Choosing the route of delivery after cesarean birth

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INTRODUCTION

Women who have undergone a previous cesarean delivery have the option of proceeding with a trial of labor after cesarean (TOLAC) delivery or planned repeat cesarean delivery (PRCD) in a subsequent pregnancy. Planned TOLAC may result in labor with vaginal birth (VBAC) or unplanned intrapartum cesarean delivery.

Decision making regarding mode of delivery must take into consideration the patient's personal preferences, obstetric history, data on the risks and benefits of TOLAC versus PRCD, and availability of TOLAC in the selected birth setting. Two major concerns that women have when making this decision are the chance of successful VBAC, which can be estimated with a calculator, and the chance of uterine rupture, which is low in women with one previous low transverse hysterotomy incision. (Related Pathway(s): Trial of labor after cesarean: Shared decision making with a pregnant woman.)

This topic will review issues related to choosing the route of delivery after cesarean birth, including calculators to predict an individual's likelihood of success. Issues related to management of labor and delivery during TOLAC and issues related to repeat cesarean delivery are discussed separately. (See "Trial of labor after cesarean delivery: Intrapartum management" and "Repeat cesarean delivery".)

RISKS/BENEFITS OF TOLAC VERSUS PRCD

Overview — The medical and obstetric benefits of successful TOLAC derive from avoidance of the potential adverse outcomes associated with repeat cesarean delivery, especially multiple repeat cesarean deliveries. Most maternal morbidity associated with TOLAC occurs when intrapartum cesarean delivery becomes necessary, which is associated with postoperative infection and other morbidities. A less common but serious potential adverse outcome associated with TOLAC is uterine rupture, which can be associated with serious morbidity, particularly for the neonate in whom uterine rupture can be fatal.

Conversely, the medical and obstetric benefits of PRCD derive from avoidance of the potential adverse outcomes associated with TOLAC, primarily uterine rupture and morbidity associated with intrapartum cesarean delivery. Thus, the benefits of TOLAC are closely related to having a successful vaginal birth, which has lower morbidity than both planned and intrapartum cesarean delivery. (See "Cesarean delivery: Postoperative issues", section on 'Complications' and "Uterine rupture: After previous cesarean delivery".)

In 2010, the National Institute of Child Health and Human Development and the Office of Medical Applications of Research of the National Institutes of Health convened a Consensus Development Conference to evaluate all available evidence related to TOLAC and make recommendations for practitioners regarding the management of women with a prior cesarean delivery [1]. Their final report summarized the state of knowledge concerning the outcomes of PRCD versus TOLAC in women who have undergone one or more prior cesarean deliveries. These findings and subsequent United States data are described throughout this topic.

Large data sets from other countries are also available and report similar findings. As an example, the Canadian Perinatal Surveillance System reported that term TOLAC in Canada between 2003 and 2015 was associated with an increased relative risk, but low absolute rate, of severe maternal morbidity and mortality compared with PRCD (adjusted rate ratio [RR] 1.96, 95% CI 1.76-2.19; 10.7 versus 5.65 per 1000 deliveries) [2]. The same was true for neonatal morbidity (seizures, assisted ventilation, continuous positive airway pressure) and mortality (adjusted RR 1.49, 95% CI 1.38-1.61; 20.8 versus 14.5 per 1000 deliveries).

Limitations of available evidence — No large randomized trials have been performed to provide comparative data on outcomes of TOLAC versus PRCD; a systematic review identified only two randomized trials involving a total of 320 women, with minimal data on maternal and infant clinical outcomes [3].

It is important to recognize that many case-control and cohort studies have compared these two routes of delivery. Most of these studies reported maternal and neonatal outcomes based on the actual route of delivery rather than the intended route. When this type of analysis is performed, the outcomes of women who underwent cesarean delivery after an unsuccessful TOLAC were grouped along with the outcomes of women who underwent PRCD, which is a less morbid procedure and biases the findings in favor of TOLAC. The outcomes of women who planned PRCD but spontaneously labored and were delivered vaginally were grouped along with the outcomes of women who had a successful TOLAC, which also biases findings and leads to misleading conclusions about the actual risk of adverse events or outcomes associated with the decision to attempt TOLAC or PRCD. Analysis of these data is also complicated by imprecise definitions and outcome measurements as well as difficulties encountered when trying to characterize events and outcomes attributable to route of delivery.

Although data from randomized trials would be ideal, it would be difficult to recruit adequate numbers of women willing to consent to randomization to TOLAC versus PRCD. In order to overcome this issue, a propensity analysis was performed to simulate a randomized trial of TOLAC versus PRCD in women with one prior cesarean delivery [4]. Propensity analyses can provide helpful insights by using statistical techniques to balance the comparison groups; however, they are not a substitute for well-designed prospective randomized trials. This propensity analysis found that the rates of endometritis, operative injury, respiratory distress syndrome, and newborn infection were lower with PRCD, whereas the rates of hysterectomy and wound complication were higher with PRCD. The authors estimated that 62 women (95% CI 40-138) would need to undergo PRCD to prevent one maternal adverse outcome from TOLAC and 43 women (95% CI 29-78) would need to undergo PRCD to prevent one neonatal adverse outcome from TOLAC.

Maternal outcomes — The following table summarizes maternal outcomes associated with VBAC and PRCD (table 1); it was derived from a 2010 systematic review of 41 studies [5] and is subject to the limitations discussed above. Selected outcomes are discussed in more detail below.

- **Uterine rupture** – The incidence of uterine rupture is low (in resource-rich countries), but when it occurs, it is often associated with TOLAC and is potentially life threatening. The National Institute of Child Health and Human Development consensus conference panel described uterine rupture risk in the following way [6], based on data in the 2010 systematic review [5]. Importantly, in this document, uterine rupture was defined anatomically as partial or complete separation of the uterine wall.
    - In a hypothetical group of 100,000 women of any gestational age who undergo TOLAC, there will be 468 cases of uterine rupture. Looked at in another way, approximately 1 in 200 TOLACs will lead to uterine rupture.
    - In a hypothetical group of 100,000 women of any gestational age who undergo PRCD, there will be 26 uterine ruptures.
    - The types and frequencies of major maternal and neonatal outcomes of uterine rupture would include:
        - Hysterectomy: 14 to 33 percent

- Maternal death: none
- Perinatal death: 0 to 2.8 percent

(See "Uterine rupture: After previous cesarean delivery".)

