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The change in the VBAC Rate: An Epidemiologic Analysis

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Summary

The objective of this study was to determine whether, and to what degree, the change in the vaginal birth after caesarean (VBAC) rate is due to a change in the characteristics of the obstetric population, the undertaking of a trial of labour (TOL), or the tendency to abandon a TOL once it has been initiated. All women with one prior low transverse caesarean and a vertex singleton gestation at term were identified in a registry of caesarean deliveries occurring at 8 academic centers during a four-year period (1999 – 2002). Women were classified by their predicted chance of VBAC and year-to-year differences were analyzed. Of the 9643 women who met criteria for analysis, 5334 (55.3%) underwent a TOL. From 1999 to 2002, the VBAC rate underwent a steady decline: 51.8% to 45.1% to 37.4% to 29.8% ($P < .001$). Although there were some changes in the characteristics of the population that predispose to successful VBAC, as well as some reduction in the chance that a VBAC is successful once a TOL is undertaken, the most pervasive reason for this decline was that women became increasingly likely to forego a TOL, regardless of their likelihood of vaginal delivery. Based on these results, it appears that the change over time in the VBAC rate is multifactorial, although the greatest change has been a decrease in the frequency with which women undertake a TOL, and this change is observed in all categories of the chance of a successful TOL.

Introduction

In recent years, the VBAC rate has plummeted throughout the United States. After peaking at 28.3% in 1996, the rate has steadily declined, such that only 9.2% of women who were eligible for a VBAC in 2004 actually had a vaginal delivery.¹

Some of this decline is due to changes in hospital policies. Many hospitals, faced with the requirement for immediate physician availability during a TOL, have stopped allowing TOL as an option.² Yet, even at hospitals where the possibility of VBAC continues to exist, the VBAC rate has decreased. There is reason to believe that this rate has changed, at least in part, because of changing perceptions of safety with regard to TOL after caesarean.³⁻⁴ Yet, the exact patient and physician factors that have contributed to this reduction in the VBAC rate are not well understood. Part of this lack of understanding is due to the use of the VBAC rate as a metric. It does not elucidate whether women are less likely to have a VBAC because they were less likely to proceed with a TOL or because the TOL was more likely to fail once it already was underway. Also, the potential contribution of changing patient demographics is unclear. It is possible, for example, that the demographics of women in the population have changed in such a way (e.g. a greater frequency of obesity) that their chance of successful VBAC has decreased. In such a scenario, even if women of similar characteristics were equally willing to undertake and continue a TOL, the VBAC rate would still decline.

Thus, a better understanding of the dynamics underlying the change in the VBAC rate is dependent upon accounting for potential differences in a population over time. Recently, based on a large observational registry, several factors (maternal age, body mass index (BMI), race, history and timing of prior vaginal delivery, indication for prior caesarean) have been identified that are significantly and independently associated with a woman's chance of achieving a VBAC if she were to undertake a TOL.⁵ These factors and the corresponding multivariable model provide a tool by which the dynamics in the decline of the VBAC rate can be better explored. The purpose of this investigation is, after accounting for patient differences, to clarify whether, and to what degree, the change in the VBAC rate is due to the change in the characteristics of the obstetric population, the undertaking of a trial of labour (TOL), or the tendency to abandon a TOL once it has been initiated.

Methods

Between 1999 and 2002, 19 academic medical centers belonging to the *Eunice Kennedy Shriver* National Institute of Child Health and Human Development Maternal-Fetal Medicine Units Network contributed to a registry of all pregnant women with a prior caesarean who delivered at their institutions. Women were identified for this registry by study personnel, who identified all cases by screening the labour and delivery logbook or database at each participating center daily. Full details of this registry, which included demographic data, medical and obstetric history, and intrapartum and postpartum events, have previously been published.⁶ From this registry, a multivariable logistic regression model was derived in which several factors (maternal age, BMI, race, history and timing of prior vaginal delivery, indication for prior caesarean) were identified as being significantly associated with successful TOL, and that allowed the estimation of an individual woman's chance of achieving a VBAC if a TOL was undertaken. This model was well calibrated, with an estimated likelihood of VBAC that reflected a patient's empirical likelihood. A full description of this model's development and assessment has been previously published.⁵

