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Epidemiology

Vaginal birth after a caesarean section: the development of a Western European population-based prediction model for deliveries at term

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Objective To develop and internally validate a model that predicts the outcome of an intended vaginal birth after caesarean (VBAC) for a Western European population that can be used to personalise counselling for deliveries at term.

Design Registration-based retrospective cohort study.

Setting Five university teaching hospitals, seven non-university teaching hospitals, and five non-university non-teaching hospitals in the Netherlands.

Population A cohort of 515 women with a history of one caesarean section and a viable singleton pregnancy, without a contraindication for intended VBAC, who delivered at term.

Methods Potential predictors for a vaginal delivery after caesarean section were chosen based on literature and expert opinions. We internally validated the prediction model using bootstrapping techniques.

Main outcome measures Predictors for VBAC. For model validation, the area under the receiver operating characteristic curve (AUC) for discriminative capacity and calibration-per-risk-quantile for accuracy were calculated.

Results A total of 371 out of 515 women had a VBAC (72%). Variables included in the model were: estimated fetal weight greater than the 90th percentile in the third trimester; previous non-progressive labour; previous vaginal delivery; induction of labour; pre-pregnancy body mass index; and ethnicity. The AUC was 71% (95% confidence interval, 95% CI = 69–73%), indicating a good discriminative ability. The calibration plot shows that the predicted probabilities are well calibrated, especially from 65% up, which accounts for 77% of the total study population.

Conclusion We developed an appropriate Western European population-based prediction model that is aimed to personalise counselling for term deliveries.

Keywords Personalised decision-making, prediction model, vaginal birth after caesarean, VBAC.

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Introduction

In pregnancies following a caesarean section, women should be offered counselling for both an intended vaginal birth after caesarean (VBAC; i.e. trial of labour) and an elective repeat caesarean section (ERCS). A substantial part of counselling is discussing the probability that an intended VBAC results in an actual vaginal delivery of a healthy child.[1] In comparison with a caesarean section, a successful VBAC (i.e. actual vaginal delivery) is associated with fewer major complications,[2] a shorter recovery period, and high maternal satisfaction.[3,4] However, if an intended VBAC results in an emergency caesarean section, in comparison with an ERCS it is associated with a higher risk of major complications, such as hysterectomy and operative injury,[2] and relatively low maternal satisfaction.[3,4] The published success rates of intended VBAC vary between 49 and 87%,[5] but it is evident that factors on patient, provider, and hospital level can influence the probability of success and VBAC-related morbidity.[5–7] Hence the prediction of a woman's individual probability of successful intended VBAC is a potentially useful tool for the decision-making process. Although many prediction tools that predict successful or unsuccessful intended VBAC have been published over the past two decades,[5,6,8] only a few of these models are externally validated in other cohorts,[6–8] whereas impact studies have not been performed at all. Consequently, current guidelines on pregnancy and childbirth after caesarean section still recommend counselling with the use of the overall probability of success, instead of using a personalised prediction.[1] It is remarkable that the majority of the prediction models were developed in a non-European population. These models cannot be directly translated to European settings as differences in obstetrical policy and the entirely different mix of ethnicities may impair the performance and validity of the models. For the European setting, only one non-externally validated model was available,[7] and two models developed in North-American cohorts were previously externally validated for a Dutch population by our research group.[9–11] However, these models are less applicable for counselling because they either include factors that are only known intrapartum or the variables have yet to be adjusted for a Western European population.[7,9,10] Hence, this study aims to develop a new prediction model by combining and improving existing models to predict successful intended VBAC more reliably, and that is suitable for a Western European population and can be applied as a tool to personalise counselling on mode of delivery after caesarean section for deliveries at term.

Methods

Setting

This registration-based retrospective cohort study was conducted in 17 Dutch hospitals that were involved in the Dutch research consortium for women's health (www.studies-obsgyn.nl). The enrolled hospitals covered all Dutch geographic regions. Included hospitals types were university teaching hospitals (n = 5), non-university teaching hospitals (n = 7) and non-university non-teaching hospitals (n = 5). Approval for this study was obtained at the Medical Ethical Committee (CMO) of Maastricht University Medical Centre+ (MUMC+; MEC number 09–4-047–13).

