Chapter 3. Results

Outcome Comparisons

Question 1. Likelihood of Vaginal Delivery

What is the frequency of vaginal delivery in women who undergo a TOL (spontaneous onset, induced, and augmented) after prior low transverse cesarean or unknown scar?

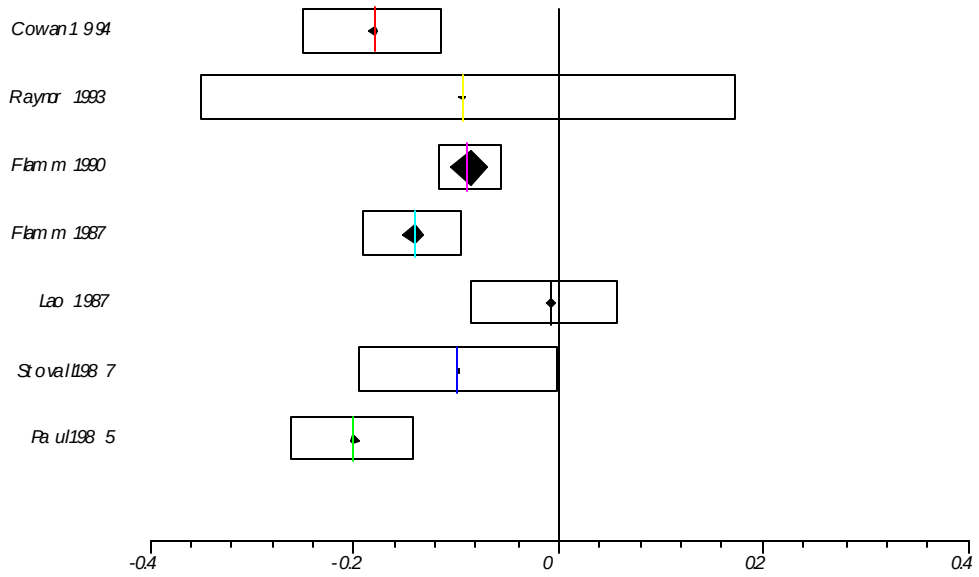
One large good-quality population-based study[5] and eight prospective cohort studies provided the best data on vaginal delivery rates for the general population of women with prior CD.[20-27](Evidence Tables 1 and 2).

In the population-based study, which was performed in Nova Scotia, 3,249 (52.9 percent) of 6,317 women with one prior nonvertical CD chose a TOL, and 1,962 of them (60.4 percent) delivered vaginally.[5] Women attending tertiary care hospitals were at least twice as likely to choose a TOL and more likely to deliver vaginally than women attending regional or community hospitals. The authors did not distinguish vaginal delivery rates for women requiring medical augmentation or induction versus women who did not require medical assistance in labor.

In the prospective cohort studies, largely conducted in university and tertiary care settings, vaginal delivery rates for all women attempting a TOL ranged from 62–82 percent, with a pooled rate of 75.9 (95 percent CI, 69.9 to 81.5).

Seven fair or good quality observational studies[22, 25, 27-31] provided comparisons of vaginal delivery rates for SL and induced or augmented labor. In all of these studies, women who received oxytocin for induction or augmentation were less likely to have a vaginal delivery (Figure 3). On average, 80 percent of women with spontaneous onset of labor delivered vaginally, versus 68 percent of women who received oxytocin.

Figure 3: Vaginal Delivery: Oxytocin versus Spontaneous Onset of Labor
Risk difference, 95% CI



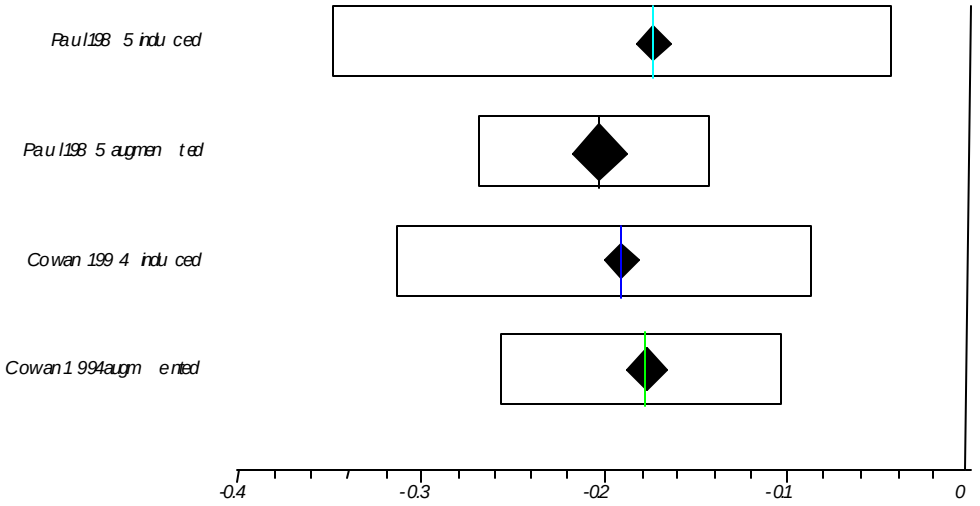
	# Oxytocin	# Oxytocin VBAC	# SL	# SL VBAC
Cowan 1994 [25]	234	163	359	315
Raynor 1993 [29]	25	14	26	17
Flamm 1990 [22]	1201	831	2756	2146
Flamm 1987 [28]	485	309	1291	1005
Lao 1987 [31]	137	112	529	436
Stovall1987 [27]	133	98	139	116
Paul 1985 [30]	289	200	443	395

*The vertical line, at "0", indicates no effect. The study mean is indicated by a vertical line surrounded by a diamond. The size of the diamond indicates sample size in relation to the other studies on the plot. The rectangle represents the 95 percent CIs around the study mean. If the rectangle is entirely to the left of the line the difference is statistically significant and oxytocin is associated with a decrease in achieving vaginal delivery compared to spontaneous onset of labor.

Two observational studies reported rates for induction and augmentation separately.[25, 30] In one of these studies the vaginal delivery rate of patients requiring oxytocin induction was lower than that of patients requiring only augmentation (risk difference 1.4 percent),[25] while in the other study the rate was slightly higher (risk difference 3 percent).[30] Neither finding was statistically significant (Figure 4).

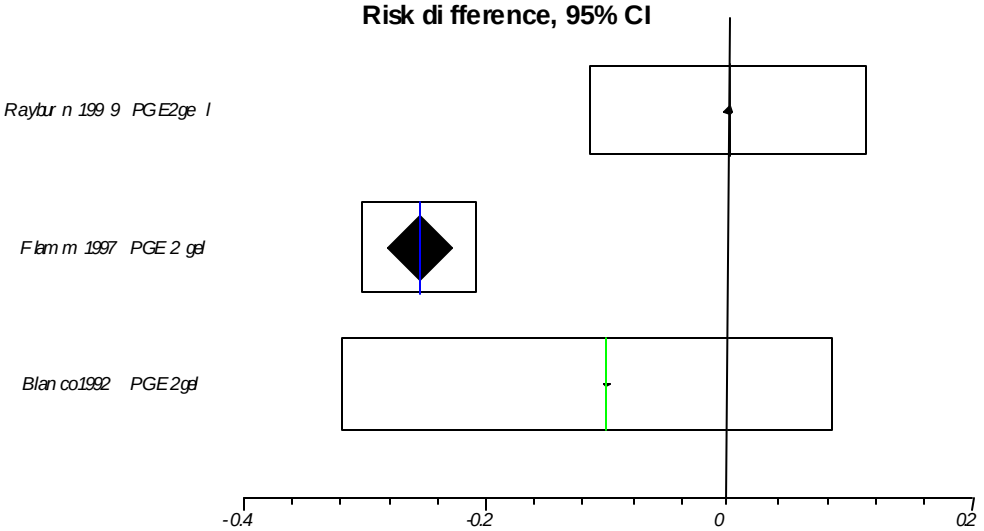
In comparing prostaglandins (any type) with spontaneous labor (Figure 5), the largest study found a significantly lower rate of success among patients induced with PGE2, than in those undergoing spontaneous labor, while two smaller studies did not find a significant effect.

Figure 4: Vaginal Delivery: Oxytocin (Induction or Augmentation) vs No Oxytocin
Risk difference, 95% CI



Study	# Induced	# Induced VBAC	# SL	# SL VBAC
Cowan 1994 induced [25]	67	46	359	315
Cowan 1994 augmented [25]	167	117	359	315
Paul 1985 induced [30]	32	23	443	395
Paul 1985 augmented [30]	257	177	443	395

Figure 5: Vaginal Delivery: Prostaglandins versus Spontaneous Onset of Labor
Risk difference, 95% CI



Study	# Induced	# Induced VBAC	# SL	# SL VBAC
Rayburn 1999 [32]	143	70	151	74
Flamm 1997 [33]	453	233	4569	3513
Blanco 1992 [34]	25	18	56	46

Although the results of the observational studies are generally consistent, these studies are inherently limited by confounding. Even in studies that controlled statistically for several potential confounders, the risk of requiring CD might be increased by the indications for medication for induction and augmentation, rather than the medication itself.

Two RCTs[32, 35] also provided information regarding vaginal delivery rates for medical augmentation or induction of labor. Neither RCT compared medicated to spontaneous nonmedicated labor because medical induction and augmentation of labor were allowed in both intervention and controls. One trial compared expectant management with administration of prostaglandin E2 (PGE2) gel for cervical ripening at weekly intervals from 39 to 41 weeks' gestation, for the same time period.[32] Oxytocin was used in both groups for augmentation or induction as needed. This study found a VBAC delivery rate of 49 percent in both intervention and expectant management. The second RCT compared mifepristone versus placebo for 2 days followed 2 days later by induction with prostaglandins, oxytocin, and/or artificial rupture of membranes as needed.[35] The VBAC delivery rates were 69 percent for the mifepristone group and 50 percent for controls.

Data were insufficient to determine whether there was a relationship between the dose of induction agents and the vaginal delivery rate. Only one fair-quality study reported data on the mean, range, or maximum doses.

Summary

- Rates of vaginal delivery when attempting TOL ranged from 60-82 percent. The largest population-based study reported a rate of 60.4 percent. The combined vaginal delivery rate for all prospective cohort studies, largely conducted in university or tertiary care settings, was 75.9 percent
- There was a 10 percent reduction in the likelihood of vaginal delivery when oxytocin was used for ether induction or augmentation. There was a similar trend for prostaglandins.

Question 2. Predictive Tools

How accurate are risk assessment tools for identifying patients who will have a vaginal delivery after a TOL?

It is important to know which patients are most likely to have an uncomplicated vaginal delivery. Several predictive tools attempt to identify groups of women at higher likelihood of vaginal delivery. Evidence Table 3 summarizes 14 studies that describe various methods for determining who will most likely succeed at a TOL and who will not. We divided these risk assessment tools into two categories: (1) tools involving a *scoring system* based on clinical or historical factors, and (2) tools involving various *imaging modalities.*

Scoring Systems

Seven studies[36-42] evaluated the use of various scoring systems in predicting the likelihood of VBAC with TOL. These studies included one prospective cohort,[36] four retrospective cohorts,[37, 40-42] and two case-controls.[38, 39] (Evidence Table 3a). All of these studies developed their scoring

systems by looking at a wide array of variables in their corresponding populations and then by combining into one model those variables significantly associated with TOL outcome. These variables were then assigned a score or point value based upon their ORs, regression model standardized beta coefficients, or simply by their presence or absence.

The only study of scoring evaluation that received a good-quality rating was the multicenter prospective cohort by Flamm.[36] The authors collected information on 5,003 women who attempted a TOL (69.2 percent of the 7,229 patients with prior CD). The sample was randomly split into a score development group (n = 2,502) and a score-testing group (n = 2,501), which were found to be similar with regard to age, race, and ethnicity. Information regarding ten different variables was collected from the score development group and possible associations with the TOL outcome were investigated using chi-square analysis for categorical variables and Student *t* tests for continuous variables. Those variables found to be significant at the $p < 0.05$ level in the univariate analyses were then entered into one of three logistic regression models, based on whether they were a historic, intrapartum, or perinatal factor. Those factors found to be significant at the $p < 0.05$ level in any of three models were subsequently entered into a final logistic regression model (3.5 percent of subjects were excluded due to missing data), which was used to identify the five predictor variables of the scoring system. Points ranging from 0 to 4 were assigned to each variable based on the Beta coefficient from the model (Table 2). The resulting scoring system was prospectively validated in the 2,501 women of the score-testing group. Patients with scores of 0 to 2 points had a VBAC delivery rate of 49.1 percent, while those who had scores of 8 to 10 points had a 94.9 percent chance of success (Table 3).

Table 2. Flamm Scoring System Tool: Included variables and point values

Variable	Beta Coefficient	Point Value
Age under 40 years	0.95	2
Vaginal birth history		
Before and after 1st cesarean	2.21	4
After 1st cesarean	1.22	2
Before 1st cesarean	0.43	1
None	Referent	0
Reason other than FTP for 1st cesarean	0.66	1
Cervical effacement at admission		
> 75%	1.00	2
25% - 75%	0.58	1
<25%	Referent	
Cervical dilation 4cm or more at admission	0.77	1

Taken from Flamm, 1997[36]

Table 3. Flamm Scoring System Tool: Performance of Admission Score in the score testing group

Score	# of subjects with score	% of subjects with VBAC
0 to 2	114	49.1
3	329	59.9
4	595	66.7
5	660	77.0
6	360	88.6
7	189	92.6
8 to 10	158	94.9
Total	2405	74.9

Taken from Flamm, 1997[36]

One other risk prediction tool was developed and validated in different populations.[40] This tool was created using a retrospective study design of ten different variables from 264 patients (46.6 percent of the 567 patients with a prior CD). Using Student *t* tests, chi-square analyses, and Wilcoxon rank sum tests, four variables were found to be significantly different (at the $p < 0.05$ level) between those with a successful TOL and those with an unsuccessful TOL. These four variables were subsequently selected for use in a scoring system tool after these patients were also found to have significantly lower VBAC rates when compared with the overall VBAC rate for the cohort. All four of these variables were weighted equally in the scoring process, where one point was given for every variable present. Patients with scores of 0 points had a VBAC delivery rate of 91.5 percent, while those with scores of 3 to 4 points had a 46.1 percent chance of success (Table 4). Success rates in a validation study using a separate sample of 263 patients are shown in Table 4. Subjects in the 0 point group had a success rate of 98 percent, versus 33 percent in the group with 3 to 4 points.[41]

Table 4. Scoring System Tools: Relationship of risk score to successful VBAC

	Troyer, 1992[40]			Vinueza, 2000[41]		
Score	Total # of subjects	% of subjects with VBAC	% False Positive/ Negative	Total # of subjects	% of subjects with VBAC	% False Positive/ Negative
0	59	91.5	2	56	98	0.4
1	92	73.9		106	69	
2	87	66.7		74	40	
3 to 4	26	46.1	5	27	33	3
Overall	264	74.9		263	63	

Other scoring systems were developed retrospectively and have not been validated in a second sample.