In the present analysis, we utilized data from all women in the registry with a vertex singleton gestation at term (at least 37 weeks of gestation) and one prior low-transverse

caesarean. This group was chosen for analysis given that the multivariable model was derived from this population, and also because this population accounts for the large majority of women who undergo a TOL. Women with a placenta previa or an antepartum intrauterine fetal demise were excluded from data analysis. Furthermore, the study was limited only to women who delivered at the eight institutions who contributed to the registry for all four years. This was necessary to ensure that any temporal changes that were noted reflected only intra-institutional differences. It should be noted that the factors associated with TOL success in this cohort were discerned after all data had been collected in the registry, thus precluding the possibility that results of the multivariable model may themselves have affected practice.

Initially, the overall VBAC rate for the population was calculated. VBAC rate was defined, according to standard practice, as the percentage of women who were eligible for a TOL who have a VBAC. The VBAC rate was stratified by year of the study, and a comparison of the year-to-year rate was performed.

All women who were eligible for a TOL then had their probability of VBAC calculated. It should be noted that this includes women who did and did not choose to undergo a TOL. Women were categorized by the deciles of their risk-adjusted probability of VBAC according to the following scheme: $\leq 40\%$, 41-50%, 51-60%, 61-70%, 71-80%, 81-90%, $>90\%$. The percentage of TOL-eligible women in each “predicted chance of success” decile was determined and stratified by each study year. In order to determine whether there was any change in demographic characteristics relevant to TOL success during the period of study, we compared the year-to-year changes in the median probability of the TOL-eligible population achieving a VBAC as well as the percentage of TOL-eligible women in each decile.

The next analysis was performed to discern whether eligible women were less likely to undertake a TOL, and whether this change in likelihood was distributed evenly across the population, regardless a woman’s chance of VBAC success. Thus, the percentage of women in each decile who underwent a TOL was calculated and stratified by year of the study, and it was determined whether this percentage within each decile changed over the period of study. For example, the women who had a $>90\%$ success rate were identified, and the percentage of those within this group who chose a TOL was compared among the four years of the study.

Lastly, women who underwent a TOL were further analyzed. The percentage of these women who achieved a VBAC, stratified by decile and year of the study, was calculated, and it was determined whether the percentage within each decile changed over the period of study. This analysis provided information with regard to whether the probability of abandoning a TOL once it had been initiated changed during the period of study.

For all statistical tests, nominal two-sided P-values are reported with statistical significance defined as a P-value < 0.05 . Comparisons of trends in percentages over the years of the study were performed with the Cochran-Armitage test while comparisons of trends in continuous variables were performed with the Kendall’s correlation test. Comparison of medians was performed with the Kruskal-Wallis test. Multivariable logistic regression was utilized to assess the potential confounding effects of geographic variation by controlling for each center. Risk ratios and 95% confidence intervals are reported when appropriate.⁷ SAS (SAS Institute, Cary, North Carolina) was used for analysis. Approval for the study was obtained from the Institutional Review Board of each institution.

Results

From 1999 to 2002, 14,276 women who were eligible for a TOL and met inclusion criteria received care at the 8 institutions that enrolled women during all four years of the caesarean registry. Nine-thousand six hundred and forty three women had all variables necessary for prediction of success and, consequently, these women form the study group for the rest of the analysis.

During the period of analysis, 5334 women (55.3%) underwent a TOL, of whom 3968 (74.4%) were successful. Thus, the VBAC rate for the study group during the period of analysis was 41.2%. This rate significantly declined during the period of study, from 51.8% (1267/2448) in year 1, to 45.1% (1121/2484) in year 2, to 37.4% (862/2303) in year 3, and to 29.8% (718/2408) in year 4 ($P < 0.001$).

