	
Previous VBAC				0.026
No	98 (97.0)	366 (90.1)	1	
Yes	3 (3.0)	40 (9.9)	2.702 (1.201-6.078)	
Antenatal characteristics				0.699
Gestational hypertension / pre-eclampsia / eclampsia	3 (3.0)	8 (2.0)	0.64 (0.166-2.464)	
Gestational diabetes	15 (14.9)	52 (12.8)	0.832 (0.446-1.55)	
Uneventful	83 (82.2)	346 (85.2)	1	

* Data are shown as median (range) or No. (%) of subjects

† Including asthma, autoimmune disease, chronic hypertension, diabetes, renal disease, and seizure disorder

‡ Including failed induction of labour, labour dystocia, and cephalopelvic disproportion

Women who had a successful VBAC were more likely to be younger and taller than those who failed ($p<0.05$, Table 1). Women with a history of vaginal delivery and previous VBAC were also more likely to have a successful VBAC ($p<0.05$). However, women with a previous emergency Caesarean delivery or with non-progressive labour as the indication for previous Caesarean delivery were more likely to have a failed VBAC ($p<0.05$).

Women who failed VBAC experienced a longer labour ($p<0.001$, Table 2). The use of Syntocinon for induction or augmentation of labour, as well as the use of epidural analgesia reduced the likelihood of a successful VBAC (all $p<0.001$). The success rate of VBAC in women requiring combined induction (artificial rupture of membrane and Syntocinon) and augmentation with Syntocinon was 58.9% and 64.7%, respectively. Two (0.39%) women had scar rupture. None reported maternal or fetal mortality. One woman had an emergency second-stage LSCS for prolonged second stage without instrumental delivery. The remaining 49 women with a prolonged second stage of labour resulted in a successful VBAC.

Multivariate logistic regression models were used to evaluate the independent effect of significant variables drawn from univariate analyses on the likelihood of a successful VBAC (Table 3). The type of previous Caesarean delivery was excluded from analysis, as such data were missing in 9% of the cases. Factors remained predictive of the success of VBAC were maternal age, height, indication for previous Caesarean delivery, duration of labour, and the use of Syntocinon. Having a non-progressive labour as the indication for previous Caesarean delivery was the most significant antepartum predictor for a failed VBAC (odds ratio [OR]=0.453; 95% confidence interval [CI]=0.271-0.756), whereas the use of Syntocinon for induction or augmentation was the most significant intrapartum predictor (OR=0.227; 95% CI=0.130-0.395).

Two nomograms (one for antepartum and another for intrapartum) derived from significant variables from univariate analyses are presented in Figures 2 and 3.

Discussion

This is the first cohort study of VBAC success and its associated factors in Hong Kong Chinese women. The overall success rate of VBAC was 80.1%, which is slightly higher than that reported in overseas studies (72-75%)[1-3,5]. Different populations might carry different maternal and obstetric risk profiles. Examples are the lower rate and less severe degree of obesity in local Chinese women[2,3,5-7], and the lower birth weight of Chinese babies[2,4,6].

Various demographic, maternal, and obstetric factors have been reported as predictive of the success of VBAC[1-5]. Using multivariate analysis, our study confirmed that a previous indication of non-progressive labour and the use of Syntocinon for induction or augmentation of labour were respectively the most significant antepartum and intrapartum factors associated with an unsuccessful VBAC.

Table 2. Intrapartum factors of women undergoing vaginal birth after Caesarean section (VBAC)*

	Failed VBAC (n=101)	Successful VBAC (n=406)	OR (95% CI)	p Value
Gestation at delivery (weeks)	39.4 (38.4-40.0)	39.4 (38.4-40.1)	0.979 (0.862-1.111)	0.998
Birth weight (g)	3200.0 (2915.0-3580.0)	3180.0 (2930.0-3462.5)	1 (0.999-1)	0.53
Gender of baby				0.563
Female	46 (45.5)	172 (42.4)	1	
Male	55 (54.5)	234 (57.6)	1.138 (0.734-1.764)	
Duration of first stage of labour (mins)	435.0 (274.0-603.5)	223.0 (135.0-382.5)	0.996 (0.995-0.997)	<0.001
Onset of labour				<0.001
Spontaneous	61 (60.4)	350 (86.2)	1	
Induced / augmented	40 (39.6)	56 (13.8)	0.244 (0.15-0.398)	
Use of Syntocinon				<0.001
No	64 (63.4)	352 (86.7)	1	
Yes	37 (36.6)	54 (13.3)	0.265 (0.162-0.436)	
Use of epidural analgesia				<0.001
No	86 (85.1)	389 (95.8)	1	
Yes	15 (14.9)	17 (4.2)	0.251 (0.12-0.521)	

* Data are shown as median (range) or No. (%) of subjects

Table 3. Logistic regression analysis of factors associated with a successful vaginal birth after Caesarean section*

