



Q/What's the best way to predict the success of a trial of labor after a previous C-section?

EVIDENCE-BASED ANSWER

A | WHILE 8 SCORING TOOLS PREDICT success rates for a trial of labor after previous cesarean section (TOLAC), it's unclear which is the best because no trials have compared prediction tools against each other, and each tool has a unique set of variables.

A "close-to-delivery" scoring nomogram predicting the success rate of TOLAC

correlates well (90% accuracy) with actual outcomes (strength of recommendation [SOR]: **B**, prospective and retrospective cohort studies) and has been externally validated with multiple additional cohorts.

All other point-prediction scoring tools are accurate within 10% when predicting the success rate of TOLAC (SOR: **B**, prospective and retrospective cohort studies).

Evidence summary

Seven validated prospective scoring systems, and one unvalidated system, predict a successful TOLAC based on a variety of clinical factors (TABLE¹⁻¹¹). The systems use different outcome statistics, so their predictive accuracy can't be directly compared.¹²

Grobman: Entry-to-care and close-to-delivery nomograms

Grobman et al created 2 prediction models, an "entry-to-care" model (used at the first prenatal visit), and a "close-to-delivery" model (used on admission to the labor ward).^{1,2} Both models display a graphic nomogram forecasting the probability of TOLAC success (with 95% confidence intervals [CIs]). The authors compared predicted TOLAC outcomes with actual TOLAC outcomes and found that the model predictions most successfully correlated with high-likelihood outcomes (70% to 90% chance of successful TOLAC, plus or minus approximately 5%). Both models were less accurate with low-likelihood outcomes (40% chance of successful TOLAC, plus or minus approximately 10%).

Many independent authors have validated the close-to-delivery model, comparing predicted with actual TOLAC success rates. In a retrospective cohort study of 490 women, Constantine et al found the correlation between the observed and predicted TOLAC rates to have an r of 0.90, $P=.002$, with an area under the curve (AUC) of 0.70.³ Yoki et al validated the model in a Japanese cohort of 729 women with an AUC of 0.81, consistent with the AUC of 0.75 reported in the development of the original model.⁴

Tessmer-Tuck: The close-to-delivery model without the race variable

Tessmer-Tuck et al developed a model similar to Grobman's close-to-delivery model, but removed race/ethnicity as a variable and compared it to the accuracy of the Grobman nomogram.⁵ Variables considered in this model were maternal age <30 years (odds ratio [OR]=1.53; 95% CI, 1.00-2.36), body mass index (BMI) <30 kg/m² (OR=1.82; 95% CI, 1.11-2.97), any previous vaginal delivery (OR=3.17; 95% CI, 1.50-6.80), previous vaginal delivery after cesarean (OR=2.24; 95% CI,

Johanna B. Warren, MD;
Andrew Hamilton, MLS, MS
Oregon Health and Science
University, Portland

ASSISTANT EDITOR

Bruin Rugge, MD, MPH
Oregon Health and Science
University, Portland

DEPUTY EDITOR

Paul Crawford, MD
Nellis Family Medicine
Residency, Nellis Air Force
Base, Nev

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➤ **Grobman's close-to-delivery scoring nomogram correlates well with actual outcomes and has been externally validated.**

1.25-4.18), and absence of a recurrent indication for cesarean delivery (OR=1.81; 95% CI, 1.18-2.76).

The model provided a successful probability of vaginal birth after cesarean ranging from 38% to 98% with AUC of 0.723 (95% CI, 0.680-0.767). When compared with the Grobman model, the AUC for features in the Tessmer-Tuck model was 0.757 (95% CI, 0.713-0.801), similar to the AUC of 0.75 reported in the development of the original model. The predictive accuracy of TOLAC success between 70% and 90% was quite poor at only ±29%.

Metz: A 5-point scoring tool

Metz et al created a point scoring tool for use on admission to the labor ward, based on 5 variables weighted by degree of correlation with TOLAC success: a history of vaginal birth (OR=2.7; 95% CI, 1.8-4.1), absence of a recurrent indication for initial cesarean delivery (OR=2.0; 95% CI, 1.3-3.1), age <35 years (OR=2.0; 95% CI, 1.1-3.4), BMI <30 kg/m² (OR=1.6; 95% CI, 1.1-2.4), and each point of Bishop score on admission (OR=1.3; 95% CI, 1.2-1.4).⁵

The authors internally validated this scoring tool with an AUC of 0.70 (95% CI, 0.67-0.74), then externally validated the tool with an independent cohort of 585 women and found an AUC of 0.80 (95% CI, 0.76-0.84). In the external validation cohort, TOLAC success rates were 37.4% (95% CI, 27.2-47.5) with a score <10 and 94.4% (95% CI, 90.9-97.8) with a score >16, performing within 8% of the prediction model.