Would these prediction tools be useful in practice? The probability that a woman would have a vaginal delivery is likely to influence her enthusiasm about trial of labor. Additionally, women who have a cesarean after a lengthy trial of labor are more likely to sustain adverse events such as uterine rupture or infection. Therefore, a tool that could accurately predict a woman's likelihood of achieving vaginal delivery with minimal adverse sequelae would be of interest to

clinicians and patients. The value of a prediction tool depends on how it affects decisions about the likelihood of false positive and false negative tests (e.g., its accuracy), and the relative costs (harms) of false positive and/or negative results. The vaginal delivery rate in Flamm's population (e.g.. the overall rate of vaginal delivery), was 74.9 percent. Thirty percent of his population would be predicted to have a high probability of vaginal delivery (e.g., score or 6-10), and 18 percent were predicted to have a low likelihood of vaginal delivery (e.g., scores of 0-3). Slightly over half of the population would gain no additional information from using the predictive tool. Ten percent of the population or 253/2,405 may have been advised to have a cesarean, due to tool's prediction of low likelihood of vaginal delivery, when they would have been able to have a vaginal delivery. This may be acceptable as the harms of having a repeat cesarean may be low. What may be of higher concern is the false positive rate, or the chance that the tool would have encouraged TOL but the patient ended up with a cesarean. This is of higher concern because this group is of higher likelihood of sustaining complications from TOL such as infection and uterine rupture. This tool has a relatively low false positive rate of 2.6 percent (63/2405). Troyer's population had a similar vaginal delivery rate of 73 percent. The tool only provided additional information, to 32 percent of the population, with 22 percent predicted to have a high chance of vaginal delivery (e.g. score of 0), and 10 percent predicted to have a low chance (e.g. score of 3 or 4). This tool had a similar false positive rate of 2 percent (5/264), and slightly improved false negative rate at 4.5 percent (9/264). When this tool was used in a population with a lower pretest probability for vaginal delivery, both the false positive rate and false negative rate improved. Vinueza's population had a 63 percent vaginal delivery rate, 21 percent were predicted to have a high chance of vaginal delivery, and 10 percent a low chance. The false positive rate fell to 0.4 percent (1/263) and the false negative rate also fell to 3 percent (9/263). Thus, Flamm's tool may be preferred, from a diagnostic test perspective, due to an ability to stratify more of the population into high and low probability subgroups with a low false positive rate.

Imaging Modalities

Seven studies[43-49] examined the role of imaging modalities in predicting the outcome of a TOL after prior CD. In these studies a variety of imaging factors were considered, including the two fundamental aspects of labor: passage (pelvic dimensions) and passenger (fetal dimensions).

Four studies[44, 45, 47, 49] focused primarily on the imaging of the passage using X-ray pelvimetry (XRP). Of these studies, three were retrospective cohorts [44, 45, 49] that were given poor-quality ratings because of inadequate control of confounding or effect modifiers, unequal application of measurements, and unidentified patient spectrum composition. The fourth study was a good-quality RCT by Thubisi.[47] Half of the 288 subjects were assigned to receive an antepartum XRP evaluation; the remaining subjects were allocated to the postpartum XRP evaluation group. Of those in the antepartum group, 84 were considered to have an adequate pelvis and 23 of these delivered vaginally (27.7 percent). All of the patients considered on antepartum XRP to have an inadequate pelvis had an ERCD. Of those in the postpartum XRP group, 41.6 percent (60/144) delivered vaginally. In the postpartum XRP group considered to have an inadequate pelvis based on clinical examination, 60 percent (33/55) had a vaginal delivery, compared with 30 percent (27/89) of those considered to have an adequate pelvis. This study provides strong evidence that XRP is a poor predictor of TOL outcome and might unnecessarily increase CD rates.

Three poor-quality prospective cohort studies[43, 46, 48] examined the value of a scoring system based on a variety of fetal and maternal pelvic measurements and calculated circumferences (fetal head, fetal abdomen, pelvic inlet, and midpelvis), to predict vaginal delivery. Two[46, 48] of the three studies that focused on the fetal-pelvic index found that it was significantly associated with vaginal delivery; however, all three studies lacked adequate control for confounders and suffered from verification or workup bias.[18]

Summary

- Two validated scoring systems categorized women into groups with likelihoods of vaginal delivery ranging from roughly 45-95 percent.[36, 40]
- Flamm's tool was able to stratify more of the population into high and low probability subgroups, with a relatively low false-positive rate.[36]
- By using a prospective cohort design and the largest study population, the best scoring system created a 10-point score based on the presence or absence of five variables commonly available for most patient admissions.[36]
- An RCT clearly demonstrated the inability of XRP to predict route of delivery reliably.[47]
- Imaging studies that combined the measurements of the pelvis and fetus showed promising results, but were limited by their lack of control for confounding and biases.[46, 48]

Question 3. Maternal and Infant Outcomes

What are the relative harms associated with a TOL (spontaneous onset, induced, and augmented) and repeat CD?

No controlled trials directly compare the harms of a spontaneous TOL (without medical induction or augmentation), a medically augmented or induced TOL, and ERCD. The ideal study would compare the outcomes of women who were similar in every respect except that some had elected a TOL and others an ERCD. The ideal study would also determine whether, in the setting of VBAC, complications were associated with SL or only with labors in which oxytocin was used for induction or augmentation.

We examined 10 fair-or-better-quality observational studies that compared rates of maternal and/or infant complications with a TOL versus ERCD. Two of these were large, retrospective, population-based studies.[5, 6] The other eight were prospective cohort studies: three large multi-center studies,[20-22] one large single institution study,[23, 30] one small multi-center study,[24] and three small single institution studies.[25-27] These studies provide indirect rather than direct evidence because factors other than the women's preferences contributed to the decision to have an ERCD or a TOL (Evidence Tables 4a and 5a).

Characteristics of these studies are described in Evidence Table 1. In most of the studies, patients who received oxytocin and those who did not were not analyzed separately. Both large population-based studies reported that medical induction and/or augmentation of labor was performed in this population, but they did not separate these groups from SL. All 10 prospective studies reported that oxytocin was used for augmentation or induction in their TOL group; only three[22, 25, 27] looked separately at the effect of oxytocin when used for augmentation or induction

within this larger population. Demographic data reported were inconsistent, making comparisons difficult across studies, or even across groups within the studies.

Maternal Complications

Three maternal complications were investigated: major maternal hemorrhage (requiring transfusion or hysterectomy), maternal infection (as manifested by endomyometritis, wound infection, and/or postpartum/puerperal fever), and maternal death (uterine rupture is detailed in question 4). While not all articles addressed each maternal complication, several addressed key aspects of these sequelae.

Two good-quality studies[5, 20] provided information concerning both transfusion and hysterectomy rates. Rates of maternal hemorrhage requiring transfusion were 1.1 percent in the TOL group versus 1.3 percent for repeat CD in the large population-based study (NS)[5] and 0.72 percent versus 1.72 percent for the prospective cohort study (p=.0001).[20]

While several studies provided information concerning hysterectomy, none specifically documented the indication for hysterectomy. Comparisons between TOL and elective CD were reported in three studies.[5, 20, 30] The best evidence comes from the one large population-based study[5] that found no difference in hysterectomy rates in TOL (0.2 percent) versus ERCD (0.2 percent). Unlike the two prospective studies reporting this outcome, McMahon attempted to exclude "elective" repeat CDs for medical or obstetric indications such as placenta previa.

The two prospective cohort studies reported higher hysterectomy rates in repeat CD: 0.12 TOL versus 0.27 percent ERCD[20] and 0.27 TOL versus 3.2 percent in ERCD.[30] These provide weaker evidence because the cesarean group may have included women who had an indication for CD and would not have been candidates for a TOL. In fact, in the latter study, Paul mentions that only 62 of the 157 "elective" repeat CD group were considered to be eligible for TOL. Thus it is possible that the higher rates of hysterectomy could be due to medical or obstetric conditions such as hemorrhage secondary to placenta previa. Hysterectomy rates were reported in only one induction study, reporting 0.2 percent in induced and 0.08 percent in SL patients.[28] Overall, there was a trend toward increased risk for hysterectomy in induced labor (increased risk 0.12 percent) and ERCD (increased risk 0-3 percent). These studies did not specify whether hysterectomies were performed for hemorrhage or other indication (cervical cancer, myomatous uterus).

Studies reporting maternal infection rates are limited by lack of explicit definitions or by combining many sources of infection, which make specific clinical insights limited. No study provides data on the risk for spontaneous TOL that is free from medical augmentation. Two studies[5, 24] defined infection clearly and compared the incidence in TOL and ERCD groups. Both definitions combined puerperal infection and abdominal wound infection. In the larger study,[5] which defined maternal infection as puerperal fever (temperature >38 degrees C; uterine, urinary, pulmonary, or wound infection; or sepsis) or abdominal wound infection, the rates were 5.3 percent in TOL versus 6.4 percent in ERCD. Subgroup analyses found that women who had a TOL but did not delivery vaginally (e.g. failed TOL), had significantly higher infection rates than women who were able to deliver vaginally (failed TOL 8 percent versus successful TOL 3.5 percent). This finding was reported consistently among prospective cohort studies that performed similar subgroup analyses[23, 26, 30] (11 to 30 percent increased risk of infection for failed TOL). The other study, a fair-quality prospective cohort,[24] reported maternal infection rates (including endomyometritis and wound infection) of 6.79 percent in TOL versus 9.73 percent in ERCD.

Compared with spontaneous onset of labor, there appears to be a trend toward increasing risk of infection when labor is induced (1-4 percent increased risk) and with ERCD (2-3 percent increased risk). However, only one study of induction agents evaluated this outcome, and found zero in the induced group and 5 percent in the SL group.[34]

Six studies examined maternal death rates. The large population-based study found no maternal deaths in either TOL or ERCD groups totaling 6,138 women.[5] In five prospective cohort studies involving approximately 19,000 patients, there were two deaths among women having a TOL and two among women having a repeat CD.[20-23, 27] No maternal deaths were mentioned in any studies of induction of labor (n = 7,525).

Infant Outcomes

APGAR scores. There are insufficient data to compare infant Apgar scores for a TOL versus ERCD. In one fair-quality prospective cohort study,[20] more infants born from TOL had 5-minute Apgar less than 7 (1.47 percent versus 0.68 percent, p=.004).[20]

Infant death. No study has measured infant death directly attributable to a mother's choice of TOL or repeat CD. Two large, population-based studies provide information about whether TOL poses increased risk of infant death compared with ERCD.[5, 6] Each has important strengths and limitations. One study[5] (n = 6,138) reported perinatal death rates of 9/1,000 in the TOL group versus 5/1,000 in the repeat CD group for women with one prior CD. The strength of this study was its ability to identify a conceptual cohort of women with one prior low transverse CD who attempted TOL or repeat CD. However, no details were provided on these deaths (e.g., whether infants with lethal anomalies were included), so it is not possible to determine whether these deaths were attributable to labor or cesarean.

A more recent population-based study from Scotland[6] did exclude all perinatal deaths associated with lethal anomalies and medical conditions; however, they did not do a good job of classifying patients as TOL and ERCD. To ascertain the perinatal death rate attributable to delivery method, the authors excluded all deaths associated with congenital anomalies, antepartum stillbirth (intrauterine fetal death), multiple gestation, and noncephalic presentation. Additionally, they excluded all primary CDs. They divided all remaining deliveries into women with no prior CD who were nulliparous or multiparous, and women with prior CD who delivered by planned repeat CD or TOL. The TOL group was defined as any vaginal delivery or emergent CD regardless of intended delivery route.

There were 20 deaths in 15,515 TOLs for a rate of perinatal death of 12.9/10,000 (95 percent CI, 7.9 to 19.9) versus one in 9,014 repeat CDs for a rate of 1.1/10,000 (95 percent CI, 0.0 to 6.1), and 135 in 137,630 nulliparous women without prior CD for a rate of 9.8 (95 percent CI, 8.3 to 11.6), and 90 in 151,549 multiparous women without prior CD for a rate of 5.9/10,000 (95 percent CI, 4.8 to 7.3). This study is discussed in significant detail in this report because it has not been reviewed in the literature to date.

The authors emphasized that the infant death rate was 11 times higher in women choosing TOL than in those having a CD, corresponding to one additional infant death for every 849 patients. The rate of infant death in women choosing TOL was similar to primiparous women having a vaginal delivery. This would indicate that the woman choosing TOL is not assuming considerable additional risk for her infant in choosing TOL in the second pregnancy. However, the rate of infant death for repeat CD patients appears to be spuriously low. The cesarean group may be low due to misclassification because all emergent CDs and vaginal deliveries were

classified as TOL regardless of intended route of delivery. There were 20 perinatal deaths in the TOL group; eight were delivered vaginally and 12 were emergent CDs. If only three of these deaths were misclassified (e.g., women intending elective repeat who required emergent CD), there would not be a statistically significant difference between perinatal death rates in TOL and repeat CD groups. One study examined the rate of emergent CDs in each group.[30] They report that two of nine (22 percent) emergent cesareans performed for fetal distress were performed for women who desired repeat cesarean. If this proportion were applied to Smith's emergent cesarean perinatal deaths, three of the 12 would have been expected to occur in the planned repeat cesarean group and 9 in the TOL group. This small change would eliminate the statistically significant difference that was observed. Another potential source of misclassification that would decrease the risk of planned CD compared with TOL is in the antepartum stillbirth data, all of which were excluded.

Even though the authors went to great lengths to consider confounding, there is still substantial detail missing in understanding the context in which these perinatal deaths occurred. For example, the authors were unable to determine the type of prior CD scar (classical, vertical, etc.). To exclude women who might have had classical incisions, they excluded all births that occurred before 40 weeks' gestation, with the thought that women with known prior classical incisions are generally delivered by cesarean before 40 weeks. In confining their sample to those women who delivered at 40 weeks or greater, they might have introduced an additional confounder in that risk of perinatal death increases with higher gestational age, especially 42 weeks and greater. In fact, when they looked at gestation less than 39 weeks versus greater than 39 weeks, they found only three deaths between 37 and 39 weeks, all of which had PGE2 induction of labor. One question that arises is in the group that was greater than 39 weeks' gestation: what proportion of the perinatal deaths were in infants who were 42 weeks' gestation or greater? One of the greatest concerns for women with prior CD is the risk of uterine rupture, and the resulting potential for maternal or fetal morbidity and mortality.

This study did not specifically examine the subset of perinatal deaths attributable to uterine rupture. Uterine rupture was combined with cord compression/prolapse, birth trauma, and asphyxia associated with disproportion in a category called "mechanical" causes. These events are all limited to vaginal delivery; therefore, it is not surprising that the authors found seven perinatal deaths attributed to "mechanical" causes in TOL and none in CD. Additionally, it is not clear how TOL versus planned repeat CD were classified (post-hoc or intention).

Another potential confounder is the use of induction and augmentation agents. The study reports deaths from 1992 to 1997, but does not describe how often induction agents were used, or in what doses, across Scotland during those years. Fifteen percent of their population with prior CD had PGE2 induction of labor. There was no association between PGE2 induction and increased risk of infant death. Although oxytocin was used, the authors were not able to examine whether oxytocin posed any increased risk. Communication with the authors revealed that oxytocin would be used for women with prior CD and premature rupture of membranes, but is not frequently used to augment women for failure to progress during labor.

Importantly, the population-based studies do not describe the likely outcomes of high-quality obstetric care. Even if one accepts that the increased infant death rate in the TOL group is real, the studies do not suggest an answer to the question, "Is there an increased risk of infant death in a properly managed TOL?"

Fifteen studies of induction agents reported infant mortality. Of these, 11 found no deaths in any group studied.[22, 25, 27, 29, 30, 32, 34-36, 50, 51] In the other four, no consistent pattern emerged

favoring spontaneous or induced labor.[6, 28, 31, 52]

In summary, there appears to be a trend toward increased risk of fetal death for TOL versus ERCD. Although these studies attempted to account for some confounders, their retrospective nature makes it impossible to determine whether the method of delivery is responsible for any increased risk. The validity of the recent publication from Scotland is uncertain because the infant death rate in the CD group appears to be spuriously low, deaths were not directly linked to uterine rupture, some antepartum deaths could have been misclassified, and the TOL group included women who really intended to have an ERCD.

Summary

Maternal Complications

- Maternal death rates did not differ between TOL and ERCD.
- The best evidence suggests that hysterectomy rates do not differ between TOL and ERCD.[5]
- Rates of infection were increased in ERCD versus TOL (8.6–9.73 percent versus 6.6–6.79 percent).[5, 24]
- Studies consistently reported significantly increased risk of infection for women who had a TOL but ultimately ended with a cesarean delivery (e.g. failed TOL).
- There is conflicting evidence regarding whether induction of labor had any effect on infection rates.

