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# The MFMU Cesarean Registry: Factors affecting the success of trial of labor after previous cesarean delivery

**Mark B. Landon, MD,[a,*] Sharon Leindecker, MS,[b] Catherine Y. Spong, MD,[c] John C. Hauth, MD,[d] Steven Bloom, MD,[e] Michael W. Varner, MD,[f] Atef H. Moawad, MD,[g] Steve N. Caritis, MD,[h] Margaret Harper, MD,[i] Ronald J. Wapner, MD,[j] Yoram Sorokin, MD,[k] Menachem Miodovnik, MD,[l,m] Marshall Carpenter, MD,[n] Alan M. Peaceman, MD,[o] Mary Jo O'Sullivan, MD,[p] Baha M. Sibai, MD,[q] Oded Langer, MD,[r] John M. Thorp, MD,[s] Susan M. Ramin, MD,[t] Brian M. Mercer, MD,[u] Steven G. Gabbe, MD,[v] for the National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network[†]**

*Departments of Obstetrics and Gynecology at The Ohio State University, Columbus, OH[a]; George Washington University Biostatistics Center, Washington, DC[b]; National Institute of Child Health and Human Development, Bethesda, MD[c]; University of Alabama at Birmingham, Birmingham, AL[d]; University of Texas Southwestern Medical Center, Dallas, TX[e]; University of Utah, Salt Lake City, UT[f]; University of Chicago, Chicago, IL[g]; University of Pittsburgh, Pittsburgh, PA[h]; Wake Forest University, Winston-Salem, NC[i]; Thomas Jefferson University, Philadelphia, PA[j]; Wayne State University, Detroit, MI[k]; University of Cincinnati, Cincinnati, OH[l]; Columbia University, New York, NY[m]; Brown University, Providence, RI[n]; Northwestern University, Chicago, IL[o]; University of Miami, Miami, FL[p]; University of Tennessee, Memphis, TN[q]; University of Texas Health Science Center at San Antonio, San Antonio, TX[r]; University of North Carolina at Chapel Hill, Chapel Hill, NC[s]; University of Texas Health Science Center at Houston, Houston, TX[t]; Case Western Reserve University, Cleveland, OH[u]; Vanderbilt University, Nashville, TN[v]*

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**Objective:** The purpose of this study was to determine which factors influence the likelihood of successful trial of labor (TOL) after 1 previous cesarean delivery (CD).

**Study design:** We performed a multicenter 4-year prospective observational study (1999-2002) of all women with previous CD undergoing TOL. Women with term singleton pregnancies with 1 previous low transverse CD or unknown incision were included for analysis.

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* Reprint requests: Mark B. Landon, MD, The Ohio State University College of Medicine and Public Health, 1654 Upham Drive, Means Hall 5th Floor, Columbus, OH 43210-1228.

*E-mail:* landon.1@osu.edu

† The other members of the network are listed in the **Appendix**.


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**Results:** Fourteen thousand five hundred twenty-nine women underwent TOL, with 10,690 (73.6%) achieving successful VBAC. Women with previous vaginal birth had an 86.6% success rate compared with 60.9% in women without such a history (odds ratio [OR] 4.2; 95% CI 3.8-4.5; $P < .001$). TOL success rates were affected by previous indication for CD, need for induction or augmentation, cervical dilation on admission, birth weight, race, and maternal body mass index. Multivariate logistic regression analysis identified as predictive of TOL success: previous vaginal delivery (OR 3.9; 95% CI 3.6-4.3), previous indication not being dystocia (CPD/FTP) (OR 1.7; 95% CI 1.5-1.8), spontaneous labor (OR 1.6; 95% CI 1.5-1.8), birth weight <4000 g (OR 2.0; 95% CI 1.8-2.3), and Caucasian race (OR 1.8, 95% CI 1.6-1.9) (all $P < .001$). The overall TOL success rate in obese women (BMI ≥30) was lower (68.4%) than in nonobese women (79.6%) ($P < .001$), and when combined with induction and lack of previous vaginal delivery, successful VBAC occurred in only 44.2% of cases.
**Conclusion:** Previous vaginal delivery including previous VBAC is the greatest predictor for successful TOL. Previous indication as dystocia, need for labor induction, or a maternal BMI ≥30 significantly lowers success rates.