Population

Women were included when they had a history of one previous caesarean section with any number of prior vaginal deliveries and had a vertex singleton pregnancy as well as a delivery at term (≥37 weeks of gestation) in their current pregnancy. We excluded women with an unknown indication of prior caesarean section, with more than one previous caesarean section, or with either an intrauterine fetal death or a contraindication for an intended VBAC in the current pregnancy. A contraindication for an intended VBAC was defined as a previous uterine rupture, a placenta praevia, or a uterine scar with extension into the fundus.

Potential predictors

Contemporary methodological guidelines for prognostic modelling state that potential predictors should be preselected based on clinical reasoning and evidence from previous reports, instead of observed significant relations with outcome variables in the same data set. This method results in higher external validity and less over-fitting of the developed model.[12–14] Therefore, we preselected potential predictors based on previously published prediction models, expert opinions, and articles reporting on risk factors for a successful intended VBAC.[5,8–10] We preselected predictor variables from obstetrical history, medical history, and demography of the patient. The final set of potential predictors that was considered for the model included: estimated fetal weight (EFW); previous caesarean section for non-progressive labour; any former vaginal birth; the occurrence of pre-eclampsia or the syndrome of haemolysis, elevated liver enzymes, and low platelet count (HELLP) during the current pregnancy; induction of labour in the current pregnancy; chronic and/or gestational hypertension; pre-pregnancy body mass index (BMI); maternal age; and ethnicity. Non-progressive labour was defined as the arrest of descent, dilation, or labour. If no pre-pregnancy BMI measurement was available, we used the routinely measured first-trimester BMI. Ethnicity is reported as one of the strongest of the demographic predictors for successful intended VBAC,[15] with women of European descent having a higher probability of successful intended VBAC than women of Hispanic and African ethnicity.[6] The underlying cause, however, has remained unexplained.[15] We hypothesised that the effect of ethnicity on successful VBAC might result from both sociocultural aspects and biological differences, and could therefore vary between countries. As there was no available literature on the relationship between ethnicity and VBAC for a Dutch or any other Western European population, we performed a univariate analysis to evaluate the association between different ethnicity strata and the probability of successful VBAC, using a liberal *P*–value of 0.20. In the Netherlands, ethnicity is documented within seven predefined categories: Dutch, Mediterranean, other European, African, Asian, Hindu, and 'other'. For the development of a prediction model we defined white ethnicity as Dutch or 'other European'.

Furthermore, we aimed to incorporate EFW as a variable that is customised to gestational age in order to enable the use of the model at any term within the third trimester of pregnancy. In the Netherlands, the curves of Snijders et al. [16] are often used, which were established along the curve of Yudkin et al.[17] Hence after calculation of the fetal weight using the Hadlock formula,[18] fetal weight was customised to gestational age. Subsequently, we chose to create two dummy variables: one indicating that EFW is equal to or below the tenth percentile; the other indicating that the EFW is equal to or greater than the 90th percentile (P90). We obtained EFW measurements performed in the third trimester between 33 and 37 weeks of gestation, measured by either ultrasound or abdominal palpation.

Sample size

There is consensus about the maximum number of predictors that can be validly included in a prediction model. It is recommended that at least ten events are collected for each potential predictor that is to be evaluated in the multivariable regression analysis.[19] An event is defined as the least frequent outcome status, which in our case was an unsuccessful intended VBAC. In the Netherlands the estimated event rate, i.e. intended VBAC failure rate, is 24–28%[11,20]; therefore, in order to develop a model with nine potential predictors, at least 90 events were required, and so a sample size of at least 321 women was required (90/28*100).

Data collection

Patient data regarding demography of the patient and potential predictors regarding obstetrical and medical history were extracted from medical records according to a standardised operating procedure by using customised case report forms (CRFs) at all participating sites. Data were obtained by trained research nurses, medical doctors or senior medical students. Subjects were consecutively selected and included from the hospital birth registers. To meet the required sample size, we requested each participating hospital to include 30 subsequent cases of intended VBAC that matched the inclusion criteria, from 1 January 2010 until 31 December 2010.