Women's characteristics, which are included in the predictive model, stratified by year of delivery, are presented in Table 1. As noted, although not great in magnitude, there were changes in the population during the period of study, as women were more likely to be older, have a greater BMI, and be Caucasian. Conversely, they were less likely to have had a prior vaginal delivery or VBAC. These changes combined in such a way that over the four years of the study, there was a small but statistically significant ($P < 0.001$) change in the median (interquartile range) risk-adjusted probability of TOL success: 71% (57% – 84%) in 1999; 70% (57% – 84%) in 2000; 69% (56% – 83%) in 2001; and 68% (55% – 81%) in 2002. The trend test was also significant ($P < 0.001$). Table 2 presents the distribution of TOL-eligible women further stratified by their predicted chance of VBAC success. For example, of eligible women who delivered in 1999, 6.0% had a predicted chance of VBAC of $\leq 40\%$. As illustrated, from year to year, there was some change in the population, as there were slightly fewer women with a predicted probability of successful VBAC $\geq 81\%$ and slightly more women with a predicted probability of successful VBAC of 51-70%.

During the period of study, women became significantly more likely to forego a TOL. After 68.4% (1674/2448) of eligible women underwent a TOL in 1999, this frequency changed to 60.5% (1503/2484) in 2000, 49.9% (1149/2303) in 2001, and 41.9% (1008/2408) in 2002 ($P < .001$). Presented in table 3, further stratified by predicted probability of VBAC, are the percentage of eligible women who underwent a TOL. Regardless of their chances of success, women were significantly more likely to forego a TOL over the years of study.

Once women underwent a TOL, the chance that they had a VBAC remained relatively stable. In 1999, 75.7% (1267/1674) of women succeeded in the TOL; in 2000 74.6% (1121/1503) succeeded; in 2001, 75.0% (862/1149) succeeded; and in 2002, 71.2% (718/1008) succeeded ($P = 0.03$). Table 4 presents the percentage of women further stratified by predicted probability of VBAC, who after having begun a TOL ultimately achieved a VBAC. The data in the table demonstrate that the percentage within any decile of predicted probability remained relatively similar throughout the period of study, and there was no predominant pattern; in the majority of decile categories the p-value was not significant, while in a few it showed a slight decrease in the chance of VBAC success once a TOL was undertaken.

Of note, results were similar after multivariable analyses were used to adjust for any potential confounding due to center-to-center variation.

Discussion

In this analysis of over 9000 women who delivered at 8 geographically disparate institutions, the VBAC rate decreased during the four years of the study. This pattern in the

VBAC rate mimics the pattern that has been reported throughout the United States.¹ This analysis, moreover, elucidates the underlying reason for this decline. While a small contribution was made both by a population that had increasingly less favorable characteristics (e.g. greater BMI's) for TOL success (Table 2) and that was a slightly less likely to have a VBAC once a TOL was undertaken (Table 4), the greatest contribution was from the increase in repeat caesareans without a TOL (Table 3). The change in approach also is notable for its relative insensitivity to a woman's chance of having a successful TOL, as the risk ratios for the decline in TOL attempts were similar in women with widely varying chances of VBAC.

This analysis further demonstrates that there has not been a large or pervasive decline in the frequency with which women achieve a VBAC once a TOL is undertaken. One contributor to a declining VBAC rate could be that physicians and/or patients are more likely to abandon a TOL after it had been initiated. However, this contention is not supported by the data from the population under study. As illustrated in Table 4, women have maintained relatively constant success rates for TOL throughout the years of the study. In fact, as can be seen from the stratified data, these rates generally have remained within the ranges of success predicted by the regression model.

Although the decline in the VBAC rate is a well known phenomenon, the exact reasons for it decline have not been extensively studied. One group of investigators who did attempt to discern these underlying reasons studied New York birth certificate data.⁸ Their analysis concluded that the predominant factor for the decreasing rate of VBAC was the decreasing tendency to undergo a TOL, and that there had been little change in achieving a VBAC once a TOL was undertaken. There are several distinguishing characteristics between that analysis and the present study. These investigators limited their study to a single geographic region, which limited generalizability of the conclusions to the rest of the country. Also, they utilized birth certificate data, which limited their ability to account for potential changes in their study population. The ability to account for these changes is a very important step toward understanding the actual dynamics of the situation. For example, if the population were increasingly composed of women who had lower probabilities of VBAC success, the reasons for decline in TOL could be very different than if the population's characteristics had remained stable. Conversely, a lack of change in VBAC success need not be due to a temporal consistency in the approach to patient care, given that such a finding would also be present if women who underwent a TOL were increasingly selected from among candidates with the most favorable chances.