- **Infection** – Although the overall risk of maternal infection appears to be similar for TOLAC and PRCD [5], specific risks vary by clinical setting. For example, only women in labor are at risk for intrapartum chorioamnionitis. VBAC has a lower frequency of postpartum infection than PRCD, while intrapartum cesarean delivery has the highest frequency of postpartum infection [7]. (See "Intraamniotic infection (clinical chorioamnionitis or triple I)" and "Postpartum endometritis" and "Cesarean delivery: Postoperative issues", section on 'Complications'.)

- **Peripartum hysterectomy** – Although some peripartum hysterectomies are performed because of uterine rupture during TOLAC, many others are performed because of placental attachment disorders, which are associated with prior cesarean delivery: An increasing number of cesarean deliveries increases the risk for placenta previa and, in turn, the placenta accreta spectrum. (See "Placenta accreta spectrum: Clinical features, diagnosis, and potential consequences", section on 'Risk factors'.)

- **Pelvic floor disorders** – PRCD avoids the potential risks and sequelae of pelvic trauma related to labor and vaginal birth; however, the absolute benefit compared with TOLAC is unclear and does not appear to outweigh the risks of PRCD. Pregnancy itself is the major risk factor for future pelvic relaxation disorders. (See "Effect of pregnancy and childbirth on urinary incontinence and pelvic organ prolapse".)

- **Convenience** – For many patients, a benefit of PRCD is that scheduled delivery allows her and her family the ability to make specific work-life plans for the delivery and postpartum period. Although induction of labor can also be scheduled, TOLAC is more likely to be successful when labor is spontaneous and thus somewhat unpredictable.

  Personal benefits of VBAC include shorter hospital stay and quicker return to normal activities compared with PRCD.

- **Postpartum sterilization** – Postpartum sterilization (also called permanent contraception) is readily accomplished at cesarean delivery; however, this is a minor advantage of PRCD since sterilization can be performed after a vaginal birth and often immediately following the birth. (See "Postpartum permanent contraception: Procedures".)

Neonatal outcomes — Data regarding the short- and long-term neonatal outcomes after TOLAC versus PRCD are limited and subject to the limitations discussed above [1]. The 2010 systematic review of 41 studies discussed above reported the following neonatal outcomes related to TOLAC and PRCD [5]:

- **Perinatal mortality and neonatal mortality** – Perinatal mortality and neonatal mortality rates were higher for TOLAC than for PRCD (perinatal mortality rate: 0.13 versus 0.05 percent; neonatal mortality rate: 0.11 versus 0.06 percent), although the absolute risk is very low.

- **Transient tachypnea of the newborn** – Transient tachypnea of the newborn was more common with PRCD compared with TOLAC (4.2 versus 3.6 percent). However, neonatal bag and mask ventilation was used more often in infants delivered following TOLAC than in those delivered by PRCD (5.4 versus 2.5 percent).

- **Other** – Data were insufficient to determine the direction of risk for hypoxic-ischemic encephalopathy, sepsis, trauma, neonatal intensive care unit (NICU) admission, and adverse neurologic outcomes. However, subsequent studies have reported that the rates of suspected and proven neonatal sepsis are higher for TOLAC than PRCD (suspected sepsis 5 versus 2 percent; proven sepsis 1 versus 0 percent) [8] and reported an increased risk of neonatal depression and NICU admission for TOLAC versus PRCD [9,10].

FACILITY RESOURCES FOR OFFERING TOLAC

The American College of Obstetricians and Gynecologists (ACOG) recommends conducting TOLAC in facilities that are able to perform an emergency cesarean delivery in the event of a situation that is an "immediate threat to the life of the woman or fetus" [11]. ACOG emphasized that this recommendation was not intended to restrict access to TOLAC and recognized the difficulty of providing this type of care, especially in rural settings. The resources necessary to perform emergency cesarean delivery are described separately. (See "Trial of labor after cesarean delivery: Intrapartum management", section on 'Facility resources'.)

When resources needed for emergency cesarean delivery are limited, ACOG recommends that practitioners discuss the available resources at the planned birth facility with women who are considering TOLAC. After this discussion, some women may consider an alternative delivery site that has resources for performing an emergency cesarean delivery and providing the required neonatal care in the event of complications, some may tolerate higher levels of risk in order to pursue TOLAC at their preferred birth facility, and some may choose PRCD. A decision to plan for TOLAC in a setting lacking resources to perform an emergency cesarean delivery should be made only after careful consideration by the woman and her health care provider. In such instances, the discussion and plan should be documented in the obstetric record. Discussion of delivery options early in pregnancy can facilitate transfer of care if desired by the patient and practitioner.

We agree with ACOG that TOLAC should not be attempted as a home birth.

FACTORS TO CONSIDER IN SHARED DECISION MAKING

The decision for a TOLAC or PRCD is made by the woman in collaboration with her provider. The discussion should begin early in the course of prenatal care and may even begin before conception. Ongoing discussion throughout pregnancy is important as conditions may arise that alter the balance of risks and benefits of the planned route of delivery. Whenever possible, the woman's preference should be honored [1,6].

This decision should be based upon the best available clinical evidence and involves a combination of factors, including:

- **Availability of TOLAC at the planned birth setting** (see 'Facility resources for offering TOLAC' above)
- **Probability of VBAC** (see 'Predicting the probability of VBAC' below)
    - In 2013, the success rate for women in the United States who attempted TOLAC after one previous cesarean delivery was 70.4 percent, and for those with two or more prior cesarean deliveries, it was 51.4 percent [12]. The success rate varies among institutions and providers and is affected by antepartum, intrapartum, and nonmedical factors [6]. Factors known to affect TOLAC success rates and the individual patient's probability of success obviously need to be addressed in shared decision making.
    - In a 2010 meta-analysis, the two factors that increased the odds of VBAC by at least threefold were history of VBAC and history of vaginal delivery [13]. The most important factor associated with failed TOLAC (ie, intrapartum cesarean delivery) was a prior cesarean delivery for a recurring indication, such as failure to progress. Other factors that played a role, but were not as strongly associated with failed TOLAC, were increasing body mass index and older maternal age. Induction of labor significantly reduced the odds of VBAC compared with entering labor spontaneously, but a better control group would have been women who were managed expectantly. (See 'Predicting the probability of VBAC' below.)
- **Benefits and significance and estimated frequency of complications with TOLAC and PRCD**, including individual patient factors that affect the risks and benefits for each delivery route (see 'Risks/benefits of TOLAC

versus PRCD' above) and individual patient factors that impact the risk of uterine rupture. (See 'Candidates for TOLAC' below.)