Infant Outcomes

- There is insufficient evidence regarding the effect of selected route of delivery on APGAR scores.
- No study has measured infant death directly attributable to a mother's choice of TOL or repeat CD.
- Studies to date, consistently suggests that infant death may be increased by TOL versus ERCD. The degree of increased risk is uncertain (90/10,000 TOL versus 50/10,000 ERCD[5] compared with 12.9/10,000 TOL versus 1.1/10,000 ERCD.[6])

Question 4. Uterine Rupture

What is the incidence of uterine rupture, and are there methods for preventing major maternal and/or infant morbidity from uterine rupture?

One of the greatest concerns for patients, providers, hospitals, and policymakers regarding VBAC is the potential for devastating consequences from uterine rupture, such as infant death and maternal hemorrhage necessitating hysterectomy. To determine how frequently uterine rupture occurs, people must agree on what it is. Terminology and definitions vary in usage among studies (Evidence Table 6a). Terminology does not explictly differentiate uterine ruptures of the cesarean scar separation from those due to other causes.

Terms used to describe the severity of uterine ruptures are also used inconsistently. For

example, the term "dehiscence" is frequently thought to signify an incidental finding of a cesarean scar defect either at cesarean or uterine exploration after vaginal delivery. However, among the 10 studies that use this term, three[26, 30, 53] used the term to include symptomatic uterine rupture. The terms "complete" or "true," which were used to modify "uterine rupture" in 13 studies,[5, 6, 20-25, 27, 50, 54-56] had several inconsistent definitions, such as separation requiring operative intervention—e.g., emergent cesarean performed for maternal bleeding or FHR tracing abnormality associated with detecting a scar separation at cesarean; extrusion of fetus found at cesarean performed for failure to progress, scar with bleeding, hematoma formation, or extrusion of the fetus; scar rupture accompanied by intra-abdominal bleeding; or exclusively for separations associated with serious maternal or infant consequences such as death or hysterectomy.

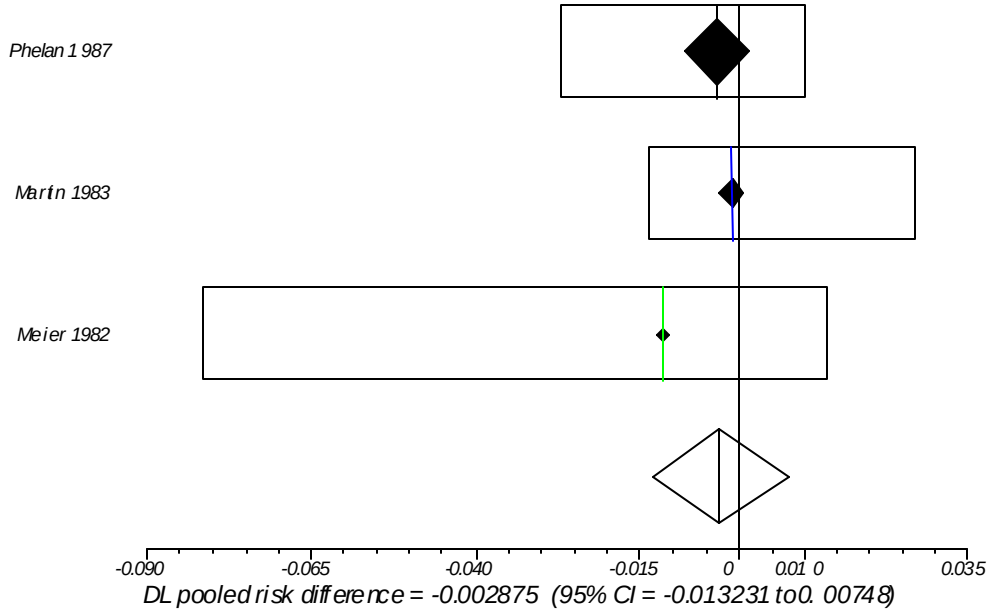
A more subtle problem occurs when uterine rupture is defined as one requiring operative intervention. Typically, a symptomatic rupture is defined as one that is discovered when an cesarean is performed because of maternal bleeding, fetal heart rate disturbances, or other clinical signs. Because uterine rupture is a rare event, finding a uterine wall defect in the context of a FHR abnormality does not necessarily signify that the defect was the cause of the fetal tracing abnormality or further that the infant would have significant morbidity attributable directly to uterine rupture of a cesarean scar. Suppose, for example, that persistent bradycardia occurs in 1 percent of labors, and is 100 percent sensitive and 99 percent specific for a clinically significant rupture of a cesarean scar. If the risk of a symptomatic rupture is 1/100, then classifying all ruptures associated with bradycardia as "symptomatic" would inflate the apparent risk of "symptomatic rupture" by 100 percent (from 1 in 100 to 2 in 100). If the true risk of a symptomatic rupture is only 1/1000, the bradycardia would be due to the rupture in only 1 of 11 cases, and classifying all ruptures associated with bradycardia as symptomatic would inflate the apparent risk of symptomatic rupture by 1100 percent (from 1 in 1000 to 11 in 1000).

What we are most interested in quantifying and aiming to reduce is *major maternal or infant morbidity attributable to uterine rupture* of a cesarean scar.

This report uses the term *"asymptomatic uterine rupture of a cesarean scar"*to indicate the opening of a prior cesarean incision with no signs or symptoms; *"symptomatic uterine rupture of a cesarean scar"* is used for uterine separation diagnosed at laparotomy performed because of FHR disturbances, maternal bleeding, or other signs of potential maternal or neonatal consequences; *major maternal or infant morbidity from a uterine rupture of a cesarean scar* cesarean scar separation leading to significant neonatal or maternal mortality or morbidity (e.g., neonatal neurologic injury, neonatal asphyxia, or maternal hysterectomy).

Asymptomatic uterine rupture of a cesarean scar, also referred to as uterine dehiscence, is an asymptomatic separation of the uterine scar that is an incidental finding at cesarean or from manual exploration of the uterus following a vaginal delivery. Asymptomatic uterine rupture might not necessitate operative intervention. Five of eight prospective cohort studies reported routinely performing uterine exploration after VBAC (Evidence Table 7).[21, 23, 24, 26, 27] In these five studies, rates of nonsignificant, asymptomatic uterine rupture ranged from 0/1,000[26] to 18.9/1,000,[23] with a mean weighted average rate of 12.6/1,000 in women undergoing TOL. Three studies compared TOL with ERCD in women with prior CD and asymptomatic uterine rupture of a cesarean scar (Evidence Table 7).[23, 24, 57] For these three studies, there was no statistically significant difference between the rates for asymptomatic uterine rupture in TOL and 16.4/1,000 (95 percent CI, 5.39 to 28.4) ERCD 12.9/1,000 (95 percent CI, 4.28 to 26.2) (Figure 6).

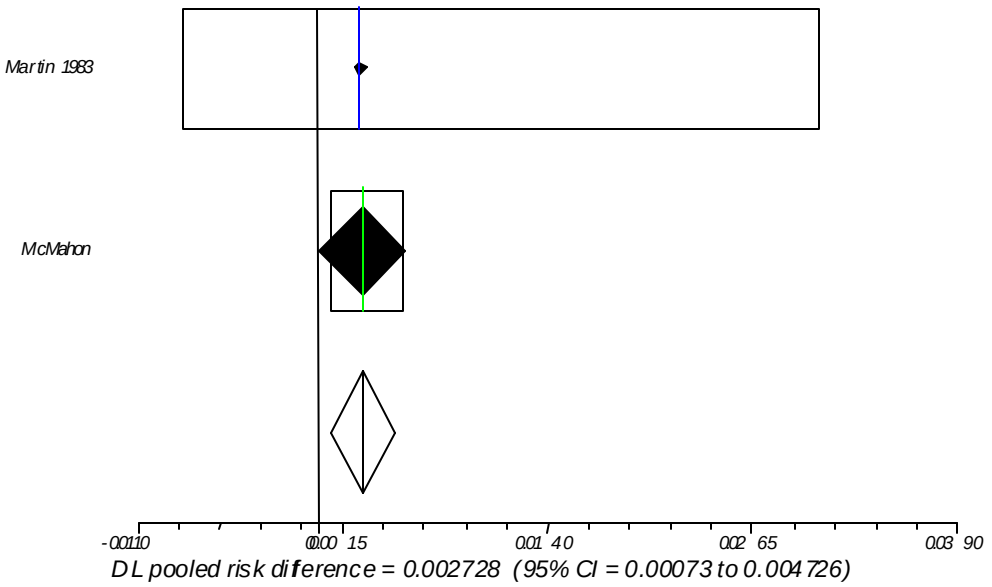
Figure 6. Asymptomatic Uterine Rupture: TOL versus ERCD
Risk difference, 95% CI



Three[4, 5, 58] of seven[4-6, 58-61] population-based retrospective cohort studies provide information about their method of classification for symptomatic uterine rupture. (Evidence Table 1). Two[4, 58] used ICD-9 codes which have been demonstrated to be unreliable (see Appendix G).[62] Nine fair to good observational studies provide the best evidence for the frequency of symptomatic uterine rupture of the cesarean scar.[5, 20-24, 26, 27, 57] The Nova Scotia database[5] had nurses and physicians extract data from charts based on an explicit definition of uterine rupture as a defect that involved the entire wall of the uterus, that was symptomatic, or that required operative intervention. They reported 10 symptomatic uterine ruptures in 3,249 TOLs (3/1,000) versus one in 2,889 cases of ERCD. Eight prospective cohort studies reported rates of symptomatic uterine rupture.[20-24, 26, 27, 57] Rates of symptomatic uterine rupture ranged from 0/1,000[57] in one of the smallest studies to 7.8/1,000 in the largest study.[20] The pooled rate for all prospective studies was 3.16/1,000 (95 percent CI, 1.29 to 5.78). Two studies[5, 57] provide comparative data for rates of symptomatic uterine rupture in TOL versus ERCD (Figure 7). When combined, these data suggest that there is an additional risk of 2.7/1000 for symptomatic uterine rupture for TOL over ERCD.

Figure 7. Symptomatic Uterine Rupture: TOL versus ERCD

Risk difference, 95% CI



Assessing the chances of significant neonatal or maternal morbidity is difficult, due to inconsistencies in classification and reporting. Frequently cited case series reported risks of neonatal death ranging from 1.6[63] to 45.8 percent,[64] and hysterectomy from 17[65] to 85.7 percent[66] (Evidence Table 7). Although none of the fair-to-good-quality population-based or prospective cohort studies specifically reported rates of clinically significant or catastrophic uterine rupture, rates were derived from details provided on cases. There were no cases of maternal death secondary to scar separation in any of the eight fair-to-good-quality prospective cohort studies,[20-24, 26, 27, 57] nor the one good-quality population-based retrospective cohort[5] reporting on uterine dehiscence or rupture (Evidence Table 6). Studies that explicitly recorded uterine rupture-related perinatal or maternal death, infant morbidity, or maternal hysterectomy[5, 20-22, 26, 55, 56] consistently reported results for symptomatic uterine ruptures; therefore, this will serve as denominator. The only population-based study with these data[5] reported no maternal deaths (0 percent), two perinatal deaths (18 percent), and two hysterectomies (18 percent) related to 11 symptomatic uterine ruptures of cesarean scars. Eight prospective cohort studies[20-24, 26, 27, 57] and two uterine rupture case series[55, 56] reported on uterine rupture-related perinatal death. Six studies[20, 21, 24, 26, 27, 57] of varying size, from 162 to 5,022 TOLs, reported no cases of uterine rupture-related perinatal deaths; the other two large cohort studies (3,957 TOLs[22] and 1,796 TOLs[23]) reported rates of 14-20 percent respectively, and the uterine rupture case series reported rates of 6 percent[55] and 4 percent.[56] Among twelve studies, 11 uterine-rupture related perinatal deaths were reported in 202 uterine rupture; suggesting that the risk of perinatal death given uterine rupture is 5 percent. Given a symptomatic uterine rupture rate of 3/1000 and 5 percent chance of perinatal death due to uterine rupture, the perinatal death rate due to TOL would be expected to be 1.5/10,000 rather than the 12.9 or 90/10,000 reported in Smith and Mc Mahon respectively. If the highest rate of uterine-rupture related perinatal death found by McMahon were true, the conditional probability for uterine-rupture related perinatal death would be 6/10,000 in TOL versus 0/10,000. Reflecting on the perinatal death rates associated with route of delivery (not just uterine rupture) reported in Smith and McMahon, 12.9-90/10,000 in TOL and 1.1-50/10,000 in

ERCD, these uterine rupture- related conditional perinatal death rates emphasize the need for caution in communicating the risk of perinatal death due to chosen route of delivery to a patient.

One population-based study[5], four prospective studies,[20-22, 26] and one uterine rupture case series[55] reported on uterine rupture-related hysterectomy with rates ranging from 0-33 percent. The total uterine rupture related hysterectomy rate among these studies was 26 in 159 cases of symptomatic uterine rupture (16 percent). Given a symptomatic uterine rupture rate of 3/1000, and 16 percent chance of hysterectomy given a symptomatic uterine rupture, our best estimate of the risk of uterine rupture-related hysterectomy for women choosing TOL is 4.8/10,000.

Increased Risk with Induction

Uterine rupture was reported in 29 of 48 studies of labor induction; however, 15 of these did not report the definition used. Twelve studies reported no cases of symptomatic uterine rupture. Of those studies providing a clear definition of symptomatic uterine rupture and finding any cases of uterine rupture, the lowest rate among the induction groups was 0.35 percent (1 of 289) in a prospective cohort study of oxytocin,[30] and the highest was 6.25 percent (1 of 16) in a randomized controlled trial of mifepristone.[35] The rates of rupture among women undergoing spontaneous onset of labor in these studies ranged from a low of 0.15 percent in a prospective study of PGE2 gel[36] to a high of 0.8 percent in a similar prospective cohort study of oxytocin.[28]

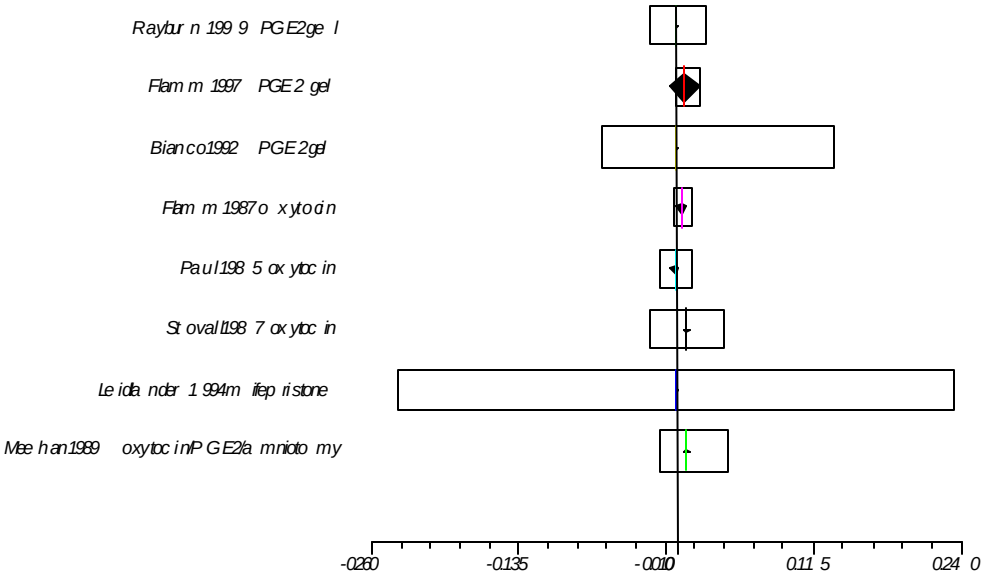
In studies comparing any method of labor induction with spontaneous labor (Figure 8), the rupture rate was slightly increased (pooled risk difference 0.3 percent, 95 percent CI, -.09 to 0.7 percent).