The overall cesarean delivery rate in the United States has risen steadily since 1996 (20.7%) to the highest level recorded, 27.6% in 2003.[1] Contributing to this rise has been a decline in vaginal birth after previous cesarean (VBAC), which has plummeted from a peak rate of 31% in 1998 to 10.6% in 2003. The safety and appropriateness of VBAC in clinical practice has been challenged after increased frequency of reported cases of uterine rupture with associated maternal and perinatal morbidity.[2] Because the absolute risks of adverse outcomes associated with VBAC remains statistically small, clinical guidelines continue to suggest that most women with 1 previous cesarean delivery with a low-transverse incision are candidates for VBAC and should be counseled and offered a trial of labor (TOL).[3,4]

The counseling process includes a discussion of risks associated with attempted VBAC, risks associated with cesarean delivery, as well as an estimate of the likelihood of a successful trial of labor. Predicting outcomes after TOL is important because the increased risk for morbidity in women attempting VBAC is primarily found in those women who fail to achieve vaginal birth.[5] While previous studies have addressed the impact of various clinical factors on VBAC success rates, many of these analyses are limited by small size or a study design that fails to control for potential confounding variables, including previous vaginal delivery. We conducted a multicenter study of women with previous cesarean delivery to determine which factors affect the success of TOL.

## Material and methods

The cesarean registry was a 4-year observational study of the National Institute of Child Health and Human Development Maternal–Fetal Medicine Units Network designed to address clinical issues related to cesarean childbirth. The study was conducted at 19 academic medical centers; 8 centers participated throughout the study, 5 participated only during the first 2 years and 6 participated for part of the last 2 years. Data were collected for women undergoing attempted vaginal birth after cesarean section (VBAC) with a gestational age of at least 20 weeks or delivering an infant of 500 g or more. The labor and delivery logbook or computer database at each participating center was screened continuously. The present analysis includes all women with a singleton gestation of at least 37 weeks' gestation and a history of a single previous cesarean delivery with a low transverse or unknown incision. Medical records were reviewed by trained study nurses. Demographic data, obstetric and medical history, as well as information concerning intrapartum events were obtained from completed medical records. These data included maternal age, race, marital status, smoking history, payor status, height, and weight. Past obstetric and medical history, including indication for previous cesarean delivery, previous uterine incision type, interval from last cesarean delivery, history of previous vaginal delivery or VBAC, and presence of maternal diseases (hypertension, diabetes, asthma, seizures, renal disease, thyroid disease, or collagen vascular condition) were recorded. Obstetric factors related to the present pregnancy included birth weight, gestational age, labor induction, or augmentation, cervical dilatation at admission, maximum cervical dilation, and epidural use. Data forms were entered at each clinical center using a distributed data entry system and transmitted weekly to the data coordinating center at the George Washington University Biostatistics Center, where they were updated to a mainframe computer and merged with the existing database. The data were edited on a regular basis for missing, out of range, and inconsistent values. Corrections were entered on the distributed data entry system.