Unlike most medical decisions, where patients are comparing risks and benefits for themselves, the pregnant patient must compare risks and benefits for both herself and her fetus, and the risks and benefits for these two individuals sometimes do not align: A decision that increases maternal risk may be associated with fetal benefit. It should be noted that most pregnant women are willing to tolerate a high degree of risk to themselves in exchange for zero or near-zero risk for their child [14,15], although, occasionally, the desire to achieve a natural birth can lead to increasing the risk to their child as in the case of the out-of-hospital TOLAC [16-19].

- **Personal values, preferences, past birthing experiences, and future pregnancy plans**. A woman's decision regarding route of delivery is influenced by factors other than the VBAC rate and risk of uterine rupture.

  Common reasons women choose TOLAC include [1,6]:

  - Future pregnancy plans since multiple cesarean deliveries increase the risk for placenta previa/accreta
  - Family obligations that make a speedy return to normal activities postpartum desirable
  - Desire to experience a vaginal birth
  - Desire for their partners' involvement in labor and birth

  Common reasons women choose PRCD include:

  - Scheduling convenience
  - Ease of sterilization at the time of delivery
  - Fear of failed trial of labor and emergency cesarean delivery
  - Avoidance of labor pain

In addition, women report that their health care providers' recommendations and preferences exert a strong influence on their decision of whether or not to pursue TOLAC [20].

CANDIDATES FOR TOLAC

Optimal candidates — The ideal candidates for TOLAC are women with a high likelihood of VBAC and a very low likelihood of intrapartum uterine rupture.

One prior low transverse uterine incision — Practitioners should obtain operative reports from prior cesarean deliveries to document the location of the hysterotomy. There is good and consistent evidence that a woman who has undergone only one previous cesarean delivery via a low transverse hysterotomy incision has the lowest risk of uterine scar separation during a subsequent trial of labor; thus, TOLAC is a reasonably safe option for these women [1,6]. In this setting, the body of evidence suggests a VBAC rate of 60 to 80 percent [21], with an estimated uterine rupture rate of 0.4 to 0.7 percent [6,22].

Other potential candidates

Prior low vertical uterine incision — As discussed above, practitioners should obtain operative reports from prior cesarean deliveries to determine whether a vertical uterine incision was performed and its upper extent. If it extended into the contractile portion of the uterus, the patient should be managed as if she had a prior classical hysterotomy and is not an appropriate candidate for TOLAC. (See 'Prior transfundal uterine incision' below.)

If the incision did not extend into the contractile portion of the uterus, we and the American College of Obstetricians and Gynecologists (ACOG) suggest that the provider discuss the available data on uterine rupture with the patient and together they may reasonably choose to proceed with TOLAC [11]. Although a literature review reported that the frequency of rupture for low vertical uterine incisions ranged from 1.05 to 2.0 percent versus 0.4 to 0.7 percent for

low transverse uterine incisions [21], the evidence was inconclusive due to study limitations and inconsistency among the studies.

Two prior low transverse uterine incisions — We and ACOG consider women with two prior cesarean deliveries to be acceptable candidates for TOLAC, with individualized counseling that accounts for other factors that predict the likelihood of success [11]. (See 'VBAC calculators' below.)

The likelihood of VBAC appears to be similar for women with one versus two prior cesarean deliveries (65 to 85 percent) [23-26]; however, women with more than one prior cesarean may have a slightly higher rate of uterine rupture. In a 2010 meta-analysis of five cohort studies of uterine rupture in women with prior cesarean deliveries, women undergoing TOLAC after one prior cesarean were at significantly lower risk of rupture than those with two prior cesareans (0.72 versus 1.59 percent, odds ratio [OR] 0.42, 95% CI 0.29-0.60); however, the definition of rupture varied among studies [27].

Three prior low transverse uterine incisions — Individual counseling, which incorporates future childbearing desires and likelihood of successful VBAC, is important in counseling women with three or more prior cesarean deliveries; however, only sparse data are available. In one retrospective cohort study, 89 women with three or more prior cesarean deliveries underwent TOLAC; women in this study were as likely to have a successful VBAC as those with one prior cesarean and did not experience higher composite maternal morbidity (uterine rupture, bowel or bladder injury, or uterine artery laceration) [28].

Unknown type of uterine incision — The prior incision type is not always available when caring for a woman in her subsequent pregnancy. Because most women with a prior uterine incision for common obstetric indications have had a low transverse hysterotomy, we and ACOG believe that decision making regarding TOLAC versus PRCD can often be based upon this assumption [11]. This conclusion is supported by data from two large studies that found women who had an unknown type of prior incision had a similar rate of uterine rupture as those with a known prior low transverse uterine incision [7,29]. As an example, uterine rupture occurred in 0.5 percent of women with an unknown scar type and 0.7 percent of women with a known low transverse uterine incision in the National Institute of Child Health and Human Development (NICHD) Maternal-Fetal Medicine Units (MFMU) Network study [7].

Importantly, TOLAC should not be pursued if there is a high clinical suspicion that a prior uterine incision was made into the upper segment of the uterus, such as when a cesarean is performed before approximately 28 weeks or in the setting of known lower uterine segment pathology (eg, large leiomyoma). It also should not be pursued if the patient was told that she is not a candidate for TOLAC in the future by the clinician performing the cesarean. As an example, a prospective study observed that over one-third of women who underwent cesarean delivery before 26 weeks had a classical hysterotomy (34.9 compared with 7.8 percent at ≥26 weeks) [30].