Data quality and missing data

Data were checked for completeness and inconsistencies. Inconsistent and incomplete data were double-checked directly with the hospital concerned. Values that we were unable to collect were imputed using a multiple imputation strategy, as the omission of patients who have one or more predictor variables missing from the analysis can cause a considerable loss of precision and may bias the results.[12,21] The number of imputations was set to five. Subsequently, we performed a sensitivity analysis by comparing outcomes of the imputed data set with the use of complete case analysis only. The purpose of this analysis was to determine whether imputation led to radically different results or to a different conclusion.

Model development

We used restricted cubic splines and graphs to determine whether continuous potential predictors could be analysed as linear terms. In each of the five imputed data sets, we introduced all of the potential predictors in a multivariable logistic regression model, using successful intended VBAC as the outcome variable. To reduce the number of predictors in these models, we used backward stepwise deletion based on the Wald test. We used a liberal *P*–value of 0.20, as recommended by prediction modelling guidelines.[13] Predictors that remained in at least three out of five imputed data sets were included in the final model, and were re-estimated in all imputed data sets separately. Results of these five models were combined into a single prediction model.[22]

Internal validation

The use of stepwise selection methods such as backward stepwise deletion is often discouraged because they can introduce selection bias, as predictors that are overestimated by chance are more likely to be included than predictors that are underestimated by chance. This can result in a prediction model that may be over-fitted to the derivation data, i.e. the model performs well for the data it was derived upon, but that performance will degrade considerably when it is applied to future patients. Generally, predictions will be too extreme. In order to reduce the risk of over-fitting, we internally validated the model using bootstrapping. In this internal validation step, *B*–bootstrap samples of the same size as the original sample (we used $B = 1000$) were drawn with replacement from the original data, which reflects the drawing of samples from the underlying population. This was performed to estimate the likely performance in future patients, and to adjust the model so that future predictions will be less extreme.

Performance of the model

To assess the performance of the internally validated model, we quantified measures of discrimination and calibration. The ability of the model to discriminate between women who had a successful intended VBAC and women who had a failed intended VBAC (emergency caesarean section) was quantified as the area under the receiver operating characteristic curve (AUC). This ranges from 50% (no discriminative capacity) to 100% (perfect discriminative capacity). The agreement between predicted probabilities and observed frequencies of the outcome (accuracy) was assessed by visually inspecting the calibration plot. Furthermore, we computed the Hosmer and Lemeshow (H–L) goodness-of-fit statistic as a quantitative measure of accuracy. A high H–L statistic is related to a low *P*–value, and indicates a poor fit.

All statistical analyses were performed using SPSS 20.0 and R 2.12.2 (www.r-project.org).

Results

Patient population

A total of 515 women with a history of one caesarean section were identified as eligible for the present study. Baseline characteristics of the cohort are presented in Table 1. The overall successful intended VBAC rate was 72.0% (in total 371 women).

Model development and internal validation

The number of missing values per predictor variable are shown in Table 1. For the majority of the potential predictors, there was only a small quantity of missing data; however, pre-pregnancy BMI was missing in 24% of women and EFW was missing in 39% of women. After imputation, all 515 women were available for multivariable modelling. Subsequently, based on univariate analyses for the variable 'ethnicity', we selected white ethnicity (yes/no) as a potential predictor (OR 95% CI = 0.92–2.32; $P = 0.11$). We entered all potential predictors in the model and identified the six predictors that met our selection criteria. These six predictors were: pre-pregnancy BMI; obstetrical history (previous vaginal delivery and previous non-progressive labour); white ethnicity; induction of current labour; and EFW ≥ P90. These six variables were combined into one model. Maternal age and BMI are continuous variables; all other predictors are dichotomous variables. Table 2 shows the original prediction model (i.e. after variable selection and estimation of parameters in five imputed data sets) that estimates a successful intended VBAC. The bootstrap validation yielded a shrinkage factor of 0.78, which was used to multiply the regression coefficients. After the adjustment of regression coefficients, the intercept was re-estimated (Table 2). The final predictive equation that can be used to estimate the individual probability of a successful intended VBAC for future patients is: $P_{(\text{success})} = 100\% \times 1/\{1 + \exp[-(1.647 + 0.371 \times \text{white} - 0.032 \times \text{pre-pregnancy BMI} - 0.537 \times \text{previous non-progressive labour} + 1.045 \times \text{previous vaginal delivery} - 0.515 \times \text{induction of labour} - 0.487 \times \text{EFW} \geq \text{P90})]\}$. For example, a woman of white ethnicity, with a BMI of 26 kg/m^2, having had a previous caesarean section for non-progressive labour, with no previous vaginal delivery, no induction of labour, and with a third-trimester EFW < P90 has a predicted probability of successful intended VBAC of 65.7%. When an indication for induction presents, the probability of this patient shifts to 53.3%, and this information can be used for a re-evaluation of the chosen mode of birth.