In the present analysis, the use of the previously published regression allows the calculation of individual-specific VBAC success rates and the stratification of women by these rates. This model, which incorporates six patient factors (maternal age, race, and BMI, history and timing of prior vaginal delivery and prior indication for caesarean), essentially allows the population to be risk adjusted in order to account for confounding differences in the population over time. Thus, the patient population can be stratified by their risk for caesarean in order to provide insight into whether changes in the choice of undergoing a TOL or the abandoning of a TOL are related to the changes in a population's characteristics or to the approach to patient care. This analysis clearly demonstrates that changes in approach are at the heart of the changes in the VBAC rate. As noted, while there have been some change in the characteristics of the population that are most relevant to VBAC success, the changes in predicted probability of VBAC are relatively limited (Table 2). And, women with similar potential for this success continue to have relatively similar rates of success once a TOL is initiated (Table 4). Yet, from year-to-year, women with a similar potential to achieve a VBAC have chosen TOL less and less frequently to a large degree (Table 3).

This analysis does not necessarily account for all the different dynamics that have resulted in a lower VBAC rate. As just one example, some of the decline in the national VBAC rate is due to some hospitals removing VBAC as an option for their patients. This analysis, however, was designed not to comprehensively document all contributors to the declining national VBAC rate, but to evaluate those contributors among women who have at least the choice at an institutional level. Also, it cannot be certain that the trends noted among these women are equally present throughout the nation. There is reason to believe, though, that the sample is reflective of a more general population. It was derived from geographically disparate institutions (i.e. from the North, South, East, and West of the US) and socioeconomically diverse patients, with an overall trend in the VBAC rate during the period of study (i.e. an approximately 40% decline) that is similar to that at the national level.⁹ And, as noted previously, the results were similar in several respects to those of Yeh et al, who studied a different population.⁸

Because these data are derived from several years ago, they do not inevitably provide a reflection on the current dynamics with regard to VBAC. However, we believe this data is still valuable to analyze for several reasons: it is unlikely any similar registry in terms of size and scope will be repeated; it is unlikely that more recent trends will be able to be as fully assessed given that similarly accurate and extensive data will not be available; and it gives insight into the decline in VBAC that still remains under-analyzed and continues unabated to this day. Also, we cannot determine to what extent the avoidance of TOL is physician or patient driven. There is support from other investigators that at least some of the change in the VBAC is related to professional liability concerns.¹⁰

This analysis allows not just an epidemiologic reflection, but provides potentially useful clinical insights. One remarkable fact about the decline in the VBAC rate is that it has occurred in the context of relatively constant clinical data regarding VBAC. The probabilities of VBAC success and uterine rupture that we understand today, for example, have changed little from the data in studies that were published two decades ago.^{6, 11-13} Thus, since the underlying fundamentals have not changed, the marked decline in the VBAC rate must largely be due to a change in perceptions. As health care providers, it is important that we ensure that our own and our patients perceptions are in accordance with the data that exist, and that we provide them with data regarding VBAC that are as individualized as possible (e.g. with regard to their chance of success) and grounded in the data from clinical investigations.