Pregnancy more than 40 weeks of gestation — Although studies have consistently observed that women who attempt TOLAC beyond 40 weeks of gestation are less likely to have a VBAC [1,31,32], we and ACOG do not consider this gestational age a contraindication to TOLAC [11].

A large retrospective cohort study including over 11,500 women delivering by TOLAC at both community and tertiary centers found similar rates of uterine rupture in those who delivered <40 and ≥40 weeks of gestation (1.0 and 1.1 percent, respectively) [32]; however, at least two reports with a total of approximately 4100 patients described a higher risk of uterine rupture with TOLAC after 40 weeks (2 to 3 percent) [33,34].

We recommend not performing induction at 39 weeks for the sole purpose of avoiding TOLAC after 40 weeks. In a large study including over 12,600 women, although induction at 39 weeks was associated with a higher VBAC rate than expectant management (74 versus 61 percent), the risk of uterine rupture was also higher (1.4 versus 0.5 percent) [35].

Twin gestation — We agree with ACOG that women with twin pregnancies and one previous low transverse cesarean delivery are candidates for TOLAC if they have no contraindications to vaginal birth [36]. While most studies

report that women with a twin gestation are significantly less likely to pursue TOLAC, the overall success rate and risk of uterine rupture in this population appears to be similar to that in singleton gestations undergoing TOLAC. (See "Twin pregnancy: Labor and delivery", section on 'Trial of labor after previous cesarean delivery'.)

Macrosomia — We agree with ACOG that suspected fetal macrosomia (estimated fetal weight ≥4000 g) alone should not preclude the option of TOLAC [11,37]. In addition to usual factors, clinicians should consider past birth weight(s) and outcomes and the predicted birth weight in the current pregnancy when assessing risks of TOLAC and probability of VBAC.

For women with no previous vaginal delivery, the likelihood of VBAC falls to ≤50 percent when birth weight increases above 4000 g [38,39]. In one study of TOLAC among such women, newborn birth weights <4000 g, 4000 to 4249 g, 4250 to 4500 g, and >4500 g were associated with VBAC in 68, 52, 45, and 38 percent of cases, respectively [38]. Success rates were lower if the indication for the previous cesarean delivery was cephalopelvic disproportion, failure to progress, or if the woman required either induction or augmentation of labor during TOLAC. In contrast, women who had a previous vaginal delivery had a ≥63 percent rate of VBAC for any of the birth weight strata.

It also should be noted that women attempting TOLAC with no prior vaginal delivery and/or newborn birth weight >4000 g may have a higher likelihood of adverse obstetric outcomes, such as uterine rupture [38,40,41]. In one study, such women had a 3.6 percent rate of rupture [38]. Notably, the overall uterine rupture rate in this study was 1.4 percent, which exceeds that in the majority of large cohort studies and may reflect ascertainment of uterine rupture through diagnostic codes rather than chart abstraction. Thus, this reported rate should be considered as part of decision making regarding TOLAC rather than utilized as a quoted probability of uterine rupture in direct patient counseling.

Outside of the setting of TOLAC, ACOG guidelines consider cesarean delivery appropriate when the estimated fetal weight is ≥5000 g in women without diabetes and ≥4500 g in women with diabetes [37].

Obese women — We agree with ACOG that women with a body mass index (BMI) ≥30 kg/m^2 are potential candidates for TOLAC after consideration of the effects of individual characteristics, such as a prior vaginal delivery, on probability of VBAC and risks associated with PRCD versus TOLAC [11]. We do not have a specific limitation related to BMI and recognize that obese women may require more time to achieve vaginal delivery. (See "Obesity in pregnancy: Complications and maternal management", section on 'Progress of labor'.)

Observational studies have consistently reported that TOLAC is less likely to result in VBAC in obese gravidas [6,42-49]. The largest of these studies was a prospective multicenter study including 6413 obese (BMI 30 to 39.9 kg/m^2) and 1638 severely obese (BMI ≥40 kg/m^2) women [45]. The rate of failed trial of labor was 15 percent in normal-weight women, 30 percent in obese women, and 39 percent in severely obese women. The rate of uterine dehiscence/rupture for the three groups was 0.9, 1.4, and 2.1 percent, respectively.

No guidelines have addressed whether TOLAC should be avoided in severely obese women or at any threshold BMI. A secondary analysis of MFMU Cesarean Registry data suggests that obese women undergoing TOLAC are more likely to undergo repeat cesarean during the latent phase despite receiving higher doses of oxytocin and a longer interval to achieve active labor [50].

Maternal diabetes — We do not consider gestational and pregestational (preexisting) diabetes a contraindication to TOLAC. We counsel women with these disorders that the overall rate of VBAC appears to be lower in women with diabetes compared with nondiabetic women undergoing TOLAC [44,51,52]; we discuss the potential for shoulder dystocia, especially in the setting of macrosomia; and we consider their past delivery history in assessing both their probability of VBAC and shoulder dystocia. (See "Shoulder dystocia: Risk factors and planning delivery of high-risk pregnancies".)

Outside of the setting of TOLAC, ACOG considers cesarean delivery appropriate when the estimated fetal weight is ≥4500 g in women with diabetes [37]. ACOG has not addressed the specific issue of TOLAC in women with diabetes.

Prior one- versus two-layer uterine closure — We generally do not take the technique of prior hysterotomy closure into consideration when counseling women about TOLAC. A retrospective cohort study of 7683 women attempting TOLAC using Danish birth registry data found no association between single-layer closure and uterine rupture when compared with double-layer closure (OR 1.17, 95% CI 0.78-1.76) [53]. These findings are consistent with a prior meta-analysis (nine studies, 5810 women) that also demonstrated no association [54]. However, observational studies have inherent biases, and most are underpowered for the outcome of uterine rupture. Long-term follow-up data from women enrolled in randomized trials are needed.

ACOG has not addressed the specific issue of prior one- versus two-layer closure when considering whether a woman is an appropriate candidate for TOLAC.

Inappropriate candidates — TOLAC is inappropriate in women with standard contraindications to labor or vaginal birth (eg, placenta previa).

We agree with ACOG that the high risk of intrapartum uterine rupture during TOLAC favors PRCD in women with [11]:

- Prior transfundal uterine incision
- Prior uterine rupture

Timing of PRCD in these settings is reviewed separately. (See "Repeat cesarean delivery", section on 'Timing'.)