Table 1. Baseline characteristics of women who attempt a vaginal birth after caesarean section.

Characteristic	Missing values	Women who intended VBAC *n* = 515
Maternal age (years, mean ± SD)	2 (0)	32.2 ± 5.0
Ethnicity (*n*, %)		
White	15 (3.0)	405 (81.0)
Mediterranean		37 (7.4)
African		24 (4.8)
Asian		12 (2.4)
Hindu		7 (1.4)
Other		15 (3.0)
Parity (median, IQR)	0 (0)	1 (1–2)
Pre-pregnancy BMI (kg/m², mean ± SD)	124 (24.1)	25.3 ± 5.7
Previous caesarean for non-progressive labour (*n*, %)	0 (0)	201 (39.0)
Any previous vaginal delivery (*n*, %)	0 (0)	127 (24.7)
Previous VBAC (*n*, %)	0 (0)	99 (19.2)
Pre-eclampsia/HELLP	0 (0)	9 (1.7)
Diabetes mellitus	0 (0)	13 (2.5)
Hypertension	0 (0)	37 (7.2)
Induction of labour (*n*, %)	0 (0)	132 (25.6)
Estimated fetal weight ≤ P10	201 (39.0)	26 (8.3)
Estimated fetal weight ≥ P90	201 (39.0)	11 (3.5)
Estimated gestational age at delivery (weeks, mean ± SD)	0 (0)	39.8 ± 1.2

Performance of the model

The discriminative performance of the prediction model is shown in Figure 1. The AUC was 70.8% (95% CI = 68.6–72.9%), which indicates a good discriminative ability. Calibration was good, indicated by a non-significant H–L statistic (0.13). The corresponding calibration curve that represents the accuracy of the model is shown in Figure 2.

Table 2. Prediction model for the estimation of a successful intended VBAC with regression coefficients and odds ratios before and after internal validation.

Variable	Regression coefficient (crude)	Regression coefficient (adjusted)*	OR (crude) (95% CI)
Intercept	1.876	1.647	–
White ethnicity (yes/no)	0.476	0.371	1.61 (0.97–2.66)
Pre-pregnancy BMI (kg/m^2)	−0.041	−0.032	0.96 (0.92–1.00)
Previous caesarean for non-progressive labour (yes/no)	−0.688	−0.537	0.50 (0.33–0.76)
Any previous vaginal delivery (yes/no)	1.339	1.045	3.81 (2.10–6.92)
Induction of labour (yes/no)	−0.660	−0.515	0.52 (0.33–2.10)
EFW ≥ P90 (yes/no)	−0.624	−0.487	0.54 (0.14–2.02)

To calculate the absolute risk of a successful intended VBAC:
$P_{(success)} = 1/(1 + e^{-\text{Linear part}}) \times 100\%$;
Linear part = 1.647 + (0.371 × white) − (0.032 × pre-pregnancy BMI) − (0.537 × Previous non-progressive labour) + (1.045 × previous vaginal delivery) − (0.515 × induction of labour) − (0.487 × EFW ≥ P90).
*Regression coefficients after adjustment for over-fitting by shrinkage (shrinkage factor = 0.78); the intercept was re-estimated.