Troyer: A simple 4-point tool

Troyer et al created a simple 4-point scoring tool for use on admission to the labor ward.⁷ The tool's 4 variables—previous dysfunctional labor, no previous vaginal birth, non-reassuring fetal heart tracing (NRFHT) on admission, and induced labor—were found to reduce the success rate of a trial of labor ($P<.05$). Dinsmoor et al used this scoring tool in a group of 156 women with an overall TOLAC success rate of 76% (3% higher than Troyer's group) and found that for labors with a favorable score (0), the tool performed within 5% and for labors with an unfavorable score (≥3), the tool performed within 10%.⁸

Flamm: 5 variables weighted by correlation with TOLAC success

Flamm et al also created a scoring tool for use on admission to the labor ward, based on 5 variables weighted according to degree of correlation with TOLAC success: age <40 years (OR=2.58; 95% CI, 1.55-4.3), history of a vaginal birth (OR=1.53-9.11 depending on where the vaginal birth fell in the woman's reproductive history), reason other than failure to progress for the first cesarean delivery (OR=1.93; 95% CI, 1.58-2.35), cervical effacement ≥75% on admission (OR=2.72; 95% CI, 2.00-3.71), and cervical dilation ≥4 cm on admission (OR=2.16; 95% CI, 1.66-2.82).⁹ Dinsmoor validated this scoring tool as well in 156 women and found 100% TOLAC success for scores ≥7 (within 5% of the original tool) and 56% TOLAC success for scores ≤4 (compared with 49% for scores 0-2 in the original work).⁸

Hashima and Guise: A 3-point scoring tool

Hashima and Guise evaluated 16 variables and identified 7 associated with TOLAC outcome: indication for cesarean delivery (recurrent vs nonrecurrent), chorioamnionitis, macroscopic infant, age, anemia, diabetes, and infant sex, from which they created a 3-point scoring tool using the variables most associated with TOLAC outcome. Each variable was assigned a score of 0 or 1, and the likelihood of TOLAC success was calculated.¹⁰

They found a relationship between score and TOLAC success. The original study population of 10,828 was randomly divided into a score development and validation group. TOLAC success percentages were most discordant between the tool development and internal validation groups for score 0 at 7%. Scores 1 to 3 were within 4% of each other.

Schoorel: A model designed for Western European women

Finally, Schoorel et al developed and internally validated a prediction model for a Western European population, to be used during counseling in the third trimester of pregnancy.¹¹ Six variables were identified and entered into the model calculations: prepregnancy BMI (entered as a continuous variable), (OR=0.96; 95% CI, 0.92-1.00); previous

TABLE

Prediction tools for TOLAC success

Prediction tool	Clinical use	Clinical variables	Validating evidence	Outcomes	Correlation of actual outcomes with predicted outcomes	Comments
Graphical nomogram predicting probability of TOLAC success (with 95% confidence intervals)	Early in prenatal care for patient counseling (Grobman 2007 ¹) On admission to labor ward (Grobman 2009 ²)	1. Maternal age 2. Prepregnancy BMI 3. Race 4. Ethnicity 5. Nonrecurrent indication for previous cesarean section 6. Prior vaginal birth All above plus: 1. GA at delivery (estimated) 2. Preeclampsia (Y/N) 3. Cervical dilation 4. Cervical effacement 5. Fetal station 6. Induction of labor (Y/N)	Prospective cohort of 10,856 women who were ≥37 wk GA with 1 previous LTCS Overall population TOLAC success rate 73% Overall population TOLAC success rate in external validation group 52% ³	Predicted TOLAC success rates of 70%-90% were accurate ±5% Predicted TOLAC success rates of 30%-40% were accurate ±10%	Externally validated with correlation: r=0.90, P<.002 and with AUC, 0.70, ³ and AUC, 0.81, ⁴ (compared with original model AUC 0.75)	Calculator online: https://mfmu.bsc.gwu.edu/PublicBSC/MFMU/VGBirthCalc/vagbirth.html
Graphical nomogram predicting probability of TOLAC success	Early in prenatal care for patient counseling (Tessmer-Tuck 2014 ⁵)	1. Maternal age <30 yr 2. BMI <30 kg/m ² 3. Any previous vaginal delivery 4. Previous vaginal delivery after cesarean 5. Absence of a recurrent indication for cesarean delivery	Retrospective cohort of 599 women who were ≥37 wk GA with 1 previous LTCS Overall TOLAC success rate 76%	Predicted TOLAC success rates >90% were accurate ±8% Predicted TOLAC success rates between 70% and 90% were accurate only ±29%	Not internally or externally validated	
Weighted additive point scoring tool, based on logistical modeling	On admission to labor ward (Metz 2013 ⁶)	1. History of vaginal birth 2. Absence of a recurrent indication for primary cesarean delivery 3. Age <35 yr 4. BMI <30 kg/m ² 5. Each point of Bishop score	Retrospective cohort of 1170 women with 1 previous LTCS, all GAs Overall population TOLAC success rate 80%	TOLAC success rates: Score <10=<42.9% Score >16=>86.1%	Internally and externally validated External validation with overall population TOLAC success rate 78.3% TOLAC success rates were accurate for score <10 ± 5% and for score >16 ± 8%	

See footnotes on next page.