Prior transfundal uterine incision — We do not offer TOLAC to women with a prior transfundal uterine incision. A transfundal uterine incision may have been made at a prior cesarean delivery, during a gynecologic surgical procedure (eg, myomectomy, uterine reconstruction because of congenital uterine anomaly), or to gain access to the fetus for a surgical procedure.

- **Classical, T, or J incisions at cesarean delivery** – In a literature review, the frequency of rupture for classical or T-shaped incisions ranged from 4 to 9 percent, which is at least twofold higher than the upper estimate of rupture risk for low vertical incisions and more than fivefold higher than the upper estimate of rupture risk for low transverse uterine incisions [21].

  The best available data derive from a large, prospective, multicenter, NICHD MFMU Network study of TOLAC that evaluated the outcome of women with prior classical or either inverted T or J incision who presented in advanced labor or declined repeat cesarean delivery [7]. The uterine rupture rate was lower than expected in this study, 1.9 percent, but still unacceptably high.

- **Transmyometrial incisions for open fetal surgery** – In a retrospective study of reproductive outcomes in subsequent pregnancies after a pregnancy in which open fetal surgery was performed, 14 percent had a uterine dehiscence and another 14 percent had a uterine rupture [55], making the risk of rupture unacceptably high.

- **Transmyometrial incisions to resect leiomyomas** – The risk of rupture may be increased if the uterine cavity was entered or nearly entered during a prior myomectomy or a large number of myomas were removed. Although the overall quality of this evidence is low, the risk of rupture in these patients is likely unacceptably high. (See "Uterine fibroids (leiomyomas): Issues in pregnancy", section on 'Route of delivery and timing of scheduled cesarean delivery'.)

Prior uterine rupture or dehiscence — We do not offer TOLAC to women with a prior uterine rupture. Women who have experienced a previous uterine rupture confined to the lower uterine segment are reported to have a high incidence (6 percent) of recurrent uterine rupture with labor [56-60]. Those in whom the prior rupture involved the upper uterine segment have experienced a repeat rupture rate as high as 32 percent [56]. In a 25-year literature review, 22 women identified to have uterine rupture subsequently became pregnant again [59]. Twenty underwent PRCD at term; the other two women died following catastrophic uterine rupture at 32 and 35 weeks of gestation. As above, although the overall quality of this evidence is low, the risk of rupture in these patients is likely unacceptably

high. (See "Uterine rupture: After previous cesarean delivery", section on 'Recurrence risk' and "Uterine rupture: After previous cesarean delivery", section on 'Management of subsequent pregnancies'.)

We also do not offer TOLAC to women with a prior uterine dehiscence, given the limitations of available data, particularly the lack of consistent definitions for rupture versus dehiscence and the lack of consistency in distinguishing catastrophic rupture from benign rupture or dehiscence. The likelihood of subsequent uterine rupture with potential catastrophic outcome is unclear. ACOG has not made specific recommendations for the management of women with dehiscence and does not distinguish between women with dehiscence and those with rupture in its TOLAC guideline [11].

Special populations and other considerations

Fetal demise — The balance of risks and benefits is different in the setting of fetal demise since PRCD has no fetal/neonatal benefit. Decision making on the route of delivery in these cases is reviewed separately. (See "Stillbirth: Maternal care".)

Thin lower uterine segment — We do not measure uterine scar thickness because no myometrial thickness threshold value performs sufficiently well to use in clinical practice to predict whether a hysterotomy scar will rupture or remain intact. Studies on use of imaging techniques to predict women at increased risk of uterine rupture during TOLAC have had mixed results and are reviewed separately. (See "Uterine rupture: After previous cesarean delivery", section on 'Antepartum imaging of the hysterotomy scar'.)

Breech presentation — Prior low transverse cesarean delivery is not a contraindication to external cephalic version; however, there is only limited evidence that it is safe in this population. (See "External cephalic version", section on 'Prior low transverse cesarean delivery'.)

PREDICTING THE PROBABILITY OF VBAC

Our approach — In the author's practice, women with a previous cesarean delivery and a history of vaginal birth (either prior vaginal delivery or VBAC) are encouraged to undertake a TOLAC (assuming no contraindications), given that the VBAC rate has been reported to be as high as 83 percent for women with a previous vaginal delivery and 94 percent for women with a previous VBAC [13].

For patients outside of this small subset of the population, the author frequently uses a VBAC calculator to inform women of their individual chance of achieving a vaginal birth. This can be enlightening for women who are unaware that they have a good chance of achieving a vaginal delivery after their previous cesarean. Many good candidates for TOLAC choose PRCD, possibly because of lack of awareness of their chance of VBAC and the relative risks of each approach [61]. (See 'VBAC calculators' below.)

The following observational data suggest that the morbidities of TOLAC and PRCD are equivalent when the predicted chance of VBAC is >60 to 70 percent, but higher with TOLAC when the predicted chance of VBAC is <60 to 70 percent [62,63]; no randomized trials have been performed.

- A prospective cohort study including over 13,500 women eligible for TOLAC compared rates of major morbidity (hysterectomy or operative injury) and minor morbidity (puerperal fever, blood transfusion, abdominal wound infection) in women undergoing PRCD with women undergoing TOLAC, stratified by their likelihood of VBAC using the Maternal-Fetal Medicine Units (MFMU) Network at entry to prenatal care calculator [62]. Women with >70 percent likelihood of VBAC had maternal morbidity similar to those undergoing PRCD (relative risk [RR] 0.80, 95% CI 0.5-1.2), while women with a calculated likelihood of VBAC <70 percent had an increased risk of maternal morbidity (RR 2.2, 95% CI 1.5-3.1).

- In a retrospective cohort study of 8505 women eligible for TOLAC, maternal morbidity in the TOLAC group was similar to that in the PRCD group when the predicted probability of VBAC was ≥60 percent (RR 0.8, 95% CI 0.6-

1.1) but was higher than the PRCD group when the predicted probability of VBAC was <60 percent (RR 2.3, 95% CI 1.4-4.0) [63]. Neonatal morbidity was similar between groups when the probability of VBAC was ≥70 percent (RR 1.2, 95% CI 0.9-1.5).