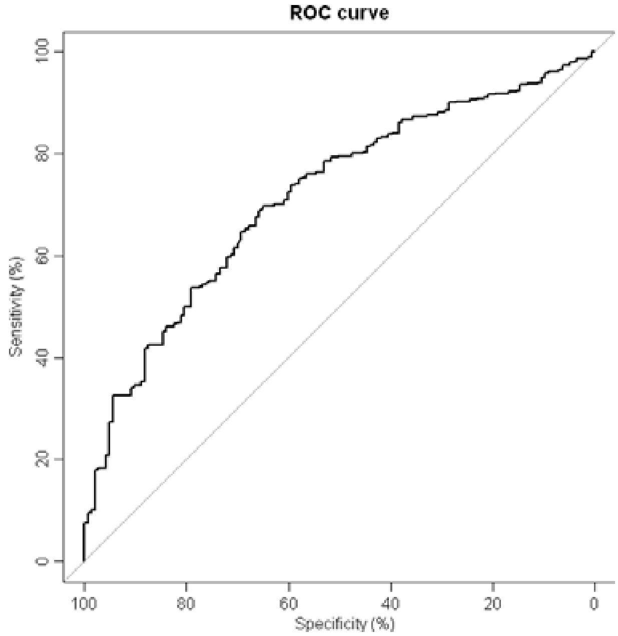

Figure 1. Receiver operating characteristic curve of the prediction model (AUC 70.8%; 95% CI 68.6–72.9%), indicating the reasonable discriminative performance of the model.

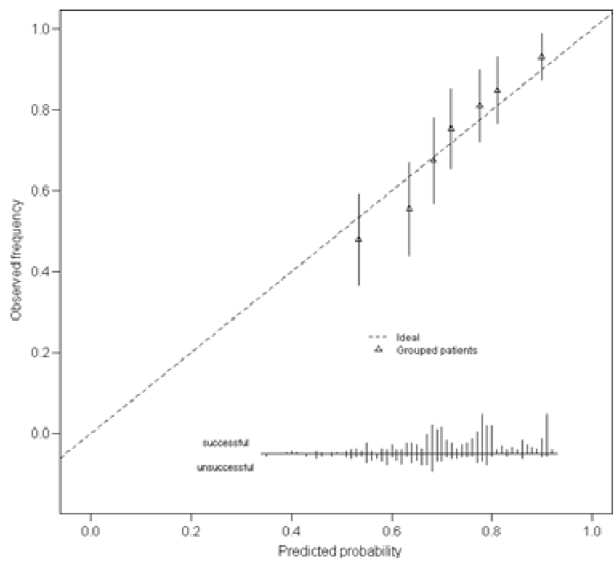

Figure 2. Calibration plot with the observed frequency of a successful intended vaginal birth after caesarean section by predicted probability. The triangles indicate quantiles of women with a similar predicted probability of success.

Predicted probabilities ranged from 39 to 93%, with a mean of 72% (SD 11%). Overall, the developed prediction model has a good fit to the reference curve, i.e. the predicted probabilities agree with the observed probabilities. The calibration plot shows that the predicted probabilities are especially well calibrated from about 65% upwards, which accounts for 77% of the target group; however, in women who have a probability of success of lower than 50%, the model generally underestimates their probability of successful intended VBAC.

Discussion

Main findings

In this study we developed and internally validated a prediction model in accordance with contemporary methodological guidelines in prognostic modelling.[12–14] The prediction model estimates successful intended VBAC, and is aimed for use in personalised counselling in the third trimester of pregnancy, i.e. for women with an expected term delivery. The final model for predicting successful intended VBAC consists of six variables, including demographic variables (pre-pregnancy BMI and white ethnicity), obstetrical history (previous vaginal delivery and previous non-progressive labour), and current pregnancy variables (induction of current labour and EFW ≥ P90). The developed prediction model has reasonable discriminative capacity and is accurate, especially for women with a predicted probability of 65% and higher. In order to determine whether the number of missing values within EFW and BMI led to different conclusions and/or results, we performed a sensitivity analysis by comparing outcomes of the imputed data set with an analysis of complete cases only. The analyses showed similar results for both data sets; therefore, we conclude that imputation did not lead to radically different results.