**Table I** Study population characteristics

| | Total (n = 14,529) | VBAC (n = 10,690) | Failed TOL (n = 3839) | *P* value |
|---|---|---|---|---|
| Age | 28.7 ± 5.7 | 28.7 ± 5.7 | 28.6 ± 5.8 | .57 |
| Race (no. [%]) | | | | < .001 |
| African American | 4949 (34.1) | 3525 (33.0) | 1424 (37.1) | |
| Caucasian | 5330 (36.7) | 4173 (39.0) | 1157 (30.1) | |
| Hispanic | 3489 (24.0) | 2445 (22.9) | 1044 (27.2) | |
| Other/unknown | 761 (5.2) | 547 (5.1) | 214 (5.6) | |
| Married (no. [%]) | 8284 (57.8) | 6186 (58.6) | 2098 (55.6) | .001 |
| Smoker (no. [%]) | 2073 (14.3) | 1574 (14.7) | 499 (13.0) | .009 |
| Pvt. insurance (no. [%]) | 6176 (42.5) | 4661 (43.6) | 1515 (39.5) | < .001 |
| BMI at delivery | 32.0 ± 6.5 | 31.4 ± 6.2 | 33.8 ± 7.1 | < .001 |
| BMI ≥30 (no. [%]) | 7549 (56.2) | 5160 (52.5) | 2389 (66.6) | < .001 |
| Previous indication (no. [%]) | | | | |
| Dystocia | 4630 (34.7) | 2940 (30.2) | 1690 (47.2) | < .001 |
| NRFWB | 3074 (23.1) | 2231 (22.9) | 843 (23.5) | |
| Malpresentation | 3407 (25.6) | 2856 (29.3) | 551 (15.4) | |
| Other | 2216 (16.6) | 1718 (17.6) | 498 (13.9) | |
| Labor type (no. [%]) | | | | < .001 |
| Induction | 3812 (26.6) | 2569 (24.0) | 1243 (34.2) | |
| Spon Labor | 5294 (37.0) | 4266 (39.9) | 1028 (28.3) | |
| Augmentation | 5214 (36.4) | 3854 (36.1) | 1360 (37.5) | |
| Cx dil @ admit | 3.3 ± 2.1 | 3.6 ± 2.1 | 2.5 ± 1.8 | < .001 |
| Cx >4 cm @ admit (no. [%]) | 5943 (42.4) | 4980 (48.1) | 963 (26.4) | < .001 |
| Epidural (no. [%]) | 10,696 (84.3) | 7850 (88.6) | 2846 (74.2) | < .001 |
| Birth weight | 3412.9 ± 473.1 | 3377.5 ± 458.0 | 3511.3 ± 499.9 | < .001 |
| Gestational age | 39.5 ± 1.2 | 39.4 ± 1.2 | 39.7 ± 1.2 | < .001 |

*Spon labor*, Spontaneous labor; *cx*, cervix; *cx dil*, cervical dilation; *BMI*, body mass index (at delivery, kg/m$^2$). Plus-minus values are mean ± SD. Data on marital status were missing for 127 VBAC and 63 failed TOL patients; data on smoking status were missing on 6 VBAC and 2 failed TOL patients; data on insurance type were missing for 1 patient in each group; data on BMI at delivery were missing for 854 VBAC and 252 failed TOL patients; data on previous indication were missing for 945 VBAC and 257 failed TOL patients; data on the type of labor were missing for 1 VBAC and 208 failed TOL patients; data on cervical dilation at admission were missing for 326 VBAC and 194 failed TOL patients; data on epidural use were missing for 1833 VBAC and 1 failed TOL patient; data on birth weight at delivery were missing for 2 VBAC and 1 failed TOL patients.

## Statistical analysis

Continuous variables were compared with the Wilcoxon rank-sum and categorical variables with chi-square. Multivariate logistic regression analysis was performed to adjust for potential confounding factors for predicting successful VBAC delivery. These potential confounding variables included previous vaginal delivery, birth weight, spontaneous labor, race, absence of maternal baseline disease, previous cesarean delivery more than 2 years ago, and indication for previous cesarean delivery other than dystocia. Nominal 2-sided *P* values are reported. SAS software, version 8 (SAS Institute, Cary, NC) was used for the analysis.

## Results

During the study period (1999-2002), there were 29,661 women who had a singleton gestation at term with a history of 1 previous cesarean delivery with a transverse or unknown incision. Of these cases, 14,529 (49.0%) underwent trial of labor. Ten thousand six hundred ninety (73.6%) achieved successful VBAC, whereas 3839 (26.4%) failed a TOL. Among those 3839 cases, repeat operation was performed in 2037 (53.1%) for cephalopelvic disproportion/failure to progress dystocia, 1123 (29.3%) for nonreassuring fetal well-being (NRFWB), and in 679 (17.6%) for other indications.

For the study population, the TOL rate declined significantly from 60.7% (1999), 54.5% (2000), 43.7% (2001), to 38.4% (2002); *P* for trend < .001. Over the same period, the VBAC success rate declined from 74.2% (1999) to 71.7% (2002) (*P* = .04). Among the 19 centers, the VBAC success rate ranged from 59.5% to 82.5% during the study period. The rate of uterine rupture did not change significantly: 0.57% (1999), 0.75% (2000), 0.69% (2001), 0.86% (2002); (*P* = .16).

Demographic and obstetric characteristics of the study population are presented in Table I. Women who achieved successful VBAC were more likely to be Caucasian, married, privately insured, tobacco users, and to have BMI less than 30 when compared with those failing a trial of labor. The successful group was also more likely to have spontaneous labor, greater cervical dilation at admission, epidural use, lower mean birth weight, and gestational age (all *P* < .001).