Comparing labors requiring oxytocin with spontaneous labor (Figure 9), a significant difference was not seen (pooled risk difference 0.3 percent, 95 percent CI, -0.01 to 0.6). All of these studies provided a clear definition of uterine rupture, but none stratified the outcome by oxytocin used for induction or augmentation. Three studies provided data on the maximum dose of oxytocin allowed by protocol.

All three studies[32-34] of a prostaglandin versus spontaneous labor that reported uterine rupture rates used PGE2 gel (Figure 10). Two studies[32, 34] found no difference in uterine rupture rates; however, neither study gave a definition of rupture. The third, much larger, study[33] found an insignificant increase in ruptures with PGE2. Although not statistically significant, the pooled risk difference was slightly elevated, 0.42 percent (95 percent CI, -0.53 to 1.36 percent).

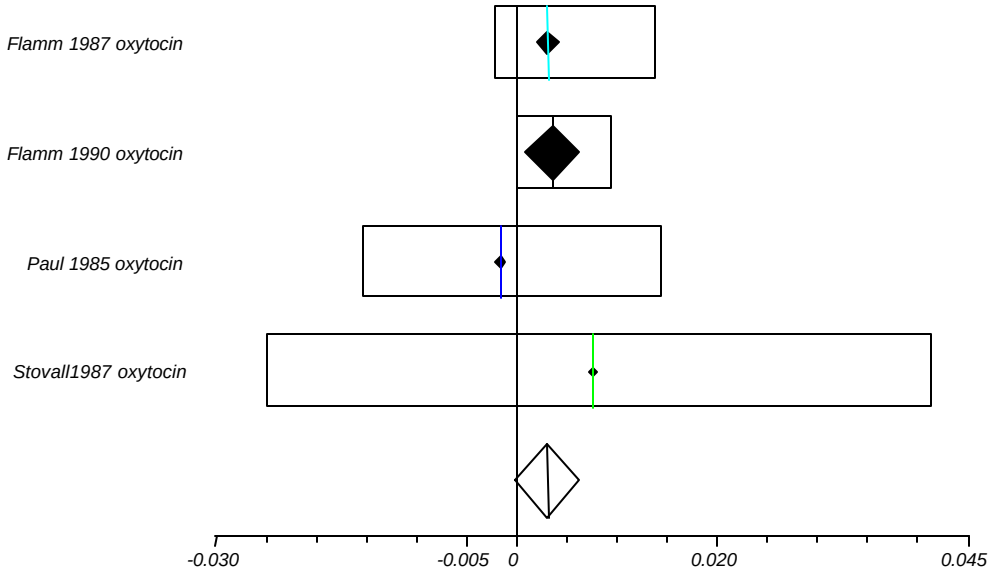
Only one study[67] compared one induction method versus another. It compared misoprostol to PGE2 (gel or pessary) in a prospective cohort study that did not provide a definition of uterine rupture.[67] This study found a higher rate of rupture with misoprostol, but the difference was not significant. The largest study of prostaglandin was excluded from analysis due to poor definition of uterine rupture.[4] Although the precision and accuracy of the results are reduced, the magnitude of the effect showing an increase in the rate of uterine rupture suggests that a real association between PG induction of labor and uterine rupture probably exists.

Figure 8: Uterine Rupture: All Induction Methods versus Spontaneous Labor
Risk difference, 95% CI



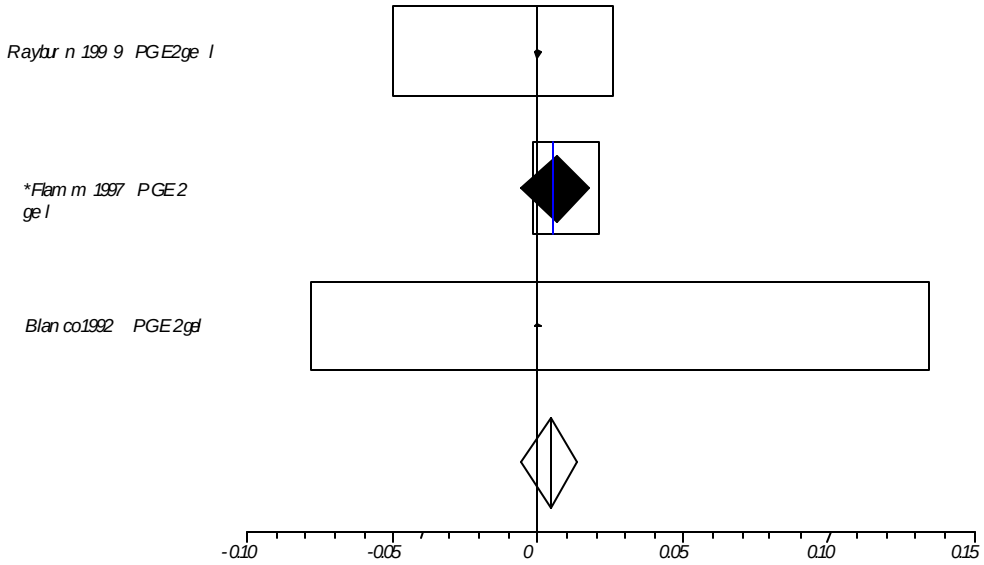
Study	# Induced	# CD	# SL	# CD
Rayburn 1999[32] PGE2 gel	143	0	151	0
Flamm 1997[33] PGE2 gel	453	6	4569	33
Blanco 1992[34] PGE2 gel	25	0	56	0
Flamm 1987[28] oxytocin	485	2	1005	1
Stovall 1987[27] oxytocin	133	1	116	0
Paul 1985[30] oxytocin	289	1	395	2
Lelaidier 1994[35] mifepristone	16	1	16	1
Meehan 1989[50] oxytocin/PGE2/amniotomy	127	1	162	0
DerSimonian-Laird pooled risk difference = 0.31% (95% CI = -0.09 to 0.72) Q statistic ("non-combinability" for risk difference) = 2.3; P = 0.94				

Figure 9: Uterine Rupture: Oxytocin versus Spontaneous Labor
Risk difference, 95% CI



Study	# Induced	CD	# SL	CD
Flamm 1987[28]	485	2	1005	1
Flamm 1990[22]	1201	6	2756	4
Stovall 1987[27]	133	1	116	0
Paul 1985[30]	289	1	395	2
DerSimonian-Laird pooled risk difference = 0.31% (95% CI = -0.012% to 0.63%) Q ("non-combinability" for risk difference) = 1.3; P = 0.73				

Figure 10 Uterine Rupture: Prostaglandins versus Spontaneous Labor
Risk difference, 95% CI



*Uterine rupture defined well

Study	# Induced	CD	# SL	CD
Rayburn 1999[32] PGE2 gel	143	0	74	0
Flamm 1997[33] PGE2 gel	453	6	4569	33
Blanco 1992[34] PGE2 gel	25	0	46	0
DerSimonian-Laird pooled risk difference = 0.42% (95% CI = -0.53% to 1.36%) Q ("non-combinability" for risk difference) = 0.66; P = 0.72				

Predictors of Major Morbidity due to Uterine Rupture

Fetal tracing predictors. In those cases where uterine rupture cannot be prevented, the next best thing would be to identify the earliest sign that it has occurred or is in the process of occurring, and to intervene to prevent significant neonatal or maternal morbidity or mortality. Ten fair-to-good-quality studies reported on abnormalities in FHR tracing as a sign of rupture.[21-23, 25, 26, 30, 50, 53, 55, 56] (Evidence Table 7). Abnormalities in FHR tracings were the most common sign of uterine rupture in 33–100 percent of all studies and 55–87 percent of fair-quality studies. Given that the definition of rupture used in most studies was any defect that involved the entire uterine wall, was symptomatic, or required operative intervention, it is not surprising that the most common sign of uterine rupture in these studies was FHR disturbances. Nonreassuring FHR tracing is the fourth leading indication for cesarean (in order: prior cesarean, breech, dystocia, fetal distress). Most commonly studies of uterine rupture reported the occurrence of prolonged fetal bradycardia. The definition of prolonged fetal bradycardia is often not provided or is inconsistent, despite a consensus definition from the NICHD workshop on electronic fetal monitoring (decrease in baseline greater than 15 beats/minutes lasting between 2 and 10 minutes).[68] Other signs reported in uterine rupture studies in descending order are maternal vaginal bleeding, maternal pain, and uterine contraction disturbances.

Many have wondered whether there are any factors that can prevent poor neonatal outcome when there are signs of potential rupture. Two fair-quality case series[55, 56] have studied cases of

uterine rupture of the cesarean scar to determine whether any predictive premonitory signs exist. Leung et al. were the first to perform an exploratory analysis to study risk factors for poor neonatal and maternal outcome; particularly FHR and uterine contraction patterns.[55] They identified 106 cases of symptomatic uterine rupture from 11,179 TOLs in women with prior CD at LA County-USC Women's Hospital, from which they were able to review the records of 99. The scar type was unknown in 99 percent of their population. They categorized cases of uterine rupture based on complete, partial, or no extrusion of the fetus. Combining death, asphyxia, and respiratory distress, they concluded that perinatal morbidity and mortality was significantly greater in cases where the fetus was extruded. However, they report that the six neonates requiring intubation were extubated and discharged from the neonatal intensive care unit (NICU) within 24 hours (range 1-24 hours) and were discharged from the hospital without adverse sequelae. If these six temporary outcomes (e.g., without significant adverse sequelae) are removed, major perinatal morbidity (asphyxia or death) occurred in 7/41 (17 percent) cases of partial or complete extrusion and 4/58 (6.9 percent) cases of nonextruded fetuses ($p = 0.113$). Of note, four of the fetal deaths occurred in patients who presented with fetal distress and underwent immediate CD, leaving two cases occurring in women undergoing supervised labor (one in the extruded group and one in the nonextruded group). Looking for premonitory signs of uterine rupture, they found that abnormalities of FHR tracing (prolonged deceleration only [defined as FHR less than 90 beats/min that exceeded 1 minute and without return to baseline], prolonged decelerations preceded by late decelerations, prolonged decelerations preceded by severe variables, mild late decelerations only, or fetal distress on admission necessitating CD) occurred in 91/99 cases (91.9 percent) and that all cases of fetal extrusion had prolonged decelerations. Prolonged decelerations occurred in 17/41 (41.5 percent) patients with extrusion and 15/58 (25.9 percent) without. In studying patients with prolonged deceleration further, they found that no patient who had prolonged deceleration only as their sign had significant clinical morbidity when delivery occurred within 17 minutes of the onset of deceleration. If the three cases of temporary neonatal intubation were removed, one case of neonatal asphyxia and no deaths in the prolonged bradycardia group would remain. Although the small numbers make the data unstable, it is intriguing that the one case of asphyxia occurred when there was 32 minutes between the onset of bradycardia and delivery, compared with 22 minutes and less in the group with intubation or no complications. Thus it is unknown what neonatal outcomes would arise between 22 and 32 minutes from bradycardia.

Leung et al. have done a superb job of exploring the details of their cases of uterine rupture; however, they are limited by the constraints of case series data. Data from a control group are important for understanding details about the association between fetal bradycardia and poor infant outcome. Decelerations are not rare; in fact, only 1.4 percent of all deliveries do not have FHR decelerations.[69] Prolonged decelerations, especially given Leung's definition, are rare, occurring in 7.9–12.5 percent of patients receiving epidurals.[70] Causes of prolonged decelerations include cervical examination; rapid decent in the second stage of labor; maternal hypotension due to positioning, epidural, or other; maternal hypoglycemia; reactive hypothermia such as with a cold amnioinfusion; prolonged cord compression (oligohydramnios); tetanic uterine contractions; maternal seizures, and cord prolapse, in addition to uterine rupture. Because fetal bradycardia is not specific to uterine rupture, the presence of a control group would allow some insight into associations with uterine rupture versus these other causes. Additionally, it is important to know details about the context of decision-making, in order to know what portion of

time delays are preventable (e.g., substantial time between decision to go to cesarean and actual time for cesarean).

A second and more recent case series found no relation between time from FHR deceleration and infant outcome.[56] All medical records in a single-institution hospital were examined to identify cases of "complete cesarean scar disruption," defined as uterine scar separation that extended through visceral serosa. As above, the study was conducted in a tertiary care hospital with in-house anesthesia and obstetrics. The authors report on 23 cases of uterine rupture of a cesarean scar, six with partial or complete expulsion of the fetus. Fetal heart rate abnormalities—which included tachycardia and late, variable, or prolonged (not defined) decelerations—were the initial sign of uterine rupture in 87 percent of cases (four had pain, one vaginal bleeding, and one hematuria). Prolonged deceleration was the first sign of uterine rupture in 6/6 (100 percent) of the extruded patients versus 8/17 (47 percent) without extrusion. There was one perinatal death that occurred in the non-extruded group (late decelerations more than 25 minutes before delivery, failed vacuum extraction, then cesarean), and three cases of impaired motor development diagnosed as hypoxic-ischemic encephalopathy, occurring in the extruded group; delivery occurred 15,16, and 23 minutes from onset of prolonged deceleration. When they looked at metabolic acidosis (their primary outcome, defined as umbilical artery pH less than 7.0 with base deficit greater than 12mMol/L), they found a non-significant trend towards less time between first sign to delivery (18 versus 24 minutes) and decision to delivery (13 versus 17 minutes) in the group with metabolic acidosis compared with those without acidosis ($p = 0.11$). In this case, the greater time delays in the group without metabolic acidosis could reflect less concern by the physician and thus a slower overall movement, rather than programmatic delays.

In summary, the literature on uterine rupture suffers from inconsistent use of terms and ambiguous definitions. Additionally, because uterine rupture of the cesarean scar is often diagnosed at cesarean performed for fetal tracing abnormalities, there is diagnostic review bias. Studies conducted thus far to examine the relationship between duration of FHR disturbance particularly prolonged bradycardia and adverse perinatal outcome, have had conflicting results. It is important to further examine the relationship between fetal tracing disturbances (e.g., prolonged fetal bradycardia) and uterine rupture. This can only be done by comparing instances of a particular fetal tracing disturbance in women undergoing a TOL and noting how many times it is truly associated with uterine rupture (true positive) and how many times it is not (e.g., false positive).

Summary

- The use of terms among studies is inconsistent.
- Definitions of terms among studies are ambiguous.
- There is not a significant difference in asymptomatic uterine rupture rates in TOL versus ERCD.
- Symptomatic uterine rupture is significantly more common in TOL versus ERCD, with an increased risk of 2.7/1000
- Based on the frequency and severity of symptomatic uterine rupture, the risk of perinatal death due to a rupture of a uterine scar is 1.5/10,000 and the risk of hysterectomy is 4.8/10,000. These rates of serious complications such as perinatal death, are probably more precise than overall risks from studies measuring death directly.

- The definition of uterine rupture as an outcome is confounded by a definition that includes the potential predictor of FHR tracing abnormality.
- Measurement of frequency of occurrence, predictors for what population is at greatest risk, and predictors for poor outcomes are difficult, because of the lack of standard case definition.

Question 5. Health Status

What is the health status and health-related quality of life for VBAC and repeat cesarean patients?