Strengths and weaknesses

A strong point of this study is that we obtained consecutive cases based on the hospital birth registers in various geographic regions and hospital types in the Netherlands. This method gives a representative data set of high quality. Another strength is that we aimed for the maximal applicability of the model in current care on pregnancy after caesarean section. As both expert opinions and literature were part of the predictor selection process, we developed a model that is actual appropriate and easy to use. Therefore, unlike other models, we included only factors that are known prior to delivery. For instance, models have been described that include birthweight, which is only known postpartum, and we chose not to include intrapartum factors like cervical examination as we aimed for decision-making in the early third trimester. Several limitations in this study should also be addressed. Firstly, although for most variables we have collected a complete data set, we had a significant number of missing values for BMI and EFW because these data were not available in the charts. As the missing data on BMI were from just a few hospitals, these missing values were considered to be missing at random and we consider the effect on model development and performance to be minor. This was confirmed by comparing performance parameters calculated with complete case analysis with the imputed data set. Another drawback of our study is that we were not yet able to assess the next steps within prognostic modelling: determining the external validity, usefulness and clinical impact of the model. Therefore, although the model development was thorough and based on contemporary guidelines within prognostic modelling, our current results should be interpreted with caution.

Interpretation

This is the first model for the prediction of successful intended VBAC that includes EFW. The other selected predictor variables have been described elsewhere.[5,6,8] Also, the discriminative capacity of our model was comparable with that reported in other studies.[5,8] An exception to all of the published models might be the model described by Naji et al.,[23] which showed promising results by incorporating an ultrasound evaluation of the caesarean section scar in the lower uterine segment. Also, Verhoeven et al.[24] recently showed that maternal height may be an independent predictor for emergency caesarean section, in agreement with Smith et al.[7] Hence our predictor selection methods did not lead to the inclusion of these variables at the moment of model development. Future studies should evaluate whether the inclusion of caesarean section scar variables and maternal height increase the accuracy of VBAC prediction. Concerning other VBAC prediction studies, in a systematic review Eden et al.[8] stated that most models lack the ability to predict the failure of intended VBAC. Our model also achieved the highest accuracy for predicted probabilities in the higher probability ranges, although the overall performance parameters are good. However, unlike other tools, our model is targeted on a Western European population and on prediction in the early third trimester, incorporating both factors that are known prior to pregnancy and factors that occur during pregnancy. Although our data set was smaller than those used in some other prediction models,[9,10] we achieved an adequate sample size for model development, and by preselecting potential predictors using other studies reporting on VBAC prediction, it is likely that our results are generalisable. Therefore, this new prediction model may provide a more appropriate and applicable alternative for countries with a Western European population than existing models.

Concurrent with the globally rising rates in primary caesarean section,[25] increasing numbers of women are pregnant with a history of caesarean section. The need for healthcare interventions in order to enhance decision-making on mode of birth after caesarean section has been addressed in several studies.[5] We think that a prediction model can be applied to enhance shared decision-making and in order to place risks of morbidity of intended VBAC into context. The prediction model is likely to contribute to more unbiased and accurate counselling, and might lead to a reduction of emergency caesarean sections. In order to test this hypothesis, we are currently performing a prospective study in which we evaluate the developed prediction model through its use, so as to determine the external validity, usefulness, and clinical impact of the model. To the knowledge of the authors, no clinical impact studies have been published of other existing models on this topic; however, we think that this is essential as using the model might lead to different birth preferences, resulting in a different selection of women undergoing intended VBAC, and this selection might alter the performance parameters of the model.[26] Consequently, models should be evaluated through application before implementation into clinical practice. The prediction model is currently being tested in a prospective controlled setting in 12 hospitals in the Netherlands. In six intervention hospitals we are using the model as a part of a patient decision aid (PtDA) on mode of delivery after previous caesarean section, and in six control hospitals we evaluate the prediction model without actually applying it. For the intervention hospitals, the model is adapted into an easy to use calculator that is used in the early third trimester. Pre-testing of this prediction model and PtDA in 25 women within the target group showed that the majority of the women judged the prediction model to be relevant for decision-making.