**Table II** TOL success rates: Demographics

| Characteristic | n (VBAC success %) (n = 10,690) | Odds ratio (95% CI) |
|---|---|---|
| Age in years | | |
| ≤17 | 84 (70.0) | 0.84 (0.57-1.25) |
| 18-34* | 8764 (73.6) | 1.0 |
| ≥35 | 1842 (73.6) | 1.0 (0.91-1.10) |
| Race | | |
| African American | 3525 (71.2) | 0.69 (0.63-0.75) |
| Hispanic | 2445 (70.1) | 0.65 (0.59-0.72) |
| Other/unknown | 547 (71.9) | 0.71 (0.60-0.84) |
| Caucasian* | 4173 (78.3) | 1.0 |
| Unmarried | | |
| Yes | 4377 (72.3) | 0.88 (0.82-0.95) |
| No* | 6186 (74.7) | 1.0 |
| Nonsmoker | | |
| Yes | 9110 (73.2) | 0.87 (0.78-0.96) |
| No* | 1574 (75.9) | 1.0 |
| Insurance at delivery | | |
| Nonprivate | 4633 (73.0) | 0.88 (0.81-0.95) |
| Uninsured | 1395 (69.5) | 0.74 (0.66-0.83) |
| Private* | 4661 (75.5) | 1.0 |
| BMI at delivery (kg/m$^2$) | | |
| ≥30 | 5160 (68.4) | 0.55 (0.51-0.60) |
| <30* | 4676 (79.6) | 1.0 |

Overall *P* values are < .001 except for age, where *P* = .67, unmarried, where *P* = .001, and smoking status, where *P* = .009. *CI*, Confidence interval.

* Women with this characteristic served as the reference group.

**Table III** TOL success rates: Obstetric and historical factors

| Characteristic | n (VBAC success %) (n = 10,690) | Odds ratio (95% CI) |
|---|---|---|
| Previous CD indication | | |
| Dystocia | 2940 (63.5) | 0.34 (0.30-0.37) |
| NRFWB | 2231 (72.6) | 0.51 (0.45-0.58) |
| Other | 1718 (77.5) | 0.67 (0.58-0.76) |
| Malpresentation* | 2856 (83.8) | 1.0 |
| Prior scar | | |
| Transverse | 8688 (72.5) | 0.71 (0.64-0.79) |
| Unknown* | 2002 (78.7) | 1.0 |
| Previous CD | | |
| ≤2 years | 2338 (67.8) | 0.70 (0.64-0.76) |
| >2 years* | 7831 (75.2) | 1.0 |
| Previous vaginal delivery | | |
| Yes* | 6121 (86.6) | 1.0 |
| No | 4499 (60.9) | 0.24 (0.22-0.26) |
| Previous VBAC | | |
| Yes* | 4166 (89.6) | 1.0 |
| No | 5924 (64.4) | 0.21 (0.19-0.23) |
| Maternal disease† | | |
| Yes | 1652 (70.1) | 0.81 (0.74-0.90) |
| No* | 9038 (74.3) | 1.0 |
| Labor type | | |
| Induction | 2569 (67.4) | 0.50 (0.45-0.55) |
| Augmented | 3854 (73.9) | 0.68 (0.62-0.75) |
| Spontaneous* | 4266 (80.6) | 1.0 |
| Admit cervical dilation (cm) | | |
| <4 | 5384 (66.8) | 0.39 (0.36-0.42) |
| ≥4* | 4980 (83.8) | 1.0 |
| Epidural anesthesia | | |
| Yes* | 7850 (73.4) | 1.0 |
| No | 1007 (50.4) | 0.37 (0.33-0.41) |
| Birth weight (g) | | |
| <2500 | 267 (77.2) | 1.14 (0.89-1.47) |
| 2500-3999* | 9486 (74.9) | 1.0 |
| ≥4000 | 935 (62.0) | 0.55 (0.49-0.61) |
| Gestational age (wk/d) | | |
| 37 0/7-40 6/7* | 9340 (75.0) | 1.0 |
| ≥41 | 1350 (64.8) | 0.61 (0.55-0.68) |

All overall *P* values are < .001; for categorical characteristics, only the comparison of birth weight <2500 g to 2500 to 3999 is not significant (*P* = .33). *CI*, Confidence interval.