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Appendix

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Table 1

Patient characteristics stratified by year of delivery

	1999 N = 2448	2000 N = 2484	2001 N = 2303	2002 N = 2408	P*
Maternal age (years)	29.1 (5.6)	29.4 (5.6)	29.5 (5.5)	29.5 (5.5)	0.004
Maternal BMI (kg/m ²)	26.6 (6.2)	26.9 (6.7)	27.0 (6.5)	27.2 (6.6)	0.002
Maternal race					
Caucasian	1452 (59.3)	1592 (64.1)	1455 (63.2)	1508 (62.6)	0.041
African-American	500 (20.4)	460 (18.5)	385 (16.7)	359 (14.9)	<0.001
Latina	407 (16.6)	335 (13.5)	380 (16.5)	434 (18.0)	0.031
Prior vaginal delivery	840 (34.3)	830 (33.4)	730 (31.7)	725 (30.1)	0.001
Prior VBAC after CD	546 (22.3)	525 (21.1)	458 (19.9)	423 (17.6)	<0.001
Recurring indication for CD	1053 (43.0)	1086 (43.7)	1016 (44.1)	1096 (45.5)	0.080

Data presented as mean (standard deviation) or N (%)

BMI = body mass index; VBAC = vaginal birth after caesarean; CD = caesarean delivery

* Kendall's correlation test or Cochran-Armitage trend test

Table 2
Percentage of women eligible for TOL, stratified by year of delivery and predicted chance of VBAC success

	1999 N = 2448	2000 N = 2484	2001 N = 2303	2002 N = 2408	P*	Risk ratio ⁺	95% CI ⁺
≤ 40%	6.0	6.5	5.9	6.5	0.68	1.09	0.87, 1.35
41 – 50%	9.5	8.3	9.4	10.0	0.32	1.06	0.89, 1.25
51 – 60%	14.5	15.1	16.6	16.9	0.01	1.17	1.03, 1.33
61 – 70%	17.8	19.2	20.0	20.6	0.01	1.16	1.03, 1.30
71 – 80%	19.4	19.1	18.9	18.2	0.29	0.94	0.84, 1.06
81 – 90%	16.3	16.0	14.6	14.3	0.02	0.88	0.77, 1.00
> 90%	16.6	15.7	14.8	13.5	0.001	0.81	0.71, 0.93

Data presented as %

⁺ 2002 versus 1999

* Cochran-Armitage trend test

Table 3

Percentage of women eligible for TOL who underwent a TOL, stratified by year of delivery and predicted chance of VBAC

	1999 N = 1674	2000 N = 1503	2001 N = 1149	2002 N = 1008	P*	Risk ratio ⁺	95% CI ⁺
≤ 40%	44.9	35.8	33.3	14.0	<.001	0.31	0.20, 0.48
41 – 50%	55.6	47.8	31.5	28.2	<.001	0.51	0.40, 0.64
51 – 60%	55.7	48.7	35.1	30.0	<.001	0.54	0.45, 0.64
61 – 70%	53.4	46.8	38.9	32.8	<.001	0.61	0.53, 0.72
71 – 80%	70.0	60.4	46.7	37.2	<.001	0.53	0.46, 0.61
81 – 90%	82.2	72.6	68.1	58.4	<.001	0.71	0.64, 0.79
> 90%	95.8	93.4	85.9	83.0	<.001	0.87	0.82, 0.91

Data presented as %

⁺ 2002 versus 1999

* Cochran-Armitage trend test

Percentage of women who had a VBAC after undergoing a TOL, stratified by year of delivery and predicted chance of VBAC

Table 4

	1999 N = 1674	2000 N = 1503	2001 N = 1149	2002 N = 1008	P*	Risk ratio ⁺	95% CI ⁺
≤ 40%	43.9	34.5	31.1	40.9	0.40	0.93	0.53, 1.65
41 – 50%	49.6	41.4	48.5	33.8	0.09	0.68	0.47, 0.99
51 – 60%	50.8	57.1	55.2	52.5	0.74	1.03	0.83, 1.29
61 – 70%	68.2	66.8	62.6	58.9	0.04	0.86	0.74, 1.01
71 – 80%	80.1	77.4	73.9	72.4	0.03	0.90	0.81, 1.01
81 – 90%	84.1	83.4	89.9	81.1	0.98	0.96	0.89, 1.05
> 90%	95.9	94.3	93.8	91.1	0.01	0.95	0.91, 0.99

Data are presented as %

⁺ 2002 versus 1999

^{*} Cochran-Armitage trend test