In general, there is limited research on the health status or health-related quality of life of patients in the weeks after any type of delivery. In studies of the general postpartum population, health status or health-related quality of life refers to general health, physical functioning, mental health, vitality, pain, social functioning, self-care activities, working, household psychosocial outcomes, and/or daily activities (including care of the infant).[12, 71-74]

No studies evaluated health status or health-related quality of life for women with a prior CD after a TOL, repeat CD, VBAC, or ERCD. There were no studies in the general birthing population that contained a subgroup analysis of women with prior CDs. Studies of the general postpartum population did not present data on subgroups of women with prior CD.[72, 74] Similarly, it was not possible to extrapolate results from the RCT of breech presentation, which examined the effect of route of delivery on health status, because women with a baby in breech presentation might not be similar to women with cephalic presentation and prior CD.[12] One review[71] and one prospective cohort study[75] separated health status and psychosocial results by planned, unplanned CDs and vaginal deliveries but neglected to describe the process, e.g., whether a TOL led up to the unplanned CD. Because of these limitations, the usefulness of these general postpartum population results as they relate to women with prior CDs is questionable. More research is needed.

Summary

- There were no studies of health status or health-related quality of life for VBAC or repeat CD patients.

Question 6. Patient Satisfaction

Regarding VBAC and repeat cesarean, what factors influence patient satisfaction/ dissatisfaction with their childbirth experience?

In this review, the term satisfaction refers to a feeling or a response to a birthing experience.[76, 77] Women who were interviewed after birth described satisfaction as a happy feeling.[78] Dissatisfaction was described as a negative feeling. Satisfaction is often multidimensional (e.g., satisfaction with information given, care and treatment, patient's involvement in decisionmaking, and control in process).[79] In this study, women might be satisfied with one aspect of the birthing experience but dissatisfied with another. The context,

birth process, and outcome affect the woman's sense of satisfaction.[78] Understanding how women feel before, during, and after the birth experience has not been explored.[76]

Studies that have measured satisfaction in the general birthing population suffer from a potential bias. Clinicians often gather the satisfaction data directly from the patients .[80] Also, the timing of the measurement might introduce recall bias. In five of 10 studies of one review, the satisfaction results were collected within days or weeks of delivery.[80] Several investigators have hypothesized that a woman having an emergency CD might be less critical if she believed the CD was performed to protect her own health or that of her baby.[80-82] The literature that focused on satisfaction for women attempting TOL and those choosing an ERCD was evaluated with these potential biases in mind.

Two cross-sectional studies[83, 84] met the inclusion criteria for this report (Evidence Table 8a). Two prospective cohort studies were also evaluated for inclusion, but both received quality ratings of poor (Evidence Table 8b).[85, 86] In both prospective cohort studies, the patient's own clinician interviewed her during her postpartum hospital stay[85, 86] and again at her 6-week checkup.[86] This method potentially introduces bias in that the patients might be unwilling to be completely honest if their own provider asks the questions about satisfaction, particularly if the clinician is actively caring for the patient during the postpartum stay. For this reason, both of these studies were rated poor and their results are likely to be invalid (Evidence Table 8b).

The two cross-sectional studies were of fair quality (Evidence Table 8a).[83, 84] These studies contained an unbiased assessment of patient satisfaction. The studies were rated fair for the following reasons: inclusion criteria were unclear (and refusal rates were not reported),[84] or was fair (72 percent),[83] or patients completed questionnaires over varied time frames during which satisfaction might have changed (1-18 months after delivery).[83]

These two studies reported satisfaction (feelings) of patients with differing delivery outcomes.[83, 84] One study reported feelings for patients achieving VBAC[84] while the other reported feelings of mothers (and fathers) who chose TOL but had another CD or who chose ERCD.[83]

In one study[84] women who completed a VBAC compared their vaginal deliveries with their prior CD experiences. Seventy percent of these women would choose VBAC again. In this study, 32 VBAC patients completed the Birth Experience Questionnaire, which contains six open-ended questions related to physical and emotional reactions to the birth experience. The responses were analyzed using content analysis by two independent reviewers (inter-rater reliability=92 percent). When all 156 comments describing feelings after birth were classified as either "adaptive" (responses that met the mother's goals for survival, growth, reproduction, or mastery) or "ineffective" (responses that did not meet the goals), chi square analysis revealed a statistically significant association between delivery and type of response (Table 5). Women were more likely to describe their feelings about their VBAC as "adaptive" and were more likely to describe their feelings about their prior CD as "ineffective." When compared with their CD experience, women described their VBAC experience as "feeling relieved, excited, more confident, and in control."

Table 5. Responses to Vaginal versus Cesarean Delivery

	Vaginal delivery	Prior CD
Total ineffective responses	37	65
Total adaptive responses	42	12

Chi square [1, n = 156] = 22.70, p < .0005)

The second study captured the feelings of women who chose TOL but ended up having another CD or who initially chose ERCD.[83] In this study, 228 couples who had experienced a CD responded to a media campaign to answer a birth survey. Ninety-one of these couples had a prior CD. The feelings of the mothers and fathers in the general population experiencing CDs are compared by obstetric history and shown in Tables 6 and 7. Thirty-five percent of mothers experiencing a second CD wanted more advice on how to cope with their feelings.

Table 6. Mother's Feelings After Cesarean Delivery

Feelings of. . .	Percent of Patients with First CD (n = 105)	Percent of Patients with first CD and Prior VD (n = 32)	Percent of Patients with second (or more) CDs (n = 91)
Relief	86	78	90
Disappointment	68	56	34
Frustration	41	56	35
Joy and happiness	93	67	90
Failure	25	31	18
Difficulty relating to baby	14	13	7
Guilt	20	22	11
Anger	20	28	20
Concern about scar	30	25	15
Guilty about dissatisfaction with birth experience	20	19	10
Uncertain about what you could do when you got home	33	59	21

CD=cesarean delivery; VD= vaginal delivery

Table 7. Father's Feelings After Cesarean Delivery

Feelings of. . .	Percent of Patients with First[t] CD Birth (n = 105)	Percent of Patients with First CD and Prior VD (n = 32)	Perfect of Patients with Second (or more) CD (n = 91)
Relief	93	76	90
Fear for mother and baby	70	55	52
Being left out	46	38	32
Joy and happiness	91	59	94
Anger	16	10	11
Guilt	10	3	11
Difficulty relating to the baby	7	3	4
Uncertain about what you could do when you got home	35	21	15

CD=cesarean delivery; VD= vaginal delivery

For both fathers and mothers, the feelings expressed most often by patients were of relief (that labor was completed and mother and baby were healthy) and joy and happiness. The proportion expressing these feelings was reduced when it was a couple who had experienced a CD after a prior VD.

The couples that participated in this study were self-selected and probably not representative of the general obstetric population. For example, 59 percent of the couples responding to this survey had attended prenatal classes compared with 30 percent in the general population for that region. Also, the study would be more pertinent to this review if the results had identified the subgroup of repeat CD patients who initially tried TOL.

Summary

- Studies of patient satisfaction largely consisted of patient's own provider obtaining information about satisfaction, introducing the possibility for measurement bias.
- Only two cross-sectional studies used methods other than the patient's own provider to obtain satisfaction information.
- No study measured satisfaction for the three types of delivery outcomes that could be experienced by women with prior CDs (VBAC, TOL followed by CD, or ERCD), which leaves room for much needed research.

Question 7. Cost and Health Care Resources

How are economic outcomes related to VBAC, repeat CD, and their respective complications?

One component of the decision to attempt a TOL or perform an ERCD is the economic value of each approach. Comparisons among alternative approaches can be evaluated using a cost-effectiveness design or other economic evaluation. While economic considerations should not be the sole driver for such a decision (unless TOL and ERCD are deemed clinically equivalent), the relative value of each approach might influence the decision.

Twelve economic analyses with data relevant to this topic were reviewed. Two of these[87, 88] are listed in Evidence Table 9a. The remaining 10 papers[89-99] had quality ratings of poor and are listed in Evidence Table 9b. The paper by Chung et al.[87] was rated good and the paper by Grobman et al.[88] was rated fair.

Chung et al.[87] focused on the probability of vaginal delivery for TOL and the cost-effectiveness of TOL in women with prior CDs. The study followed the guidelines for such analyses, including use of quality-adjusted life years (QALYs).[100] A QALY compares a certain state of health (e.g., life after a hysterectomy) to a perfect state of health. This analysis included a societal perspective, performed a long-term analysis, and included most adverse events associated with the two modes of delivery. The paper focused on sensitivity analyses for the rate of successful TOL (that is, achieving VBAC). If the TOL success rate is less than 65 percent, ERCD cost less and provided more QALYs than TOL. This means that ERCD is more cost-effective or more efficient. For TOL success rates between 65 percent and 74 percent, ERCD provided more QALYs at a cost of less than $50,000 per QALY (the upper limit of cost-effectiveness used in this article). For TOL success rates between 74 percent and 76 percent, ERCD provided more QALYs but at a prohibitive cost (greater than $50,000 per QALY). When the probability of vaginal delivery for TOL exceeded 76 percent, TOL was more effective and less costly. The results were also sensitive to the probability of infant mortality, costs for "moderate" morbidity for the infant, the probability of urinary incontinence, the discount rate,

and the probability of cesarean rupture. The authors defined moderate morbidity for the infant, "...principal diagnoses of meconium aspiration, neonatal infection/sepsis screening, and respiratory distress/failure." The authors recommend that more precise tools be developed to estimate the probability of a successful TOL and, if the probability of success were 74 percent or greater, that TOL would be the efficient (cost-effective) choice; if the probability of success were less than 74 percent, ERCD would be the efficient choice. Clearly, the success probability for TOL was a key variable in these analyses. Chung's analysis did not consider future pregnancies.

The study by Grobman et al.[88] used a variety of literature sources and estimated a cost of $2.4 million (M) to prevent one major neonatal adverse outcome by performing ERCD instead of TOL. This means that 1,591 ERCDs would be performed resulting in 0.1 additional maternal deaths and 74 additional maternal morbid events to prevent one serious neonatal outcome. Extensive sensitivity analyses estimated that the cost to prevent one major neonatal outcome would exceed $1M for all scenarios considered. This estimate was based on a payer or health care system perspective and considered a range of adverse outcomes including maternal and neonatal deaths and other major adverse outcomes.

Among the remaining 10 studies, there is at least one fatal flaw in each that cast doubt on the conclusions drawn. Several shortcomings are consistent across the 10 reports: the lack of cost data (reliance on charge data), failure to consider all relevant outcomes (especially among adverse events), lack of a societal perspective, and failure to use a recommended effectiveness outcome as the QALY.

Summary

- Based on the economic evaluation with the best quality score, when the probability of vaginal delivery is 76 percent or greater, TOL is more cost-effective and provides higher quality of life.
- Based on the economic evaluation with the best quality score[87] and assuming costs per QALY of $50,000 as cost-effective, the more cost-effective of TOL and ERCD depends on the probability of successful VBAC after TOL.
- Further evaluation is needed of the sensitivity of the probability cut point of 76 percent to other potential predictor variables.

Health Care Resources

One component of the economics of TOL versus ERCD is units of health care resources. Various types of health care resources (including time in labor and delivery, time in surgery for CD, and time in neonatal intensive care) contribute to the costs of delivery; however, other than one study of operative time,[101] the literature dealt with maternal and/or neonatal length of stay (LOS). One would expect shorter LOSs for successful TOL than for repeat cesarean, either elective or after failed TOL. Among 19 studies (two of which[102, 103] discuss exactly the same data) of resources for mother and/or infant, all had quality ratings of poor (Evidence Table 10). In all cases, there was no adjustment for baseline risk to allow for comparisons of resource units adjusted for other risk factors. Flamm et al.[20] reported fitting a regression model of maternal LOS in which significant predictors were medical center of delivery, TOL (yes or no), unknown status of prior uterine scar, absence of postpartum fever, lack of transfusion, 5-minute Apgar score of 7 or greater, and no tubal ligation. However, these authors did not provide details of this

regression model, so adjusted difference in LOS due to delivery mode cannot be estimated. The LOS for TOL was at least one day shorter across all studies. However, without information on other resources (including labor and delivery time, time in surgery, and time in neonatal intensive care) and without comparable groups or risk adjustment, there are no good estimates for resource utilization comparisons of TOL and ERCD.

Decision Factors

Question 8. Individual Factors

What individual factors influence route of delivery?

Thirteen fair-to-good-quality studies[36-39, 42, 104-111] examined individual factors that influence route of delivery (Evidence Table 11). We classified individual factors that influence route of delivery into four general categories (Table 8): (1) demographic, (2) past obstetric, (3) current obstetric, and (4) nonclinical.

Table 8. Individual factors by general categories

Category	Factors (number of studies)	
Demographic	*Age (20)* Race (1)	SES (0)
Past Obstetric	***Gravidity (6)*** ***Parity (12)*** *Prior VD (26)* *Order of Prior VD (10)* Previous Cervical Dilation (7)	*Number of prior CD (22)* *prior CD Indications:* **Recurrent versus Nonrecurrent (61)** **Recurrent versus Breech (44)** **Recurrent versus Fetal Distress (41)**
Current Obstetric	*Gestational age (15)* *Birth weight (37)* Multiple gestations (3) *Breech/External Cephalic* **Version (3/3)** *Cervical dilation (8)* Cervical dilation rate (2) **Cervical effacement (5)** *Station (5)*	**Bishop score (2)** SL (26) Induced labor (26) **Augmented labor (21)** Oxytocin use (nonspecified) (25) *Epidural use (16)* Maternal height (5) Maternal weight (4) Maternal weight gain (3)
NonClinical	Insurance (1) Hospital (2)	Physician (0)

Bold factors are those that had adjusted ORs from fair-to-good-quality studies

Three fair-to-good-quality cohort studies[36, 42, 107] provide conflicting results on the association of maternal age and likelihood of vaginal delivery (Table 9). While two[36, 42] suggest a negative association between increasing age and vaginal delivery, one[107] suggested the likelihood of VBAC increased with each year of maternal age (adjusted OR, 1.18; 95 percent CI, 0.98 to 1.40). While one could speculate that this discrepancy could be explained by the fact that McNally adjusted for more extraneous factors, none of these factors appeared associated with both the exposure (age) and outcome (VBAC) of interest. The only exception to this finding is parity, which we would expect to create an apparent association between increasing age and an increased likelihood of VBAC, based on previous studies. Because McNally adjusted for parity

and still found a positive association, and because Flamm and Weinstein did not adjust for parity and still showed a negative association, confounding apparently was not the reason for the different findings. Another possible explanation for the discrepancy lies in the fact that unlike the other two studies, McNally's population included only those who were induced. Perhaps it was the case that those who were induced tended to be younger in age (e.g., all less than 35 years old), and since McNally's calculations were based on the continuous data (for age), this resulted in the observed positive association. Although this theory cannot be tested using the information provided by McNally, this finding introduces the issues of the use of continuous versus categoric data, the consideration of the age ranges when calculating such measures of association, and the possible interaction between age and labor induction.

Table 9. Demographic Factors

Factor	Author (year)	Adjusted OR for VBAC	95 percent CI, p-value
Maternal Age	Flamm 1997[36]	**2.58** (<40 yrs)	1.55-4.3
	McNally 1999[107]	1.18 (per yr of age)	0.98-1.40
	Weinstein 1996[42]	0.9 (>37yr)	0.5-1.7

Bold=significant; NR=not reported; NS=not significant

There were no fair-to-good quality studies for the individual factors of maternal race or socio-economic factors.

Past Obstetric Factors

While over 50 studies have investigated the influence of clinical history and past obstetric factors on the outcome of TOL after prior CD, only five were of fair-to-good quality. This relatively small percentage of quality studies did not provide any information for the individual factors of gravidity, parity, and previous cervical dilation.