* Women with this characteristic served as the reference group.

† Maternal disease was defined as diabetes, asthma, thyroid disease, seizure disorder, pregestational chronic hypertension treated with medication, renal disease, or connective tissue disease.

Dystocia as previous indication for cesarean delivery was more common in women who failed a trial of labor ($P < .001$).

Trial of labor success rates according to demographic characteristics are presented in Table II. Women of Caucasian race, married, smokers, and those with private insurance all had a greater likelihood of successful TOL. Obese women (BMI ≥30) were significantly less likely to deliver vaginally than nonobese women (OR 0.55; 95% CI 0.51-0.60; $P < .001$).

The rates for successful VBAC associated with obstetric and medical historic factors are presented in Table III. Women with previous vaginal delivery and previous VBAC had the highest rates of successful TOL (86.6% and 89.6%, respectively). Among previous indications, malpresentation was also associated with a high TOL success rate (83.8%), whereas previous operation for dystocia resulted in success in only 63.5% of cases. Unknown scar type, interval >2 years from previous cesarean delivery, and absence of a complicating medical diagnosis were all factors that increased the likelihood of successful TOL. Women who entered spontaneous labor without oxytocin use achieved vaginal birth in 80.6% of cases compared with 67.4% of women undergoing induction and 73.9% of those requiring oxytocin augmentation ($P < .001$). Cervical dilation at admission of 4 cm or more, epidural use, fetal size less than 4000 g, and gestational age <41 weeks all were associated with greater likelihood of successful TOL ($P < .001$).

The results of 3 multivariate logistic regression models used to evaluate the independent effect of 7 significant variables on trial of labor outcome is presented in Table IV. All significant variables identified using univariate analysis remained predictive of TOL success using the multivariate model except for interval

**Table IV** Indicators of successful TOL

| Characteristic | Univariate | Multivariate | | |
|---|---|---|---|---|
| | | Model 1* | Model 2† | Model 3‡ |
| Previous vaginal delivery | 4.2 (3.8-4.5) | 4.2 (3.9-4.6) | 4.2 (3.9-4.6) | 3.9 (3.6-4.3) |
| Birth weight <4000 g | 1.8 (1.6-2.0) | 2.1 (1.8-2.4) | 2.1 (1.8-2.4) | 2.0 (1.8-2.3) |
| Spontaneous labor | 1.7 (1.5-1.8) | 1.6 (1.5-1.8) | 1.6 (1.5-1.8) | 1.6 (1.5-1.8) |
| Caucasian | 1.5 (1.4-1.6) | 1.8 (1.6-1.9) | 1.8 (1.6-1.9) | 1.8 (1.6-1.9) |
| No maternal disease§ | 1.2 (1.1-1.4) | 1.3 (1.1-1.4) | 1.2 (1.1-1.4) | 1.2 (1.1-1.4) |
| Last CD >2 y | 1.4 (1.3-1.6) | | 1.0 (0.9-1.1) | 1.0 (0.9-1.1) |
| Previous CD not dystocia | 2.1 (1.9-2.2) | | | 1.7 (1.5-1.8) |

Data represent ORs and 95% CIs.

* Model 1 results in 292 (2.0%) patients with missing data.

† Model 2 results in 922 (6.3%) patients with missing data.

‡ Model 3 results in 1973 (13.6%) patients with missing data.

§ No maternal disease was defined as not having any of the following conditions: diabetes, asthma, thyroid disease, seizure disorder, pregestational chronic hypertension treated with medication, renal disease, and connective tissue disease.