Neither study's composite maternal morbidity outcome included obstetric anal sphincter injury (OASIS), which appears to be increased in patients undergoing TOLAC compared with nulliparous patients undergoing a first vaginal delivery [64-66]. Risk factors for OASIS are reviewed separately. (See "Obstetric anal sphincter injury (OASIS)", section on 'Epidemiology and risk factors'.)

The author uses the MFMU Network at entry to prenatal care calculator (see 'MFMU Network calculator for use at entry to prenatal care' below) to help women begin to make decisions regarding their planned delivery route [42]. The calculated predicted probability of VBAC is documented in the medical record but does not replace documentation of the complete counseling session, including the risks and benefits associated with a TOLAC. Other clinical factors that are discussed with some patients, as clinically appropriate, include specific circumstances of the prior cesarean delivery, anticipated size of this infant, desire for future childbearing, and other individual level factors that may influence the chance of success.

The author does not use VBAC calculator results to strongly discourage a motivated patient from pursuing a TOLAC, given the poor negative predictive value of existing models. Many patients with a low predicted probability of vaginal birth using a VBAC calculator will still deliver vaginally [13].

Women who are good candidates for TOLAC but desire a repeat cesarean delivery are encouraged to keep an open mind. If these women present in spontaneous labor prior to their scheduled cesarean delivery or are undecided at admission to the labor unit, the possibility of TOLAC can be readdressed using an admission for delivery model, such as the MFMU Network model. (See 'MFMU Network calculator for use at admission for delivery' below.)

VBAC calculators — Both clinicians and patients typically desire individualized information about (1) the chance of VBAC and (2) the balance between the risks of maternal or fetal morbidity with TOLAC compared with PRCD. Many calculators have been created in order to assist women in better understanding their individual chance of success.

The goal of TOLAC calculators and models is to predict a woman's chance of VBAC based on her demographic and clinical risk factors [42,67-71]. The probability of VBAC is not only important as a direct measure of outcome, but also as an indirect measure of maternal morbidity: Major maternal morbidity is lowest in women who have VBAC (morbidity 0.2 percent), higher in women who undergo PRCD (morbidity 0.8 percent), and highest in women who have a repeat cesarean delivery after a failed TOLAC (morbidity 3.8 percent) [72].

Although a TOLAC calculator or model can predict the probability of vaginal birth, which is a key concern of women contemplating TOLAC versus PRCD, a variety of other factors also influence a woman's decision regarding route of delivery. These factors are not addressed by calculators and are discussed above. (See 'Factors to consider in shared decision making' above.)

The calculators discussed in this topic were chosen because they are widely used in practice, were developed using a multivariable logistic regression model, and have been validated in at least one external retrospective cohort. However, these calculators have several limitations, including [73,74]:

- No calculator has been prospectively validated to determine whether utilization of the calculator actually affects patient decision making or reduces maternal morbidity
- No calculator has been validated in women with multiple gestations
- No calculator predicts patient-specific morbidity rates, such as risk of uterine rupture

MFMU Network calculator for use at entry to prenatal care — The MFMU website provides a VBAC calculator at no cost that predicts the chance of VBAC based on information available at the first prenatal visit [75]. The

calculator includes fields for maternal age, height, weight, and prepregnancy body mass index (BMI), and yes/no options for the following fields: African American race, Hispanic ethnicity, prior vaginal delivery, prior VBAC, and prior cesarean for arrest of dilation or descent (ie, a potentially recurring indication for cesarean delivery). It has been validated in women with one or two prior cesarean deliveries [23].

The MFMU Network entry to prenatal care calculator was created using a multivariable logistic regression model in a prospective cohort of women undergoing a trial of labor with a term singleton fetus in cephalic presentation after one prior low transverse cesarean delivery [42]. Of the study population of 11,856 women, 73 percent delivered vaginally. The overall predictive capability of the model was fair to good, with an area under the curve (AUC) of 0.75 (95% CI 0.74-0.77). (A Receiver Operating Characteristic curve plots true positives against false positives; a test with AUC 0.5 is equivalent to a coin toss whereas AUC 1.0 accurately discriminates between true positives and false positives.) The best performance was in women with a predicted probability of vaginal delivery greater than 35 percent. Imprecision below 50 percent is unlikely to be clinically important because many clinicians and patients consider an estimate below 50/50 a disincentive to attempt TOLAC. The nomogram was internally validated with a subset of the initial study population [42] and several independent retrospective cohorts [76-79].

Although the MFMU Network prenatal care prediction nomogram is useful for identifying women who are either excellent or very poor candidates for TOLAC, it does not incorporate factors that arise later in gestation that are known to influence the probability of VBAC. While the addition of midtrimester cervical length at 18 to 24 weeks to the prenatal care prediction nomogram improved the overall predictive capability of the model based on the AUC, it did not significantly improve the clinical utility of the model [80]. Incorporating cervical length did not significantly lower the prediction for VBAC in women who went on to have an intrapartum cesarean and did not significantly raise the prediction for VBAC in women who went on to have a VBAC.

An UpToDate calculator (calculator 1) for predicting the probability of VBAC in patients at presentation for prenatal care is also available, based on the same source as the MFMU calculator and yielding the same results. UpToDate acknowledges that the association between race/ethnicity and VBAC success rates is not based on biologic evidence and is likely explained by other variables. UpToDate is working toward better defining these variables and making adjustments to the calculator so that race and ethnicity can be removed.

MFMU Network calculator for use at admission for delivery — The MFMU Network website also provided a VBAC calculator at no cost that predicted the chance of VBAC based on information available at the time of admission for delivery [81]. This model was developed using the same MFMU Network data described above but replaced the prepregnancy height and weight (BMI) with height and weight (BMI) at delivery (or at last prenatal visit within two weeks of delivery if not available at the time of delivery) and included other factors determined at admission for delivery [71]. These additional factors include gestational age, cervical examination (effacement, dilation, station), preeclampsia/gestational hypertension (yes/no), and induction (yes/no). Inclusion of these additional factors slightly improved the performance of the calculator. The overall AUC for this model was 0.77 (95% CI 0.76-0.78). It was externally validated in independent cohorts of women with one prior cesarean delivery [82,83].