Prior vaginal delivery (VD) is associated with an increased likelihood of vaginal delivery in TOL. This association is strongest when the prior VD occurred after cesarean. Of the 26 studies investigating the role of prior VD, only one was rated as fair. McNally[107] demonstrated that those with a prior VD had a significantly higher probability of a VBAC compared with those without a prior VD (adjusted OR 27.78; 95 percent CI 3.85 to 200). Four of 10 studies addressing the order of the prior VD,[36, 38, 42, 112] were rated as either being good or fair-quality and suggest that order of the Prior VD is important as well. While studies by Flamm[36] and Weinstein[42] showed that those with a vaginal delivery before prior CD had a significantly higher likelihood of VBAC compared with those without such a history (adjusted OR 1.53; 95 percent CI, 1.12 to 2.10 and adjusted OR 1.8; 95 percent CI, 1.1 to 3.1, respectively), Flamm[36] and Macones[38] demonstrated that this probability of VBAC was greatly increased if instead the prior VD came after the prior CD (adjusted OR 3.39; 95 percent CI 2.25 to 5.11 and adjusted OR 7.69; 95 percent CI 3.23 to 20, respectively). The significance of having a prior VD after prior CD was further illustrated by the only good-quality study.[112] Caughey found that those with a prior VD after prior CD were more than three times as likely to have a vaginal delivery compared with those with a prior VD before prior CD (adjusted OR 3.48; 95 percent CI, 1.9 to 6.1). Overall, the importance of having a prior VD was perhaps most strongly demonstrated by Flamm,[36] who showed that those with a vaginal delivery both before and after prior CD had a nine-fold increase in the likelihood of VBAC compared with those without a prior VD (adjusted OR 9.11; 95 percent CI, 2.18 to

38.04) (Table 10).

When considering the issue of prior CD, the two most investigated factors include the number of prior CDs and prior CD indication. Of the 22 studies looking at the number of prior CDs, only one was rated as being fair in quality.[39] Consistent with the overall literature, Pickhardt[39] demonstrated that the probability of VBAC significantly decreased as the number of prior CDs increased (adjusted OR 0.43; $p < 0.05$). By controlling for a great number of potential confounders in his analysis, Pickhardt established this factor as a true independent predictor of TOL outcome. Also consistent with the overall VBAC literature were the findings of the two[36, 42] of 61 studies given a fair rating regarding prior CD indication. While Flamm[36] demonstrated that those with a nonrecurrent indication compared with those with a recurrent prior CD indication (CPD or failure to progress), had a significantly higher VBAC rate (adjusted OR 1.93; 95 percent CI, 1.58 to 2.35), Weinstein[42] showed similar, yet nonsignificant findings. Weinstein also found that although nonsignificant, those with a prior CD indication of breech presentation or fetal distress had a greater chance of VBAC compared with those with a recurrent indication (adjusted OR 1.9; 95 percent CI, 1.0 to 3.6 and adjusted OR 1.05; 95 percent CI, 0.4 to 2.6, respectively). As reported by previous studies, those with a prior CD indication of breech presentation had the highest relative likelihood of VBAC.

Table 10. Past Indicators of VBAC Delivery

Factor	Author (year)	Adjusted OR for VBAC	95 percent CI p-value
Prior VD	McNally 1999[107]	**27.78**	3.85-200
Order of prior VD			
Before prior CD	Flamm 1997[36]	**1.53**	1.12-2.10
	Weinstein 1996[42]	**1.8**	1.1-3.1
After prior CD	Flamm 1997[36]	**3.39**	2.25-5.11
	Macones 2001[38]	**7.69**	3.23-20
After vs. Before prior CD	Caughey 1998[112]	**3.48**	1.9-6.1
Before & After prior CD	Flamm 1997[36]	**9.11**	2.18-38.04
Number of prior CD	Pickhardt 1992[39]	**0.43**	p<0.05
Prior CD Indication			
Nonrecurrent vs. Recurrent	Flamm 1997[36]	**1.93**	1.58-2.35
Recur vs. Nonrecurrent	Weinstein 1996[42]	0.8	0.3-2.0
Breech vs. Recurrent	Weinstein 1996[42]	1.9	1.0-3.6
Fetal Distress vs. Recurrent	Weinstein 1996[42]	1.05	0.4-2.6

Bold=significant; NR=not reported; NS=not significant

Current Obstetric Factors

We found no fair or good studies addressing the factors of multiple gestations, cervical dilation rate, SL, induced labor, oxytocin use, maternal height, maternal weight, and maternal weight gain.

The review of the current obstetric factors related to the fetus, including gestational age and birth weight, produced findings similar to those of previous reviews. Two[39, 110] of 15 studies (including the article focusing on gestational age greater than 40 weeks) providing information regarding gestational age were considered to be of fair quality (Evidence Table 11). Both of these studies concluded that there is a negative association between gestational age and the likelihood of VBAC. Although 37 studies provided information regarding birth weight, only

two[42, 111] (including the article focusing on birth weight) were rated as being of fair quality. In a separate study from the one mentioned above, Zelop[111] demonstrated that those with a birth weight greater than 4,000 g had nearly half the likelihood of VBAC compared with those with infants weighing less than 4,000 g (adjusted OR, 0.59; 95 percent CI, 0.45 to 0.77). While Weinstein[42] showed similar findings with regards to birth weight, his results were not significant, which again could be explained by his relatively small sample size and decreased power to detect a difference.

Three case series provide the only data regarding the association between external cephalic version (ECV) and VBAC.[104, 105, 108] Rates for VBAC after ECV attempts ranged from 65.8 to 100 percent. By comparing ECV attempts in those with prior CD to those without prior CD, Flamm[105] showed that those with prior CD were significantly more likely to be successfully verted (82 percent and 61 percent, respectively, $p = 0.02$). Although the overall VBAC rate in these three studies ranged from 50 to 54.5 percent, de Meeus[104] showed that of those who had a successful version, the VBAC rate was actually higher (76 percent). Another finding of interest came from the Schacter[108] study, which found that those delivering within a week of ECV had a significantly lower VBAC rate compared with those who delivered more than a week after ECV (0 percent [0/4] and 86 percent [6/7], respectively).

Four[36, 38, 39, 109] of the eight studies that examined the influence of cervical dilation at admission on VBAC were rated as being of fair quality. Three[36, 38, 39] found a positive association between cervical dilation and the likelihood of VBAC. For example, Flamm[36] found that those with a cervical dilation greater than 4 cm were significantly more likely to have VBAC, compared with those with a cervical dilation less than 4 cm (adjusted OR, 2.16; 95 percent CI, 1.66 to 2.82). Macones[38] and Pickhardt[39] showed similar findings in that those with a higher cervical dilation were significantly more likely to have VBAC (adjusted OR, 1.87; 95 percent CI, 1.14 to 3.23 and adjusted OR, 1.62; $p < 0.05$, respectively). The fourth study[109] found no significant association between cervical dilation and TOL outcome, which might be due to a lack of power and relatively small sample size. Two of the five studies[36, 107] identified by this review to include the factor of cervical effacement were determined to be of fair quality. Both of these studies found an association between higher cervical effacement and higher likelihood of VBAC. Flamm[36] showed the internal consistency of this association by demonstrating that compared with those with a cervical effacement at admission of less than 25 percent, both those with an effacement of 25 to 75 percent and those with an effacement of greater than 75 percent had significantly higher likelihoods of VBAC (adjusted OR, 1.79; 95 percent CI, 1.31 to 2.44 and adjusted OR, 2.72; 95 percent CI, 2.00 to 3.71, respectively). Similar to these findings, McNally[107] found that those with an effacement of 100 percent had a five-fold increase in the likelihood of VBAC compared with those with a cervical effacement less than 100 percent (adjusted OR, 5.0; 95 percent CI, 1.28 to 19.23). None of the five studies that presented information regarding fetal station were rated as being of fair-to-good quality. However, while the evidence in the fair-quality study by Stronge[109] regarding head engagement did not present itself in the form of fetal station, it appeared very similar in nature. Stronge defined head engagement as when less than three-fifths of the head was palpable on abdominal exam or when the cranium was palpated below the level of the ischial spines during vaginal examination. Those with head engagement had a 12-fold increase in the likelihood of VBAC compared with those without head engagement (adjusted OR, 12.3; 95 percent CI, 4.6 to 33.3). The collective consideration of the cervical factors in the form of a Bishop score was investigated by two studies, of which only one was of fair quality. This study by Weinstein[42] found that those with a

Bishop score greater than 4 were significantly more likely to have VBAC compared with those with a score less than 4 (adjusted OR, 6.0; 95 percent CI, 3.5 to 10.4) (Table 11).

The effects of various *medications* on TOL outcome have been one of the more heavily investigated areas of VBAC literature. No fair-to-good-quality studies provided information regarding labor induction or oxytocin use (in general); however, of 21 studies that provided information regarding the factor of labor augmentation, there were two fair-quality studies.[38, 109] Although Macones[38] demonstrated that those with labor augmentation were significantly less likely to have VBAC compared with those without augmentation (adjusted OR, 0.47; 95 percent CI, 0.25 to 0.88), Stronge[109] found no significant association between labor augmentation and TOL outcome. Once again, one could speculate that this difference in results could be due to a lack of power in Stronge's study to find an association or perhaps due to a differential level of confounding adjustment. Of the 16 studies to investigate the influence of epidural use on the outcome of TOL, only one was of fair quality. Although nonsignificant, McNally[107] demonstrated that those with the use of an epidural tended to have a lower likelihood of VBAC compared with those who did not use an epidural.

Table 11. Current Indicators of VBAC Delivery

Factor	Author (year)	Adjusted OR for VBAC	95% C p-value
Gestational Age	Pickhardt 1992[39]	**0.81**	p < 0.05
	Zelop 2001[110]	**0.67** (>40wks GA, spontaneous)	0.56-0.83
	Zelop 2001[110]	**0.67** (>40wks GA, induced)	0.45-0.91
Birth weight	Weinstein 1996[42]	0.95 (>4000g)	0.17-5
	Zelop 2001[111]	**0.59** (>4000g)	0.45-0.77
Cervical Dilation	Flamm 1997[36]	**2.16** (>4cm)	1.66-2.82
	Macones 2001[38]	**1.87**	1.14-3.23
	Pickhardt 1992[39]	**1.62**	p < 0.05
	Stronge 1996[109]	NR	NS
Effacement	Flamm 1997[36]	**2.72** (>75%) – referent <25 percent	2.00-3.71
	Flamm 1997[36]	**1.79** (25-75%) – referent <25 percent	1.31-2.44
	McNally 1999[107]	**5.0** (100%)	1.28-19.23
Station	Stronge 1996[109]	**12.3**	4.6-33.3
Bishop score	Weinstein 1996[42]	**6.0** (score ≥4)	3.5-10.4
Augmentation	Macones 2001[38]	**0.47**	0.25-0.88
	Stronge 1996[109]	NR	NS
Epidural use	McNally 1999[107]	0.26	0.06-1.12

Bold=significant; NR=not reported; NS=not significant

NonClinical Factors

Although medical decisions are often based on clinical factors alone, it is important to remember that nonclinical factors might also play an important role in VBAC. For example, McMahon[5] found that those who attended prenatal classes were significantly less likely to fail a TOL compared with those who did not attend (crude OR, 0.8; 95 percent CI, 0.6 to 0.9). In addition to this, Fraser[106] conducted a fair-quality RCT comparing the effect of either a verbal-based (individualized discussion program) or a document-based (pamphlet) prenatal program for those attempting a TOL after prior CD. Although statistically nonsignificant, the results showed

that those in the verbal treatment arm had a higher rate of VBAC compared with those in the document treatment arm (53 percent and 49 percent, respectively; RR, 1.1; 95 percent CI, 1.0 to 1.2). This review investigated the influence of three nonclinical factors (i.e., insurance, physician characteristics, and hospital characteristics) on the outcome of a TOL after prior CD.

While a number of studies in the VBAC literature provided information regarding the nonclinical factors of insurance status, physician characteristics, and hospital characteristics, none of them were of fair-to-good quality. The majority failed to adjust for confounding (e.g., Socol[113], McMahon[5]); those that did provide adjusted ORs (e.g., Goldman,[114] King,[115] Stafford[116]) did so using database information that limited them to the comparison between those with VBAC and those with CD, which included those with either an ERCD or a failed TOL.

Summary

- The vast majority of studies looking at individual factors that influence the route of delivery were of poor quality due to inadequate control for confounding factors.
- The factors that were significantly associated with an *increased likelihood of vaginal delivery* (i.e., successful TOL) were: maternal age less than 40 years,[36] PRIOR VD (particularly vaginal delivery after cesarean),[36, 38, 42, 107] a nonrecurrent indication for the prior CD,[36] and favorable cervical factors.[36, 38, 39, 42, 107, 109]
- The factors that were significantly associated with a *decreased likelihood of vaginal delivery* (i.e., failed TOL) were: an increasing number of prior CDs,[39] gestational age greater than 40 weeks[39, 111] birth weight greater than 4000 g,[111] and augmentation of labor.[38]

Question 9. Patient Preferences

What factors influence a patient's decision making regarding VBAC or ERCD?

Several factors might influence a patient's preference for TOL, including education about VBAC, the patient's ethnicity, and social motives. Preference refers to choice about delivery method (TOL or ERCD).

Two recent systematic reviews[80, 117] that addressed a women's choice for delivery reported that the included studies were descriptive and had many methodologic limitations: small sample sizes, selection bias, recall bias and preferences assessed by potentially biased observers. In particular, one review noted that in seven of 10 studies, the women's own providers recorded the patient's preferences for delivery.[80] This direct involvement by women's providers in recording results might have influenced women's responses. Also, only three of the 10 studies reported if the women received education on birthing options, so whether the women made informed decisions was unclear. There were also conceptual issues to consider. Only seven of 10 studies reported whether the women requesting ERCD had an obstetric contraindication for TOL. Some women might not really have had a choice to make.

The findings of these two reviews[80, 117] provided a backdrop for the current review. Before considering patient preference results, the studies were evaluated for the methodologic limitations identified in these reviews.

One RCT,[106] one nonrandomized trial,[118] four prospective cohort studies,[24, 57, 119, 120] one

retrospective cohort study,[121] and four cross-sectional studies[84, 122-124] met the inclusion criteria for this report (Evidence Table 12a).

Four additional prospective studies[85, 86, 125, 126] and one cross-sectional study[127] were excluded for poor quality (Evidence Table 12b). In four of the five studies the patient's own provider interviewed the patients directly, introducing bias to the preference measures.[85, 86, 125, 126] The patients might be unwilling to provide complete information if their own provider asks the questions, particularly if the provider is actively caring for the patient during the postpartum stay. Also, the providers might insert their own perspective on the reasons for delivery. The last study we rated as poor did not identify patients eligible for VBAC and lost 67 percent of patients in recruitment.[127] The results of these five studies excluded for poor quality are not discussed further in this section (Evidence Table 12b).[85, 86, 125-127]

The methods to collect patient preference data varied across the included studies. In four of the 11 studies, the women completed questionnaires.[57, 84, 106, 118] In two studies independent researchers interviewed the patients about their reasons for delivery.[120, 124] In one retrospective cohort study, certified abstractors reviewed the charts, followed by a second reviewer, an obstetric nurse.[121]

Only the RCT met all criteria and was rated good quality for all results.[106] We rated the remaining studies fair because they did not clearly state their inclusion or exclusion criteria,[122-124] they had fair followup (60 to 80 percent),[118] were unclear about followup,[57] or had unreported followup rates.[24, 84, 128] Other reasons for a fair rating included no description of how the measures were tested for validity or reliability,[24, 118, 120] or a lack of clarity about who interviewed patients.[119] When the inclusion/exclusion criteria were not reported or were vague, the number of women eligible for TOL was unknown. Attempted TOL rates and VBAC rates for three studies were unknown.[118, 123, 124]

Factors Relating to Patient's Birth Choice and Reasons for Choice

Before patient preferences were assessed, the proportion of women who actually had a choice was determined for each study. The proportion of eligible women (minimal requirement: low-transverse scar, singleton fetus, and no other contraindications) choosing to attempt a TOL ranged from 22.6 to 90 percent in the six fair-to-good-quality studies that were clear about the inclusion/exclusion criteria.[24, 57, 106, 119, 121, 128] As might be expected, the two studies conducted in the early 1980s[24, 57] had much lower attempt rates (22.6 to 31.5 percent) compared with the other four studies, which were conducted between 1989 and 2001 (attempt rates 42 to 90 percent).[106, 119, 121, 128]

In total, 1,083 of 2733 eligible women in six studies chose TOL (sample weighted average of 39.6 percent).[24, 57, 106, 119, 121, 128] The VBAC rate for eligible women choosing TOL ranged from 56.5 to 84.5 percent. In total, 778 of the 1,083 eligible women had a VBAC (sample weighted average of 71.8 percent).