Conclusion

We developed an appropriate Western European population based prediction model that is aimed for counselling on mode of birth after caesarean section for term deliveries. The model holds promise as a tool that personalises decision-making on mode of birth after caesarean section, and could be used to place the potential risks of intended VBAC into context.

Disclosure of interests

The authors declare that they have no conflicts of interest.

Contribution to authorship

RH and HS obtained the funding for the trial. All authors contributed to the protocol and design of this study. ES, RA, KdB, FD, IvD, MF, MK, GK, SK, AK, FL, BM, FR, JS, ESK, HV, and MW collected data. ES and SvK analysed the data. ES, SvK, SM, AK, BM, JN, LS, RH, and HS contributed to the interpretation of the results. ES and SvK drafted the article, with input, critical review, and editing from all authors. All the authors accept full responsibility for the overall content of this article.

Details of ethics approval

The Medical Ethical Committee (CMO) of Maastricht (azM/UM) declared that no ethical approval was required for this study protocol (MEC 09-4-047-13; 13 April 2011).

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Commentary on 'Vaginal birth after a caesarean section: the development of a Western European population-based prediction model for deliveries at term

The decision to pursue a vaginal birth after a caesarean delivery (VBAC) for many women rests on balancing the risks and benefits of an attempted vaginal delivery versus those of a planned repeat caesarean delivery. Some factors related to the decision – such as the personal value a patient places on attempting a vaginal delivery – are unrelated to quantifiable risks and benefits. Other factors, such as planned family size and anticipated number of future deliveries, are unrelated to a current pregnancy. Counselling women appropriately on this decision, however, must involve a clear discussion of the risks associated with both options and the probability for success with an attempted vaginal delivery.

A number of prediction models for success in achieving a VBAC have been developed and validated. These models provide patients and providers with data on probability of success in individual cases. Additionally, they highlight clinical risk factors for failure (such as the absence of spontaneous labour) that may alter the balance of risks and benefits, and guide decision-making. The degree to which prediction models are useful across diverse patient populations is unclear, and the creation and validation of models for specific populations to optimise the quality of information for counselling is a laudable goal.

In the above article, Schoorel and colleagues present an analysis that incorporates prior vaginal delivery, labour induction, body mass index, ethnicity, indication for prior caesarean delivery, and estimated fetal weight in a prediction model for a primarily white Dutch population. The inclusion of these parameters adds to a growing literature on the importance of several of these parameters in predicting the success of VBAC (Grobman et al. *Obstet Gynecol* 2007;109:806–12).

Are the differences in probability of success for individual patients predicted by this model clinically significant? We simulated data on covariates for two patients: the first, a non-white woman with a pre-pregnancy BMI of 40 kg/m^2, with previous non-progressive labour, no previous vaginal delivery, induced labour, and with a fetus that is large for gestational age; and the second, a white woman with a pre-pregnancy BMI of 20 kg/m^2, without previous non-progressive labour, with previous vaginal delivery, with no labour induction, and with a fetus that is not large for gestational age (the two scenarios are in stark contrast with one another). The predicted VBAC success probabilities are 23.6 and 91.1%, respectively. Is this model successful in discriminating between high and low probability for success? We believe so!

The success of a prediction algorithm depends on several statistical aspects. First, the model needs to incorporate important risk factors while maintaining parsimony. Second, validating the derived model in both an internal population (i.e. on the same patient base as was used to derive the model) and an external population is crucial. Third, the model needs to be refined and improved to increase the efficiency and accuracy of predictions. Lastly – and arguably the most important characteristic of the model – is that the model should be easy to implement, widely applicable to different patient populations, and universally acceptable. Time alone will determine whether the model developed by Schoorel and colleagues meet these criteria. At the moment, their algorithm for predicting the success of VBAC seems solid, and one that is likely to be successful, at least for a European population.

Disclosure of interests

C.V.A. is the Editor-in-Chief of *Paediatric and Perinatal Epidemiology*, an international journal that is also published by Wiley-Blackwell. C.V.A and A.M.F. have no interests to disclose. ■

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