An UpToDate calculator (calculator 2) for predicting the probability of VBAC in patients at presentation for delivery is also available, based on the same source as the MFMU calculator and yielding the same results.

The MFMU and UpToDate acknowledge that the association between race/ethnicity and VBAC success rates is not based on biologic evidence and is likely explained by other variables. Both are working toward better defining these variables and making adjustments to their calculators so that race and ethnicity can be removed.

Shared decision-making model — A shared decision-making model for choosing mode of delivery in women with a history of cesarean delivery uses an existing VBAC calculator as part of the shared decision-making process (algorithm 1). It has been hypothesized that the number of women eligible for TOLAC who opt for it rather than PRCD could be increased with use of a decision support tool that provides accurate information regarding the process and potential outcomes of both modes of delivery, an individualized assessment of their likelihood of

successful VBAC, and consideration of their values and preferences. However, the first large randomized trial (PROCEED) of a well-designed, patient-centered decision support tool did not raise the TOLAC rate compared with usual care (TOLAC rate 43.3 versus 46.2 percent) [84]. The multicenter trial included 1485 patients less than 25 weeks with one prior cesarean delivery and no contraindication to TOLAC. It is possible that usual care in the academic centers where the trial was conducted was highly effective, and the tool might be more useful in other settings. In this trial, both groups had low decisional conflict, similar knowledge, high decision self-efficacy, and high decisional satisfaction, which indicated similar decision quality.

Model for preterm pregnancies — Only one model predicts the likelihood of VBAC in women who are delivering preterm. This model was created from an existing prospectively collected cohort of 1295 women undergoing TOLAC between 26+0 and 36+6 weeks of gestation and had an overall VBAC rate of 76.6 percent [85]. Factors associated with increased likelihood of VBAC were diabetes, greater cervical dilation, history of vaginal birth, and history of VBAC. Factors associated with a decreased likelihood of VBAC were induction of labor, recurring indication for prior cesarean, and hypertensive disease. The overall predictive capability of the model was very good with an AUC of 0.80 (95% CI 0.77-0.83). The lengthy logistic regression equation used to calculate the likelihood of VBAC is not useful as a point-of-care resource but is available at the end of the publication.

COST-EFFECTIVENESS

The cost-effectiveness of TOLAC depends upon the likelihood of VBAC. In a decision analytic model with a hypothetical cohort of 100,000 women undergoing TOLAC versus PRCD, TOLAC was cost-effective when the probability of VBAC was >47.2 percent [86]. Although this model was based upon costs in 2009, the findings are likely to continue to be valid.

SOCIETY GUIDELINE LINKS

Links to society and government-sponsored guidelines from selected countries and regions around the world are provided separately. (See "Society guideline links: Cesarean delivery".)

INFORMATION FOR PATIENTS

UpToDate offers two types of patient education materials, "The Basics" and "Beyond the Basics." The Basics patient education pieces are written in plain language, at the 5th to 6th grade reading level, and they answer the four or five key questions a patient might have about a given condition. These articles are best for patients who want a general overview and who prefer short, easy-to-read materials. Beyond the Basics patient education pieces are longer, more sophisticated, and more detailed. These articles are written at the 10th to 12th grade reading level and are best for patients who want in-depth information and are comfortable with some medical jargon.

Here are the patient education articles that are relevant to this topic. We encourage you to print or e-mail these topics to your patients. (You can also locate patient education articles on a variety of subjects by searching on "patient info" and the keyword(s) of interest.)

- Basics topics (see "Patient education: Vaginal birth after cesarean delivery (The Basics)")

SUMMARY AND RECOMMENDATIONS

Women who have undergone a previous cesarean delivery have the option of proceeding with a trial of labor after cesarean (TOLAC) or planned repeat cesarean delivery (PRCD) in a subsequent pregnancy. Planned TOLAC may result in labor with vaginal birth (VBAC) or unplanned intrapartum cesarean delivery. Decision making regarding mode of delivery must take into consideration the patient's personal preferences, obstetric history, scientific data on risks and

benefits of TOLAC versus PRCD, and availability of TOLAC in the selected birth setting. (Related Pathway(s): Trial of labor after cesarean: Shared decision making with a pregnant woman.)

- The medical and obstetric benefits of successful VBAC derive from avoidance of the potential adverse outcomes associated with cesarean delivery, especially multiple cesarean deliveries. Conversely, the medical and obstetric benefits of PRCD derive from avoidance of the potential adverse outcomes associated with TOLAC, primarily uterine rupture and morbidity associated with intrapartum cesarean delivery. (See 'Risks/benefits of TOLAC versus PRCD' above.)

- The decision for a TOLAC or PRCD is a shared decision made by the woman in collaboration with her provider. This decision involves a combination of factors, including (see 'Factors to consider in shared decision making' above):

  - Availability of TOLAC at the planned birth setting. (See 'Facility resources for offering TOLAC' above.)

  - Probability of VBAC. (See 'Predicting the probability of VBAC' above.)

  - Significance and estimated frequency of complications with TOLAC and PRCD, including individual patient factors that affect the risks and benefits for each delivery route. The following table summarizes maternal outcomes associated with VBAC and PRCD (table 1); it was derived from a 2010 systematic review of 41 studies and is subject to several limitations. The maternal morbidity of TOLAC appears to be higher than that for PRCD when the predicted chance of vaginal delivery is <60 to 70 percent. (See 'Risks/benefits of TOLAC versus PRCD' above.)

  - Personal values, preferences, past birthing experiences, and future pregnancy plans.

- A woman who has undergone only one previous cesarean delivery via a low transverse hysterotomy incision has the lowest risk of uterine scar separation during a subsequent trial of labor; thus, TOLAC is a reasonably safe option for these women. The body of evidence suggests a VBAC rate of 60 to 80 percent, with an estimated uterine rupture rate of 0.4 to 0.7 percent. (See 'One prior low transverse uterine incision' above.)

- TOLAC is inappropriate in women with standard contraindications to labor or vaginal birth (eg, placenta previa). We agree with the American College of Obstetricians and Gynecologists that the high risk of intrapartum uterine rupture during TOLAC favors PRCD in women with a prior transfundal uterine incision or prior uterine rupture. (See 'Inappropriate candidates' above.)