The heterogeneity of the inclusion criteria (when they were assessed) might have contributed to variation in the proportion choosing a TOL. In three studies the women were pregnant and had a history of a prior CD when preference was assessed.[24, 119, 122] In three studies the women were assessed within days of delivery.[84, 106, 118] In one study the assessment was within 1 month of delivery,[124] and in one study the women were assessed several months after delivery.[57] Finally, in one study the women were interviewed both when they were pregnant and postpartum.[120]

Several factors (race, prior VD, social motives, safety, future childbearing plans) appeared to

influence choice of delivery. The proportion of nonwhite patients ranged from 2.4 to 47 percent in the four fair-quality studies that reported race.[118, 120-122] Only one prospective cohort study of good quality examined the effect of race on preference.[120] In this study 23/43 (53.5 percent) nonwhite patients attempted a TOL and 42/50 (84 percent) of white patients attempted a TOL. Forty-seven percent of the nonwhite patients were black, 28 percent were Latino, and 21 percent were Asian. All women in this study were middle-class and working class women. Although the white patients were more educated than the nonwhite patients, all other socioeconomic status indicators were similar. Several results in this study suggested that the minority patients had less opportunities to gain medical information about delivery options than white patients. Fewer minority patients attended childbirth courses (43 percent) during their first pregnancy when compared with white patients (81 percent) ($p < .0001$). Compared with white patients, minority patients were less likely to have been told by their former providers after their prior CD that VBAC was possible ($p < .003$). Even though minority patients received less medical information and encouragement for a TOL, more patients (39 percent) identified the provider as an important influence in their decision, compared with 19 percent of white patients ($p < .02$).

In addition to informational differences between the races, underlying cultural ideologies might account for the different approaches to delivery.[120] From structured interviews, these investigators reported that ethnic minority women viewed labor as a painful necessary evil that does not relate to one's intrinsic worth. Forty-six percent of minority patients did not want to experience labor again compared with 22 percent of white patients. If a woman could become a mother through a less painful, less risky manner, e.g., with an ERCD, no one look downed on them. By contrast, these same investigators described the view of labor by white patients as a challenge to be overcome to gain full status as mothers. White women viewed vaginal birth as a "once-in-a-lifetime experience not to be missed."

Two of 11 studies examined prior VD as a predictor for a TOL preference.[24, 123] In both studies, patients who had delivered at least one baby vaginally were more likely to choose TOL. A greater proportion of the women choosing TOL had a history of vaginal delivery either before or after their CD (18/53, 40.0 percent) when compared with women who chose ERCD (only 5/46, 10.9 percent had prior VDs) ($p = 0.007$).[123] Possibly, women who have already succeeded with a vaginal delivery have a stronger self-efficacy or belief that by doing a TOL they will indeed deliver the baby vaginally. One cross-sectional study that examined state anxiety reported that women choosing TOL had lower state anxiety and felt better prepared than women choosing ERCD.[122] Four of 11 studies cited fear of labor or fear of failure as a strong reasons for choosing ERCD.[57, 118, 123, 124] These patients felt that a TOL would lead to a difficult labor, failure to deliver vaginally, and, in the end, another CD.[57]

Social motives (ability to care for children at home, convenience) appeared more often in these studies as the primary reason for selecting TOL or ERCD than careful weighing of health risks for mother or baby. Six of the seven studies that reported patients' reasons for choosing TOL cited "easier recovery" as a strong reason.[84, 118, 120, 122-124] Women in these studies already had children at home who needed care, so a shorter delivery was very desirable. Five of the six studies reported that the women wanted to experience a vaginal birth.[84, 118, 120, 122, 124] Structured interviews with women before delivery and 2 months after delivery showed that the women also chose TOL so their husbands could be more involved.[128, 129] Finally, two of 10 studies cited convenience as a primary reason for ERCD.[57, 118] A scheduled delivery allows mother and provider to set a date that coordinates well with work and allows time to plan for childcare.

Safety for the mother and/or baby was cited as an important reason in only four of the 11

studies reporting reasons for deliveries.[84, 118, 122, 124] In a cross-sectional survey of women who had just delivered healthy babies either by ERCD or VBAC, 18/21 women who chose and delivered by VBAC felt that vaginal delivery was safest for the mother compared with 7/11 women who chose and delivered by ERCD.[124] In this same group of mothers who chose and delivered by VBAC, 10/21 felt vaginal delivery was safest for the infant also, compared with 2/11 who chose and delivered by ERCD. Since this study only recruited women with healthy babies, the results are potentially biased in that the patients tended to believe the method was safe because the outcome was good. Another study using structured interviews showed that the women did not know actual probabilities or complication rates when they made their decisions.[129] It was unclear if the provider had told them the probabilities and they did not recall them or place importance on them, or if the patients were never informed of the actual probabilities.

Only one good-quality RCT[106] and two fair-quality prospective cohort studies[24, 120] examined the effect of future childbearing plans on the birthing preference. In the RCT, 23 percent of women with a low motivation for a TOL desired to have a ligation sterilization compared with the 13 percent of women with a high motivation for TOL.[106] In one prospective cohort study,[128] 22/56 (39.3 percent) women having an ERCD had their tubes tied after delivery, compared with 4/44 (9.1 percent) of women delivering vaginally. Similarly, more women having an ERCD, 245/547 (44.8 percent) requested a ligation sterilization, compared with 18/101 (17.8 percent) of women experiencing VBAC, and 14/61 (23.0 percent) choosing TOL but having a CD.[24]

Education, Hospital, and Physician Influence on Patient Delivery Choices

The confidence a woman has to succeed at TOL might also be related to how knowledgeable she is about VBAC, particularly before she becomes pregnant or early in her pregnancy. Only three of the 11 studies with valid results described an education process for women with prior CD.[106, 120, 121] The best-quality study, a good-quality RCT,[106] reported that overall there was no difference in the proportion of eligible women attempting a TOL when given a pamphlet at 21 weeks' gestation versus an individualized VBAC education and support program started at 21 weeks' gestation. However, when the subgroup of patients with very low motivation for TOL was educated and given support, more patients, 28/86 (32.6 percent) chose TOL than the very low motivated patients who received pamphlets (18/93, 19.4 percent) (RR, 1.7; 95 percent CI, 1.0 to 2.8, $p = 0.043$). The investigators also commented that it was possible that the intervention was launched too late to influence the patient's choices. Indeed, 28 to 49 percent of patients in four other studies had decided to attempt a TOL before the pregnancy began.[84, 118, 123, 124] Another 34 to 40 percent of patients decided to attempt a TOL before the midpoint of their pregnancy.[118, 124] The results of these studies suggest that education should be started shortly after the first CD, perhaps at the first postnatal visit.[123] In contrast, only 0 to 15 percent of the women in two studies had decided to have a ERCD before their pregnancy began, but 25 to 42 percent had selected it by the middle of the pregnancy.[118, 124]

The likelihood of VBAC counseling also appears related to the overall CD rate of the hospital the patient chooses for delivery. One fair-quality retrospective cohort study of 51 California hospitals reported that hospitals with higher overall CD rates had higher rates of ERCDs without documented evidence of counseling regarding TOL.[121] In this study, 1,662 birth records were randomly selected from 11 "high CD" hospitals (average CD rate of 30 percent), from 32 "intermediate CD" hospitals (average CD rate of 21 percent), and from eight "low CD"

hospitals (average CD rate of 15 percent). Of women eligible for TOL who chose ERCD, 21 percent of women at the "high CD" hospitals had no documented proof of counseling, compared with 15 percent of "intermediate CD" hospitals and 0.3 percent of "low CD" hospitals ($p < 0.01$ for the three proportions). Another 36 percent of women at "high CD" hospitals were counseled but refused TOL, compared with 29 percent at "intermediate CD" hospitals and 10 percent of women from "low CD" hospitals ($p < 0.01$ for three proportions). The study further reported that once a patient had been counseled and consented to a TOL, she had a similar chance of a vaginal delivery regardless of the underlying hospital CD rate.

The patient's exposure to VBAC education appears related not only to the hospital she chooses for delivery but also to her own specific physician. The specific wording the provider uses in discussing TOL with patients is difficult to document and might reflect the provider's underlying preferences. In one retrospective cohort study of the general birthing population (not focused on patients with prior CD) for 11 physicians, the variances for CD rates were not explained by patient obstetric risk factors, socio-economic status, service status, or physician's experience, suggesting that the physician's own practice style might influence route of delivery.[130] In a cross-sectional study of 19 public hospitals in Italy, obstetricians would chose TOL if they worked at a large hospital (delivered more than 1,000 babies/year) ($p < 0.01$), and if they worked at a hospital with a CD rate of less than 25 percent ($p < 0.001$).[131]

The education and support for TOL a patient perceives from her physician might also be related to her ethnicity. In one fair prospective cohort study, 60 percent of nonwhite patients were aware of a VBAC option before the pregnancy, compared with 86 percent of white patients ($p < 0.003$).[120] Seventy-two percent of white patients felt they received "some to much" information and encouragement by their provider on attempting a TOL, compared with 50 percent for nonwhite patients ($p < 0.005$). Although white patients perceived that they received sufficient information, a lower proportion of white patients placed great value on their physician's information than nonwhite patients. Thirty-nine percent of nonwhite patients in one prospective cohort study felt the doctor was an important influence, compared with 19 percent of white patients ($p < 0.02$).[120]

Summary

- Patient preferences for birth choice are unclear because of the heterogeneity of the 11 included studies.
- Several factors appear related to choice for TOL (white race; prior VD; lower levels of anxiety during the pregnancy).
- Lack of medical information along with cultural ideologies might account for minority women being less likely to attempt a TOL when compared with white women.
- A woman's choice for delivery was often based on social motives (e.g., easier recovery, so she can care for baby and children at home).
- Only four of 11 studies cited safety for mother or baby as important reasons for delivery choice.
- It remains unclear if VBAC education increases the proportion of women who choose TOL. Future studies of education should include education before next pregnancy, perhaps at the postnatal visit of patients with first CD. Future work should also insure that all patients regardless of race receive the same information.

Question 10. Provider Characteristics

How do legislation, policy, guidelines, hospital characteristics, provider characteristics, insurance type, and access to care affect health outcomes for VBAC candidates?

Several aspects of the overall health care system might impact the rates of VBAC, TOL, and ERCD and safety of each route. These various aspects are grouped into legislation or other legal characteristics (Evidence Table 13), guidelines or policies (Evidence Table 14a, 14b), physician characteristics (Evidence Table 15), hospital characteristics (Evidence Table 116a, 16b), and insurance modalities (Evidence Table 17a, 17b). No study reported on how legislation, policy, guidelines, hospital characteristics, provider characteristics, insurance type or access to care affect the safety of TOL or ERCD. Studies that consider these factors focus exclusively on VBAC rates. Studies that address more than one of these categories are discussed under each characteristic addressed.

Legal or Legislative Characteristics

Two papers[115, 132] were identified that compared VBAC rates under different legal circumstances (both rated good). Studnicki et al.[132] compared the year before and the year after implementation of legislation of obstetrics guidelines in Florida (EvidenceTable 15). This law mandated that obstetricians receive guidelines on obstetric care (including TOL and VBAC for women with prior CD) and that hospitals use peer review to enforce the guidelines. Most hospitals implemented these rules either in the last quarter of 1992 or the first quarter of 1993. The VBAC rate in women with prior CD increased from 26.7 percent in 1992 to 30.9 percent in 1993. Rates in 1990 and 1991 were 21.8 percent and 25.6 percent, respectively. When stratified by potential confounder variables, in 12 of 54 strata there was a significant increase in VBAC rate from 1992 to 1993. The authors also did not look for an overall time trend to determine what would have been expected without legislative action. Sample sizes by strata were not provided. Thus, this legislation, which was intended to increase rates of TOL, appeared to do so, at least in the short term.

King and Lahiri[115] considered a variety of medical and socioeconomic predictors of rates of VBAC including two variables related to professional liability. These two variables were annual average paid loss (for years 1985-1989) of the hospital due to malpractice claims settlements divided by patient days and the mature-claims-made rate for OB/GYNs in the county of the hospital. A multiple logistic model to predict the probability of VBAC was developed. This model adjusted for a variety of patient demographic and socioeconomic characteristics and for hospital characteristics. The authors fit models with and without data from New York City to determine whether the influence of a characteristic on the results was due largely to New York City. Hospital-paid loss due to practice claims was statistically significant when New York City patients were excluded (OR, 0.96; 95 percent CI, 0.95 to 0.98) but not when New York City patients were included (OR, 1.01; 95 percent CI, 0.99 to 1.03). The physician's premium was statistically significant with the inclusion of hospitals in New York City (OR, 0.98; 95 percent CI, 0.97 to 0.99 for risk of a $5,000 increase in annual premiums) but not when New York City hospitals were excluded (OR, 1.01; 95 percent CI, 1.00 to 1.08). No summary statistics are provided to facilitate interpretation of these ORs and inclusion of interaction terms for New York City would have been more useful. Whether these ORs are statistically significant, the

magnitude of the OR is small, indicating relatively little impact on rates of VBAC. While the professional liability variables are statistically significant, since the odds ratios are close to 1.0 they may not be very meaningful.

These two studies provide little evidence of the impact of legal or legislative components on rates of VBAC. For the paper by King and Lahiri,[115] the effect of hospital paid loss due to malpractice claims settlements and physician's malpractice premiums were relatively small (OR very close to 1.0). Changes observed in VBAC rates in Studnicki et al.[132] occurred only in some risk strata. There are not studies regarding the impact of the current malpractice crisis on availability of obstetric providers and impact on a patient's options. Thus additional research needs to be conducted to determine the influence of legal and legislative factors on changing provider behavior relative to type of delivery.

Guidelines

Nine articles[133-141] were identified that addressed guidelines or policies to modify rates of outcomes (typically to increase rates of VBAC). One[133] was rated good and three[134-136] were rated fair (Evidence Table 14a). There were two randomized trials[133, 134] that assessed the effect of guidelines. Lomas et al.[133] reported on a Canadian trial in which hospitals were randomized to no intervention, opinion leader intervention, or audit and feedback intervention. The number of hospitals is small (8, 4, and 4, respectively) and there were no differences in the baseline characteristics reported. The analysis did account for the sampling model used. There were significant differences in the rates of women offered a TOL (opinion leader 74 percent, audit and feedback 56 percent, no intervention 51 percent, $p = 0.002$), rates of women undertaking a TOL (opinion leader 38 percent, audit and feedback 21 percent, no intervention 28 percent, $p = 0.007$), VBAC rates (opinion leader 25 percent, audit and feedback 12 percent, no intervention 14 percent, $p = 0.003$), and ERCD rates (opinion leader 54 percent, audit and feedback 70 percent, no intervention 67 percent, $p = 0.001$). There were no significant differences in rates of unscheduled CDs. While multiple comparisons were not made to determine exactly which groups differed from one another, opinion leaders appear to have a greater impact in modifying rates of delivery methods than does audit and feedback.

Bickell et al.[134] selected a random sample of 45 hospitals in New York to receive a program of peer review and audits of 100 cases of labor and delivery with feedback These hospitals were compared with the remaining 120 hospitals in the state to determine differences in VBAC and repeat CD rates. While there was a significant difference in the overall CD rate, there were no significant differences in rates of VBAC or repeat CD, when comparing the year before audits began (1988) with the year after the audits and feedback were completed (1993) There were no differences in baseline characteristics reported and no adjustment was made for potential confounders.