Risk factor	Unadjusted OR (95% CI)	p Value
Age at delivery	0.939 (0.886-0.995)	0.032
Maternal height (cm)	1.051 (1.001-1.102)	0.044
Previous Caesarean for non-progressive labour	0.453 (0.271-0.756)	0.002
Duration of first stage (mins)	0.997 (0.996-0.998)	<0.001
Use of Syntocinon	0.227 (0.130-0.395)	<0.001

* Hosmer-Lemeshow goodness-of-fit test, Chi-square statistics=4.827, degrees of freedom=8, p=0.776

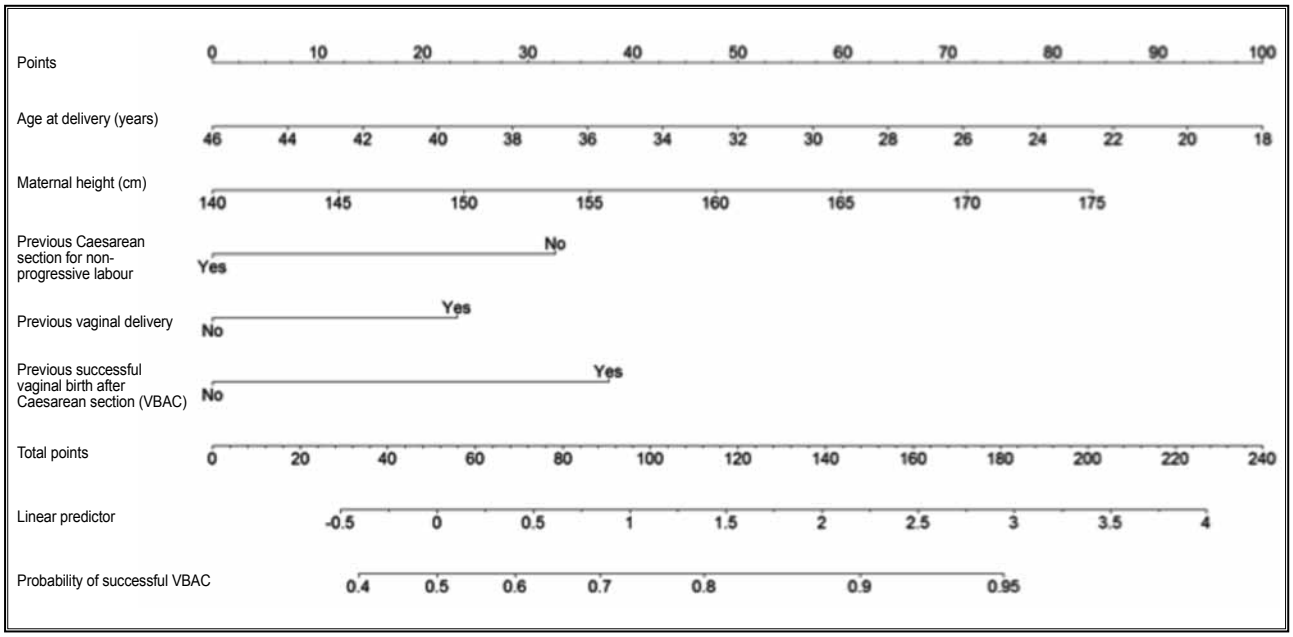

Figure 2. Nomogram with antepartum factors

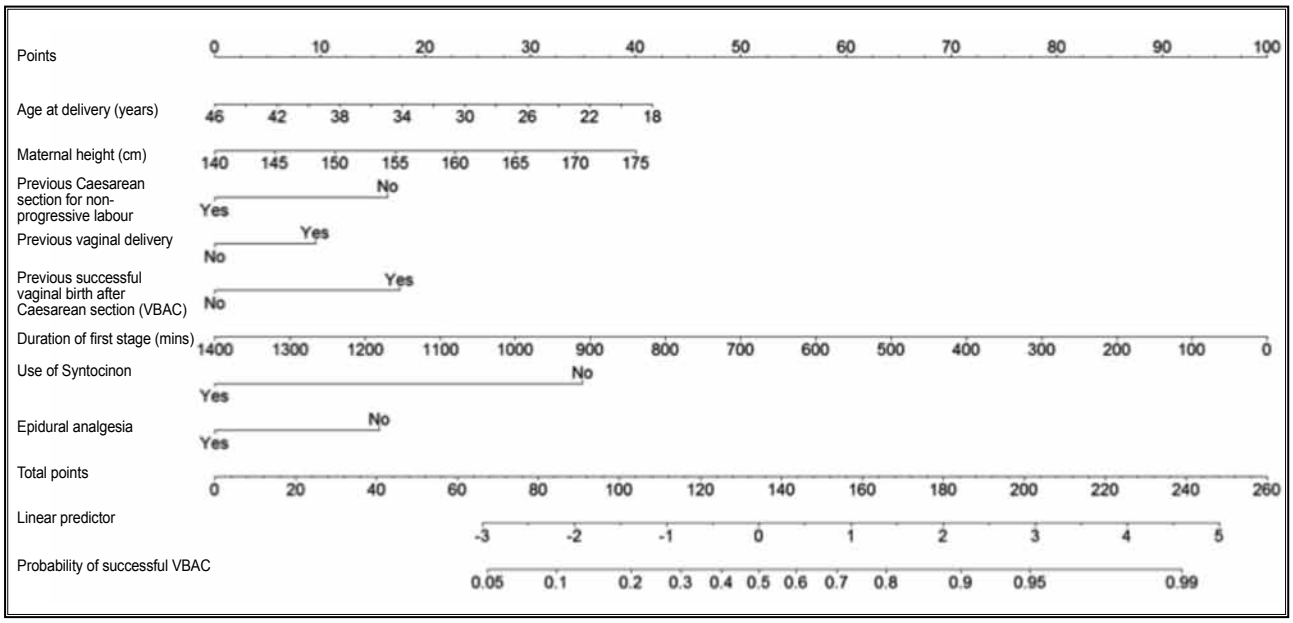

Figure 3. Nomogram with antepartum and intrapartum factors

Taller and younger mothers had an increased likelihood of VBAC success; these findings are in line with others[9]. Nonetheless, the sample size of our study was insufficient to determine a cut-off value for height and age.

In our study, 75 (14.8%) women who achieved VBAC had a history of vaginal delivery including previous VBAC. The success rate was 90.7% in those with a history of vaginal delivery and 93% in those with previous VBAC. Despite this, they were not the most significant predictors in our cohort following multivariate analysis. This is probably because of the high baseline VABC success rate in the comparison group (78% for those without a history of vaginal delivery and 78.9% for those without previous VBAC) that in turn contributed to the favourable risk profile for VBAC success.

We were unable to demonstrate significant effects of maternal BMI and fetal birth weight on VBAC success. This may be related to the intrinsic characteristics of our Chinese population wherein 98.4% of women had a pre-pregnancy or first visit BMI <30 and 97.8% of babies had a birth weight <4 kg.

Two nomograms are created for clinical use. As both antepartum and intrapartum factors influence the likelihood of VBAC, staged predictive tools enable obstetricians to evaluate the likelihood of VBAC success for an individual patient at different stages of care. A predicted probability of a successful VBAC corresponds to the summed points of patient characteristics. The nomograms provide a handy tool to facilitate patient counselling and clinical decision making about the mode of delivery. As a woman with an increased risk of a failed VBAC is also at increased risk of scar rupture[10], this risk should be included in counselling when the risk of failed VBAC is predicted to be high.