**Table V** TOL success rates: Combined factors

| | Total | Previous dystocia | Previous NRFWB | Previous malpresentation |
|---|---|---|---|---|
| Spontaneous labor | 3827 (80.0) | 1155 (71.6) | 840 (80.5) | 1146 (86.7) |
| Induction | 2374 (67.0) | 681 (57.7) | 554 (64.5) | 698 (80.8) |
| Previous vaginal delivery | 5516 (86.5) | 1397 (82.1) | 1344 (84.1) | 1726 (91.1) |
| No previous vaginal delivery | 4195 (60.7) | 1538 (52.7) | 881 (60.0) | 1119 (74.8) |
| BMI <30 | 4297 (79.4) | 1171 (70.0) | 904 (77.1) | 1491 (87.7) |
| BMI ≥30 | 4696 (67.8) | 1516 (58.4) | 1167 (68.9) | 1152 (79.5) |
| Spontaneous labor and previous vaginal delivery | 2291 (90.8) | 590 (87.9) | 533 (89.9) | 746 (92.9) |
| Induced and no previous vaginal delivery | 948 (51.7) | 331 (44.7) | 203 (48.9) | 259 (69.8) |
| Spontaneous labor, previous vaginal delivery, and BMI <30 | 998 (93.6) | 208 (93.3) | 228 (90.5) | 382 (94.8) |
| Induced, no previous vaginal delivery, and BMI ≥30 | 476 (44.2) | 186 (39.8) | 106 (43.3) | 101 (59.1) |

from last cesarean delivery. Previous vaginal delivery was found to be the most significant predictor of VBAC success (OR 3.9; 95% CI 3.6-4.3).

Trial of labor rates according to previous indication for cesarean delivery stratified with respect to various predictive factors are presented in Table V. In most cases, success rates exceed 50%. The combination of factors which reduced the likelihood of successful VBAC, including BMI ≥30, induction, and lack of history of previous vaginal delivery significantly lowered the chance for successful TOL. When all of these factors were present, VBAC was achieved in only 44.2% of cases.

Labor characteristics among women who failed a TOL with an indication for repeat cesarean designated as dystocia stratified according to previous indication for cesarean delivery is presented in Table VI. Of these cases, 1030 (54.1%) represent women with a history of previous operation for dystocia. Repeat cesarean with indication of dystocia was more common in women with previous dystocia 1030/1690 (60.9%) than in women with previous NRFWB 349/843 (41.4%) or previous malpresentation 283/551 (51.4%). Overall, oxytocin augmentation was used in 66.1% and intrauterine pressure catheter monitoring in 65.7% of cases undergoing repeat operation for CPD/FTP in the current pregnancy. In cases where an intrauterine pressure catheter was employed to assess the adequacy of labor, Montevideo units (MVU) ≥200 was achieved in 62.7% of cases. IUPC use, as well as MVU ≥200, was at least as frequent for women with previous history of dystocia as it was for other previous indications. The maximum mean cervical dilatation at the time of repeat operation was greatest for those with a history of previous dystocia ($P < .001$).

**Table VI** Failed TOL with repeat CD for dystocia: Labor characteristics (n = 2037*)

| Previous indication for CD | Dystocia (n = 1030) | NRFWB (n = 349) | Malpresentation (n = 283) | Other (n = 242) | *P* value |
|---|---|---|---|---|---|
| Oxytocin use | 688 (66.8) | 247 (70.8) | 167 (59.0) | 160 (66.1) | .019 |
| IUPC use | 649 (64.6) | 242 (70.4) | 174 (62.4) | 154 (66.1) | .16 |
| MVU $\geq$200 | 373 (64.1) | 147 (68.1) | 88 (57.9) | 86 (60.6) | .20 |
| Maximum cx dilation | 6.5 $\pm$ 2.6 | 5.9 $\pm$ 2.7 | 5.9 $\pm$ 2.8 | 6.1 $\pm$ 2.8 | $<$ .001 |
| Cx dilated 10 cm | 230 (22.7) | 65 (18.8) | 51 (18.1) | 46 (19.4) | .22 |

*IUPC,* Intrauterine pressure catheter; *MVU,* montevideo units.

* One hundred thirty-three out of 2037 were missing indication for the previous cesarean delivery.

## Comment

Because previous studies have indicated success rates ranging from 60% to 80%, this large multicenter observational cohort study confirms that nearly three fourths of women at term undergoing a trial of labor after previous cesarean section will achieve a successful vaginal delivery.[6] Various demographic and clinical characteristics are clearly predictive of VBAC success. Among these factors, we found previous vaginal delivery including successful previous VBAC as the most significant. In our study population, 7065 (48.9%) of women undergoing TOL had a history of previous vaginal delivery. This large percentage of the study population likely reflects the evolution of a conservative approach to selecting candidates for TOL. These women achieved a high rate of VBAC success (86.6%) compared with only 60.9% in women without a history of previous vaginal delivery. A similar high rate of success for women with previous vaginal birth has been reported by Elkousy et al, who found 83% success compared with 65% without such history.[7] During the time period (1995-1999) of their study, women with previous vaginal delivery comprised 36% of their study population.