CONTINUED

CLINICAL INQUIRIES

TABLE

Prediction tools for TOLAC success (*cont'd*)

Simple additive 4-point scoring tool	On admission to labor ward (Troyer 1992 ⁹)	<ol style="list-style-type: none"> 1. Previous dysfunctional labor (defined as failure to progress, cephalopelvic disproportion, or dystocia) 2. No previous vaginal birth 3. NRFHT on admission 4. Induced labor 	<p>Retrospective cohort of 264 labors in women ≥ 36 wk GA with 1 previous LTCS</p> <p>Overall population TOLAC success rate 72.7%</p>	<p>TOLAC success rates:</p> <p>Score 0=91.5%</p> <p>Score 1=73.9%</p> <p>Score 2=66.7%</p> <p>Score 3-4=46.1%</p>	<p>Externally validated with overall TOLAC success rate population 76%⁸</p> <p>TOLAC success rates were accurate for Score 0 \pm 5% and Score $\geq 3 \pm 10\%$</p>	
Weighted additive 10-point scoring tool, based on logistical modeling	On admission to labor ward (Flamm 1997 ⁹)	<ol style="list-style-type: none"> 1. Age <40 yr 2. History of vaginal birth 3. Reason other than failure to progress for the first cesarean delivery 4. Cervical effacement $\geq 75\%$ on admission 5. Cervical dilation ≥ 4 cm on admission 	Prospective cohort of 5022 women with 1 previous LTCS, all GAs included	<p>Scores 0-2 yielded 49% success rate for VBAC</p> <p>Scores 8-10 yielded 95% success rate for VBAC</p>	<p>Externally validated with overall TOLAC success rate population 76%⁸</p> <p>TOLAC success rates were accurate $\pm 5\%$ for all scores</p>	
Simple additive 3-point prediction scoring system	Early in prenatal care (Hashima and Guise 2007 ¹⁰)	<ol style="list-style-type: none"> 1. Nonrecurrent indication for prior cesarean delivery 2. No history of a macrosomic infant 3. No current maternal anemia 	<p>Retrospective cohort of 10,828 women ≥ 37 wk GA with 1 previous LTCS</p> <p>Overall population TOLAC success rate 64.1%</p>	<p>TOLAC success rates:</p> <p>Score 0=16.7%</p> <p>Score 1=44.1%</p> <p>Score 2=54.5%</p> <p>Score 3=67.9%</p>	<p>Internally validated with high correlation</p> <p>TOLAC success rates were accurate for score 0 $\pm 7\%$ and for all other scores $\pm 4\%$</p>	
Logistical modeling leading to final predictive equation	Specifically Western European population, for use in counseling in the 3rd trimester of pregnancy (Schoorel 2014 ¹¹)	<ol style="list-style-type: none"> 1. Prepregnancy BMI 2. Previous vaginal delivery 3. Previous nonprogressive labor 4. White ethnicity 5. Induction of current labor 6. EFW >90th percentile 	<p>Retrospective cohort of 515 women who were ≥ 37 wk GA with 1 previous LTCS</p> <p>Overall TOLAC success rate 72%</p>	<p>Predicted TOLAC success ranged from 39%-93%, with a mean of 72% (SD 11%)</p> <p>Accuracy data not reported</p>	<p>Internally validated with low correlation and no specific performance data reported</p>	<p>Predictive equation: $P_{\text{success}} = 100\% \times \{1 + \exp[-(1.647 + 0.371 \times \text{white} - 0.032 \times \text{prepregnancy BMI} - 0.537 \times \text{previous nonprogressive labor} + 1.045 \times \text{previous vaginal delivery} - 0.515 \times \text{induction of labor} - 0.487 \times \text{EFW} \geq P 90)]\}$</p>

AUC, area under the curve; BMI, body mass index; EFW, estimated fetal weight; GA, gestational age; LTCS, low transverse segment cesarean section; NRFHT, nonreassuring fetal heart tracing; SD, standard deviation; TOLAC, trial of labor after previous cesarean section; VBAC, vaginal birth after cesarean.

cesarean for nonprogressive labor (OR=0.50; 95% CI, 0.33-0.76); previous vaginal delivery (OR=3.81; 95% CI, 2.10-6.92); induction of labor (OR=0.52; 95% CI, 0.33-2.10); estimated fetal weight >90th percentile (OR=0.54; 95% CI, 0.14-2.02); and white ethnicity (OR=1.61; 95% CI, 0.97-2.66). The authors noted that the predicted probability of TOLAC success ranged from 39% to 93%, with a mean of 72% (standard deviation, 11%), and only noted the predicted probabilities were well calibrated from 65% upwards without additional data on specific performance.

Recommendations

The American College of Obstetricians and

Gynecologists (ACOG) lists strong predictors of a successful vaginal birth after cesarean as previous vaginal birth and spontaneous labor. Factors associated with decreased probability of success are recurrent indication for initial cesarean delivery (labor dystocia), increased maternal age, nonwhite ethnicity, gestational age greater than 40 weeks, maternal obesity, preeclampsia, short interpregnancy interval, and increased neonatal birth weight. ACOG does not offer any weighted or risk-based scoring tools for predicting success.¹³

Neither the American Academy of Family Physicians nor the American College of Nurse Midwives recommend specific scoring tools or success predictors. **JFP**

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