- In the author's practice, women with a previous cesarean delivery and a history of vaginal birth (either prior vaginal delivery or VBAC) are encouraged to undertake a TOLAC, given that the VBAC rate has been reported to be as high as 83 percent for women with a previous vaginal delivery and 94 percent for women with a previous VBAC.

  For patients outside of this small subset of the population, the author frequently uses a VBAC calculator (calculator 1 and calculator 2) to inform women of their individual chance of achieving a vaginal birth. (See 'Our approach' above and 'VBAC calculators' above.)

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Topic 4479 Version 95.0

GRAPHICS

Maternal outcomes from TOLAC versus PRCD

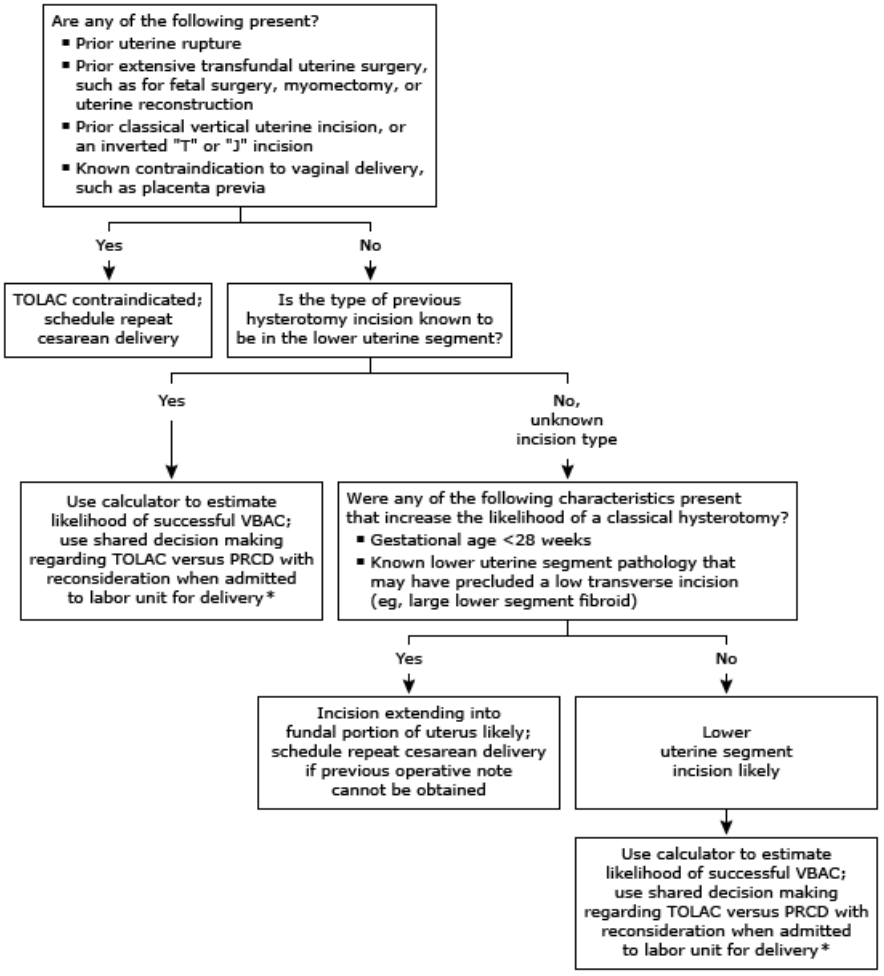
Maternal outcome	Number of studies/subjects	Frequency of outcome		
		TOLAC (95% CI)	PRCD (95% CI)	
Maternal death	12/402,883	0.004% (0.001-0.015)	0.013% (0.004-0.042)	RR 0.33, 95% CI 0.13-0.88
Uterine rupture	8/63,499	0.47% (0.28-0.77)	0.026% (0.009-0.082)	RR 20.7, 95% CI 9.8-44.0
Hysterectomy	8/402,059	0.17% (0.12-0.26)	0.28% (0.12-0.76)	NS
Hemorrhage	6/47,754	Insufficient data to evaluate	Insufficient data to evaluate	Insufficient data to evaluate
Transfusion	9/401,307	0.9% (0.4-2.0)	1.2% (0.5-2.6)	NS
Infection	22/354,060	4.6% (0.15-13.5)	3.2% (1.3-7.3)	NS
Surgical injury	4/53,282	Insufficient data to evaluate	Insufficient data to evaluate	Insufficient data to evaluate

TOLAC: trial of labor after cesarean delivery; PRCD: planned repeat cesarean delivery; RR: relative risk; NS: not significantly different.

Data from: Guise JM, Denman MA, Emeis C, et al. Vaginal birth after cesarean: New insights on maternal and neonatal outcomes. Obstet Gynecol 2010; 115:1267.

Graphic 65114 Version 15.0

Algorithm for choosing the route of delivery after a previous cesarean in women who are in early pregnancy



TOLAC: trial of labor after cesarean delivery; VBAC: vaginal birth after cesarean delivery; PRCD: planned repeat cesarean delivery.

* The decision for a TOLAC or PRCD is made by the woman in collaboration with her provider. This decision should be based upon the best available evidence and involves a combination of factors, including:

- Availability of TOLAC at the planned birth setting
- Probability of successful VBAC
- Significance and estimated frequency of complications with TOLAC and PRCD, including individual patient factors that affect the risks and benefits for each delivery route
- Personal values, preferences, past birthing experiences, and future pregnancy plans

Refer to UpToDate content on choosing the route of delivery after cesarean birth for detailed information.

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Contributor Disclosures

Torri D Metz, MD Nothing to disclose **Vincenzo Berghella, MD** Consultant/Advisory Boards: ProtocolNow [Clinical guidelines]. **Vanessa A Barss, MD, FACOG** Nothing to disclose

Contributor disclosures are reviewed for conflicts of interest by the editorial group. When found, these are addressed by vetting through a multi-level review process, and through requirements for references to be provided to support the content. Appropriately referenced content is required of all authors and must conform to UpToDate standards of evidence.

Conflict of interest policy

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