There was one retrospective cohort study rated fair. Santerre,[136] using data from a group of 55 hospitals in Massachusetts, performed a regression analysis on VBAC rates over 9 years (1985-1993) during which time the ACOG guidelines were published (in 1988). Using a model that adjusted for potential confounding variables including some baseline risk factors (e.g., low birth weight, race, and source of payment), the model predicted a "permanent" 5.6 percent increase in VBAC rate attributable to the guidelines.

Lomas et al. [135] also compared average monthly change in rates of repeat CD in Ontario for 6 years before and two years after publication of guidelines recommending reductions in the rates

of CD. The guidelines were a Canadian national consensus statement similar to the National Institutes of Health 1980 consensus conference in the US. The rates of repeat CD decreased at a higher rate after the guidelines than before. As these authors did not fully describe the other variables included in their regression model, this study was rated fair.

The study[133] that provides the best evidence suggests that use of opinion leaders provides a greater likelihood of changing practice compared with audit and feedback. A recent conference summary[142] echoed this view when it concluded that involvement of opinion leaders is an important step in achieving local buy-in for guidelines. Another study[134] of peer review and audit failed to demonstrate a significant change in the rates of either VBAC or RCD. The other two studies[135, 136] suggested that publications of national guidelines do impact practice although perhaps not to the degree expected.

Provider Characteristics

All 14 studies of clinician characteristics[114, 143-155] were rated poor (Evidence Table 15). In all cases, there was no adjustment of baseline risk and/or potential confounding variables (Evidence Table 13c). There is a strong likelihood of selection bias especially for type of clinician (e.g., midwife versus obstetrician) in these studies. That is, to the extent that a patient's choice of provider depends on the patient's underlying risk profile (e.g., choosing an obstetrician over a midwife due to care for a high-risk pregnancy) comparisons of rates across types of providers need to be adjusted by risk to be valid. The effect of patient self-selection in provider outcomes has been tested in an RCT of low risk pregnancies (non-VBAC), to resident physician versus midwifery management.[156] Prior to the study, primary cesarean rates were reported to be 9 percent for the physician service and 2 percent in the midwifery service. When 492 low-risk women were randomized to provider, there was no difference in primary cesarean rates between the two groups. Thus, without proper controlling for patient selection factors, these studies provide no useful information with respect to differences in VBAC rates among types of providers.

Hospital Characteristics

Of 22 studies that included hospital characteristics [5, 29, 61, 114-116, 136, 143, 147, 157-169], nine were rated good or fair (Evidence Table 16a). Of these, six were comparative studies[5, 115, 116, 136, 163, 164] (comparing TOL and ERCD) and three[29, 157, 162] were descriptive studies (only reporting results of TOL).

Gregory et al.[164] compared VBAC rates across hospital settings in California in a study that was rated good. Rates of VBAC (adjusted for baseline and medical characteristics of mother and fetus) were 14 percent in private nonteaching hospitals, 57 percent in public hospitals, 60 percent in private teaching hospitals, and 41 percent in health maintenance organizations (HMOs). When compared with private, nonteaching hospitals, the repeat CD rates in other types of hospitals was statistically significantly different ($p < 0.001$). The adjusted repeat CD rates were 85.7 percent in private, non-teaching hospitals (the reference group), 43.0 percent in public hospitals, 40.0 percent in private teaching hospitals and 59.0 percent in HMOs.

McMahon et al.[5] compared rates of TOL and VBAC with type of hospital in Nova Scotia. Compared with tertiary care centers, the ORs for TOL rate were 0.5 (95 percent CI: 0.5 to 0.6) for regional hospitals and 0.4 (0.3 to 0.5) for community hospitals. The ORs for successful TOL

were 0.7 (0.6 to 0.8 and 0.5 to 0.9, respectively) for both regional and community hospitals, compared with the tertiary care centers.

Stafford[116] reported on relationships between several hospital characteristics and rates of VBAC. The study was rated good and represented all relevant discharges in California in 1986. Across hospital ownership types (compared with proprietary hospitals), the adjusted ORs for VBAC were (1.4; 95 percent CI, 1.2 to 1.6) for private nonprofit hospitals, 3.9 (3.3 to 4.6) for Kaiser Permanente hospitals with Kaiser payment, 2.6 (1.4 to 4.6) for Kaiser Permanente hospitals without Kaiser payment, 2.5 (2.1 to 2.9) for county hospitals with indigent payment, 2.7 (2.1 to 3.5) for county hospitals without indigent payment, and 3.7 (3.0 to 4.6) for the University of California hospitals. Compared to nonteaching hospitals, the adjusted ORs for VBAC were 0.7 (0.6 to 0.8), 0.9 (0.8 to 1.0), and 1.7 (1.5 to 1.9) for nonmedical-school-affiliated teaching hospitals, medical-school-affiliated hospitals, and Council of Teaching Hospitals member hospitals, respectively. Compared with a hospital without an NICU), the adjusted OR for VBAC for a hospital with an NICU was 0.9 (0.8 to 1.0). Across four categories of annual numbers of births, rates of VBAC increased with increasing numbers of annual births.

King and Lahiri[115] assessed the impact of various hospital factors on the VBAC rates in New York hospitals in a study rated good. Compared with voluntary hospital ownership, church hospitals had a higher OR (1.13; 95 percent CI, 1.01 to 1.26) of VBAC compared with ERCD. The odds ratio was not significantly different from 1 (1.07; 95 percent CI, 0.95 to 1.21) if New York City hospitals were excluded. Government hospitals had a lower OR (0.77; 95 percent CI, 0.63 to 0.94) and this association did not change if New York City hospitals were excluded. Odds ratios increased with increasing levels of care from I (reference) to II (1.30, 95% CI: 1.18 to 1.44) to III (1.55; 95 percent CI, 1.34 to 1.81). The OR for teaching hospitals was 1.11 (0.99 to 1.24) compared with nonteaching hospitals although not significantly greater unless New York City hospitals were excluded (OR 1.36; 85 percent CI, 1.21 to 1.54).

Santerre[136] evaluated various predictors for rates of VBAC in a panel of 55 hospitals in Massachusetts in a study rated fair. The authors were specifically interested in ACOG guidelines but they also controlled for other factors, including hospital characteristics. Their model estimated lower VBAC rates at hospitals with a higher proportion of low birth weight babies, hospitals with a higher percentage of Hispanic babies, and nonteaching hospitals. Volume of births, presence of neonatal ICU, ownership status, and urban location did not predict VBAC rate in their model.

Shiono et al.[163] surveyed a random sample of US hospitals in a study rated fair. They reported rates of TOL adjusted for size of the delivery service (the stratification variable). Adjusted TOL rates were 12.5 percent and 6.5 percent in hospitals with and without NICUs, respectively. Rates for TOLs were 14.6 percent and 6.6 percent in hospitals with and without OB residency, respectively. Rates of TOLs and VBAC increased with increasing size of delivery service, but rates of successful TOLs were highest in hospitals with the smallest (less than 500) and largest (5,000 or more) number of annual deliveries.

The three descriptive studies[29, 157, 162] of hospital characteristics were all rated fair. These evaluated VBAC in small rural hospitals. Raynor[29] reported on the VBAC rate in a small rural hospital in North Carolina. The rate of TOL in 67 eligible patients was 76 percent and the rate of VBAC among these was 61 percent. Two uterine ruptures were reported in this study but neither was related to labor. Schimmel et al.[162] reported on a nurse-midwife service in a rural county in California. Among 37 patients, the VBAC rate was 87 percent and no uterine ruptures were reported. While these studies are small, they provide some evidence of the success of VBAC in

rural settings. The third descriptive study was conducted by Walton et al.[157] at an isolated US military hospital in Japan. Of 62 patients, 79 percent agreed to a TOL but 14 failed to meet guidelines for VBAC. Of the remaining 32, 88 percent achieved a VBAC. No uterine ruptures were reported. These reports, while limited, suggest that VBAC might be safely attempted in small rural hospitals. However, the effects of an adverse outcome of a TOL in a small rural setting have yet to be defined.

The comparative studies suggest there are some differences among types of hospital ownership with respect to rates of VBAC. However, categorization of hospital types varied across studies makes comparisons across studies difficult. Gregory et al.[61] reported higher rates of VBAC in public hospitals and private, non-teaching hospitals, and lower rates in private, non-teaching hospitals. Stafford[116] found statistically significantly higher rates of VBAC in Kaiser-affiliated hospitals, county hospitals, and University of California hospitals, compared with proprietary and private, nonprofit hospitals. King[115] found that, compared with voluntary ownership, rates of VBAC were statistically significantly higher in church-affiliated hospitals and lower in government-affiliated hospitals. McMahon et al.[5] found statistically significantly lower ORs for VBAC in regional and community hospitals, compared with tertiary medical centers. Santerre[136] found no statistically significant association of type of hospital ownership with VBAC rates. Thus, additional research is required to clarify this potential association.

With respect to hospitals with teaching programs, Gregory et al.[61] found private teaching hospitals had statistically significantly higher rates of VBAC than private non-teaching hospitals. King and Lahiri[115] estimated an statistically non-significant OR of 1.11 comparing VBAC and ERCD in teaching versus non-teaching hospitals. Stafford[116] found the highest OR for VBAC versus ERCD at hospitals that were members of the Council of Teaching Hospitals but ORs for other teaching hospitals (whether or not they were affiliated with medical schools) were lower than for non-teaching hospitals. Santerre[136] found a statistically significantly lower VBAC rate among non-teaching hospitals than teaching hospitals. Shiono et al.[163] estimated that hospitals with OB residency programs had statistically significantly different rates VBAC rates about twice as high as those that did not. Thus, as with ownership above, some studies suggest that teaching hospitals have higher rates of VBAC than non-teaching hospitals, but the association does not hold across all categorizations of teaching versus nonteaching.

With respect to the association of an NICU with rates of VBAC, Shiono et al.[163] estimated VBAC rates were about twice as high in hospitals with an NICU compared with hospitals without an NICU. Stafford[116] found an OR of 0.9 comparing hospitals with an NICU with those without (for VBAC versus ERCD). Santerre[136] found no significant association of the presence of an NICU with VBAC rate. Thus if there is an association of the presence of an NICU with VBAC rate, this association is not consistent across studies.

Across several hospital characteristics, there are no consistent associations with rate of VBAC. This might reflect lack of consistent definitions of categories across studies (e.g., types of hospital ownership), changes in these categorizations over time, a variation in the potential confounding variables that were controlled for in each study, or other factors.

As discussed in the patient preferences section, the decision between a TOL and ERCD is generally made prior to arrival at the hospital for delivery. Thus some hospital characteristics are likely to be confounded with other health care system characteristics (or patient or clinical status characteristics). In particular, providers affiliated with a particular type of hospital might exert much more influence on the decision for TOL or ERCD than the hospital itself. To the extent that a specific type of provider is associated with a particular type of hospital, there is a potential

for confounding of provider type with hospital type. It is important to know the extent to which hospital characteristics influence the decision on mode of delivery, compared with other health care system characteristics, so that future interventions can be effectively targeted.

Insurance

Among 12 papers[60, 115, 116, 136, 159, 164, 167, 169-173] evaluating the effect of insurance type on VBAC rates, five[115, 116, 136, 164, 170] were rated good or fair (Evidence Table 17a). The other seven were rated poor (Evidence Table 17b).

Stafford[170] reported on a cohort of women who delivered in 1986 in California in a study rated good. Unadjusted rates of VBAC were 8.1 percent (95 percent CI, 7.6 percent to 8.6 percent) for private insurers, 8.3 percent (7.3 percent to 9.4 percent) for non-Kaiser HMOs, 9.4 percent (8.6 percent to 10.1 percent) for Medi-Cal (California Medicaid), 18.1 percent (16.3 percent to 19.9 percent) for self-pay, 19.9 percent (18.3 percent to 21.5 percent) for Kaiser Permanente, 24.8 percent (20.4 percent to 29.3 percent) for indigent services, and 17.1 percent (10.5 percent to 19.7 percent) for other payers. Stafford reported that the unadjusted rates were similar to rates stratified on three potential confounders and rates adjusted by logistic regression model but only reported unadjusted rates. Stafford[116] reported adjusted ORs for the above cohort in another study rated good. The adjusted ORs for VBAC compared with ERCD (with private insurance as the reference) were 1.0 (95 percent CI, 0.8 to 1.1) for non-Kaiser HMO, 0.8 (0.8 to 0.9) for Medi-Cal, 1.7 (1.5 to 1.9) for self-pay, 3.9 (3.3 to 4.6) for Kaiser-Permanente with Kaiser payment, 2.6 (1.4 to 4.6) for Kaiser Permanente without Kaiser payment, 1.9 (1.0 to 3.6) for indigent services, and 1.3 (1.1 to 1.5) for other payers. All were significantly different from the reference except for nonKaiser HMO.

King and Lahiri[115] compared VBAC rates and adjusted ORs (adjusted for baseline risk and potential confounders) for VBAC across four insurance types. There was little variation among VBAC rates (21 percent for Medicaid to 25 percent for HMOs) and only the OR between HMOs and private insurance was different from 1 (1.15, 95% CI: 1.02, 1.30). The authors provided results for the state of New York that both included and excluded data from New York City. If data from New York City were omitted, the previous OR would not be different from 1 (OR 1.03; 95% CI, 0.90 to 1.17) but the OR comparing self-pay with private insurance (1.28; 95% CI, 1.01 to 1.81) would differ significantly from 1 (this OR was not different with data from New York City included). These ORs are all close to 1.0 whether or not they are statistically significant, suggesting a weak relationship of insurance type with VBAC rate.

A multivariable regression model by Santerre[136] showed no effect of payment source (private payer or public payer) on rates of VBAC. Thus, insurance type had no impact on VBAC rates after adjusting for other factors. Similarly, Gregory et al.[164] found no difference in VBAC rates for a dichotomous payment source variable (private insurance: yes or no) in a multivariable regression model.

The association between types of insurance (or payer) and VBAC rates are inconsistent across studies. While data from 1986 in California showed substantially higher rates of VBAC with Kaiser Permanente coverage and, to a lesser extent, indigent services and self-pay, similar associations have not been seen in other studies. Thus, this result may have been unique with respect to state, year, and payor.

In summary, because many factors including patient characteristics, access to obstetric providers, practice variation among providers, training of providers, ability to perform a cesarean

expeditiously, and hospital characteristics may all influence the likelihood of a patient to choose TOL and the safety of each choice, current studies have not been able to identify the conditions that increase risk of TOL or ERCD. While the various characteristics of health care systems have been discussed separately above, studies need to look across these characteristics to provide a complete picture and avoid potential confounding variables. For example, an analysis of type of provider might determine a lower rate of VBAC among midwives than among obstetricians. However, midwives might be more likely to provide obstetric care to women without insurance and women of lower education levels and socio-economic status, and might be more likely to work in clinical settings without around-the-clock availability of surgical and anesthetic services and might be subject to different legal restrictions. Given the large number of potential confounders, careful adjustment for these potential confounders needs to be performed. This will require large and detailed data sets with information on patients (both mother and newborn), hospital, and provider.

Summary

- Studies of legislation, policy, guidelines, hospital characteristics, provider characteristics, insurance type or access to care focus exclusively on VBAC rates rather than safety.
- There are no studies regarding the impact of the current malpractice crisis on availability of obstetric providers and impact on a patient's options.
- Studies of provider characteristics failed to control for important confounders such as patient selection bias.
- Studies of hospital characteristics consistently report higher VBAC rates for teaching hospitals, but they conflict on whether having a NICU affects rates.
- The association between insurance status and VBAC rates is inconsistent among studies
- Current studies have not controlled for confounding for factors such as patient selection bias, as such, they have not identified conditions or practice management styles that increase risk of TOL or ERCD.