The main limitation of our study was its retrospective nature. In addition, 9% of data for the type of previous Caesarean section were missing. Nonetheless, the overall missing data for other variables was <1%. Our cohort was from a single tertiary centre in Hong Kong; further internal validation with another dataset and external validation of the prediction models with a territory-wide population are needed to determine its generalisability.

Conclusions

The success rate of VBAC in local Chinese women appears high (80.1%). A previous Caesarean delivery for non-progressive labour is the most significant antepartum predictor for VBAC failure, whereas the most significant intrapartum predictor is the need for Syntocinon.

Declaration

The authors have declared no conflict of interests in this study.

References

1. Birth after previous caesarean birth (Green-top Guideline No. 45). *London: Royal College of Obstetricians and Gynaecologists*; 2015.
2. Landon MB, Leindecker S, Spong CY, et al. The MFMU Cesarean Registry: factors affecting the success of trial of labor after previous cesarean delivery. *Am J Obstet Gynecol* 2005; 193(3 Pt 2):1016-23.
3. van der Merwe AM, Thompson JM, Ekeroma AJ. Factors affecting vaginal birth after caesarean section at Middlemore Hospital, Auckland, New Zealand. *N Z Med J* 2013; 126:49-57.
4. Knight HE, Gurol-Urganci I, van der Meulen JH, et al. Vaginal birth after caesarean section: a cohort study investigating factors associated with its uptake and success. *BJOG* 2014; 121:183-92.
5. Grobman WA, Lai Y, Landon MB, et al. Development of a nomogram for prediction of vaginal birth after cesarean delivery. *Obstet Gynecol* 2007; 109:806-12.
6. Metz TD, Stoddard GJ, Henry E, Jackson M, Holmgren C, Esplin S. Simple validated vaginal birth after cesarean delivery prediction model for use at the time of admission. *Obstet Gynecol* 2013; 122:571-8.
7. Schoorel EN, van Kuijk SM, Melman S, et al. Vaginal birth after a caesarean section: the development of a Western European population-based prediction model for deliveries at term. *BJOG* 2014; 121:194-201.
8. Cheuk QK, Lo TK, Lee CP, Yeung AP. Double balloon catheter for induction of labour in Chinese women with previous caesarean section: one-year experience and literature review. *Hong Kong Med J* 2015; 21:243-50.
9. Chaillet N, Bujold E, Dubé E, Grobman WA. Validation of a prediction model for vaginal birth after caesarean. *J Obstet Gynaecol Can* 2013; 35:119-24.
10. Smith GC, White IR, Pell JP, Dobbie R. Predicting cesarean section and uterine rupture among women attempting vaginal birth after prior cesarean section. *PLoS Med* 2005; 2:e252.