Both previous indication for cesarean delivery and labor characteristics have been cited as important determinants of VBAC success.[8] Using multivariate models, we and others have confirmed induction as being associated with lower VBAC success rates.[9] Other significant obstetric variables, including cervical dilation at admission and birth weight $<$4000 g, were validated in our study as predictors of successful VBAC.[7,8] The low rate of VBAC success in women who did not receive epidural analgesia deserves comment. This finding is possibly related to repeat operations performed after relatively short labor in which spinal technique was used or to cases of nonreassuring fetal well-being where regional anesthesia was not employed for repeat cesarean delivery.

The present study also confirms the strength of the independent effect of previous cesarean indication on subsequent labor success rates. The highest rate of success (84% with previous malpresentation) in our series is nearly identical to the data of Coughlan et al, who reported 85% success for women with a history of cesarean for breech presentation.[10] This rate is similar to vaginal delivery rates for nulliparous women. For other indications such as history of dystocia, TOL success rates have been consistently lower than for other previous indications and as such, dystocia is considered a potentially recurring condition. Using a 12-year database of 2207 women with only 1 previous delivery, a 62.7% VBAC success rate was reported by Shipp et al, which is similar to our rate of 63.5% for this population.[11] Because many obstetricians are reluctant to offer VBAC to women with previous dystocia because of lower success rates, investigators have examined previous delivery records in this population to determine if the degree of maximum cervical dilation achieved could predict the likelihood of success in a subsequent trial of labor.[12] Hoskins and Gomez reported a success rate of 74% for women who reached 6 to 9 cm dilation, compared with only 13% of women who were fully dilated at the time of their previous delivery. Unfortunately, we did not collect specific data concerning labor events at the time of previous cesarean delivery as part of our data collection.

Dystocia and nonreassuring fetal well-being were the 2 major indications for repeat cesarean in our study. Interestingly, only 65.7% of women who failed TOL with repeat operation performed for dystocia had placement of an internal pressure catheter (IUPC) during labor and, of these, only 62.7% demonstrated adequate labor in the 1 hour preceding delivery. For women undergoing repeat CD for dystocia, both the rates of IUPC utilization and adequacy of labor were not significantly different in women with previous dystocia compared with other previous indications. This suggests that physicians managing labor were not influenced by previous indication in their threshold for repeat cesarean and is further supported by the finding that the greatest degree of cervical dilation was achieved by this group with their VBAC attempt. In contrast, Shipp et al reported the duration of labor was approximately

2.5 hours shorter in women with previous cesarean for CPD/FTP undergoing repeat operation for the same indication when compared with women with other previous indications who failed to progress in a subsequent TOL.[11]

Using various factors associated with successful TOL, several scoring systems have been devised to help predict which women are likely to deliver vaginally. In the largest such study of 5003 women with an overall VBAC success rate of 74%, Flamm and Geiger identified 5 significant variables which were incorporated into a weighed scoring system.[8] These included age under 40, vaginal birth history, previous indication, cervical effacement, and cervical dilation 4 cm or more at admission. Rates of successful vaginal birth ranged from 49% in patients scoring 0 to 2 to 95% in patients scoring 8 to 10. However, only 234 (4.7%) of women had a score of 0 to 2. Beyond this score, the majority of women had successful VBAC. The use of this scoring system is thus limited by this finding and the requirement for implementation at the time of admission, rather than providing an assessment of the likelihood of VBAC before the decision to undergo trial of labor.

The large size of our study enabled identification of many factors which were significantly associated with the likelihood of VBAC success. For some of these variables, however, the clinical significance of the reported differences may be only marginal. Small differences in success rates are unlikely to influence counseling or an individual woman's decision to undergo trial of labor. Some authors have thus suggested that estimates of cost-effectiveness of TOL be employed to better identify populations of women who should be offered VBAC.[13,14] A true analysis of cost-effectiveness includes hospital and physician costs, reimbursement, potential liability expenses, and the probability that a woman will continue with childbearing after her first VBAC attempt.[4] Based on risks associated with VBAC, decision models analyses have concluded that it is reasonable to offer TOL if the chance of success is at least 50% to 70%.[13,14] Given this consideration, using a combination of clinically significant factors that can be identified before labor would be helpful in selecting optimal candidates for TOL. Because the majority of women will be successful in achieving VBAC, better identification of those at highest risk for failure may actually be of greatest value in the counseling process. Stratifying women according to both previous indication for cesarean delivery and history of previous vaginal delivery, Elkousy et al demonstrated that birth weight clearly affected VBAC success rates.[7] They concluded that given the risks associated with VBAC, those women without history of previous vaginal delivery should be counseled that success rates may be less than 50% when other clinical factors are present, such as fetal weight exceeding 4000 g, history of previous dystocia, or if treatment requires induction of labor.[7] Our study also indicates that for only certain populations (Table V), there is a significantly lower chance of successful VBAC. For obese women without previous vaginal delivery who require induction, we found that only those with a previous indication of malpresentation achieved a VBAC success rate greater than 50%.

Our study does have several limitations. While a multicenter design may be less likely to introduce biases towards selection of women for TOL, the possibility of such practice remains a consideration. In the absence of randomized trials, information concerning outcome in women undergoing TOL is limited by the inclusion of only women who have agreed to undergo a VBAC attempt. Similarly, physicians' practice style cannot be controlled for and, because our data comes primarily from tertiary institutions, it may not be applicable to all clinical settings. Nonetheless, the present report provides a comprehensive analysis of factors that influence success rates of TOL. We conclude that the majority of women undergoing TOL will achieve a successful VBAC. Only in a small proportion of cases are success rates likely to be less than 50%. Previous obstetric history, requirement for labor induction, and maternal BMI are the most important variables to consider in estimating the likelihood of VBAC success. Along with an individual assessment of risk for adverse outcomes associated with TOL, meaningful counseling of women with previous cesarean delivery considering their options for childbirth can be undertaken.

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## Appendix

In addition to the authors, other members of the National Institute of Child Health and Human Development Maternal–Fetal Medicine Units Network are as follows: J. Iams, F. Johnson, S. Meadows, H. Walker, The Ohio State University, Columbus, OH; E. Thom, H. Juliussen-Stevenson, M. Fischer, George Washington University Biostatistics Center, Washington, DC; D. McNellis, K. Howell, S. Pagliaro, National Institute of Child Health and Human Development, Bethesda, MD; D. Rouse, A. Northen, S. Tate, University of Alabama at Birmingham, Birmingham, AL; K. Leveno, J. McCampbell, D. Bradford, University of Texas Southwestern Medical Center, Dallas, TX; M. Belfort, F. Porter, B. Oshiro, K. Anderson, A. Guzman, University of Utah, Salt Lake City, UT; J. Hibbard, P. Jones, M. Ramos-Brinson, M. Moran, D. Scott, University of Chicago, Chicago, IL; K. Lain, M. Cotroneo, D. Fischer, M. Luce, University of Pittsburgh, Pittsburgh, PA; P. Meis, M. Swain, C. Moorefield, K. Lanier, L. Steele, Wake Forest University, Winston-Salem, NC; A. Sciscione, M. DiVito, M. Talucci, M. Pollock, Thomas Jefferson University, Philadelphia, PA; M. Dombrowski, G. Norman, A. Millinder, C. Sudz, B. Steffy, Wayne State University, Detroit, MI; T. Siddiqi, H. How, N. Elder, University of Cincinnati, Cincinnati, OH; F. Malone, M. D'Alton, V. Pemberton, V. Carmona, H. Husami, Columbia University, New York, NY; H. Silver, J. Tillinghast, D. Catlow, D. Allard, Brown University, Providence, RI; M. Socol, D. Gradishar, G. Mallett, Northwestern University, Chicago, IL; G. Burkett, J. Gilles, J. Potter, F. Doyle, S. Chandler, University of Miami, Miami, FL; W. Mabie, R. Ramsey, University of Tennessee, Memphis, TN; D. Conway, S. Barker, M. Rodriguez, University of Texas Health Science Center at San Antonio, San Antonio, TX; K. Moise, K. Dorman, S. Brody, J. Mitchell, University of North Carolina at Chapel Hill, Chapel Hill, NC; L. Gilstrap, M. Day, M. Kerr, E. Gildersleeve, University of Texas Health Science Center at Houston, Houston, TX; P. Catalano, C. Milluzzi, B. Silvers, C. Santori, Case Western Reserve University, Cleveland, OH.