OBSTETRICS

Labor in 2013: the new frontier

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Incredibly, labor is the new frontier in 2013 and arguably our most important one in obstetrics. Although women labor and deliver more than 3 million times per year in the United States,\textsuperscript{1} what we considered normal and abnormal labor was incorrect for decades. It is only in the last 10 years that the correct shape of the first stage of normal labor has been described. And with these discoveries have come additional challenges. We are at once faced with both the realization that much more work is left to be done to provide good scientific evidence for management of labor to optimize outcomes as well as the clinical challenge to change behavior at the bedside with the important evidence that we have recently been given.

The objective of this review is to highlight critical aspects of both new data and knowledge gaps for clinicians at the forefront of practice change as well as scientists working to generate the evidence needed to guide clinical practice.

Friedman’s labor curve

In 1955, Emanuel Friedman\textsuperscript{2} described the labor of 500 nulliparous women in a convenience sample, plotting their labor progress in centimeters of cervical dilation on the Y-axis and time on the X-axis, generating a sigmoid-shaped curve. This curve, despite its descriptive and non-representative nature, came to define normal and abnormal labor over the following 40 years.

In 2002, Zhang et al\textsuperscript{3} discovered that the common understanding of normative labor progress in the first stage was likely incorrect and further validated the corrected first-stage labor curve in a large multicenter cohort. Specifically, Zhang et al\textsuperscript{3} discovered an analytic flaw in the historical approach to labor data; it was assumed that the time of cervical change was known. In fact, the exact time when cervical dilation changes from one measure to another is unknown, and thus, cervical dilation data are interval censored.

What is known is the time at which a patient has an examination and that her cervix changed sometime between the last and the current cervical dilation. Furthermore, cervical examinations during labor are repeated measures that are correlated, violating the assumption of independence needed for many statistical methods. Thus, appropriate analytic tools for labor progress must take into account both the interval-censored and repeated-measures nature of cervical dilation data. Such analyses have reshaped our understanding of the normal first stage. Specifically, it appears that active labor, or the period of increasing slope, occurs most commonly after 6 cm dilation, not 4 cm. Furthermore, the deceleration phase once described at the end of the first stage was most likely an analytic artifact of the prior analytic approach.

Despite the frequency with which obstetricians manage labor, evidence has emerged in the past few years challenging our historical understanding of normal labor progress over time. We are also confronted with the dearth of evidence to guide the optimal management of labor. With these data, we are presented with both the challenge of changing practice at the bedside and the opportunity for new discovery to optimize labor and delivery outcomes. Given the sheer frequency of labor and delivery, changes that improve outcomes even by a small magnitude have the potential to dramatically impact labor-associated morbidity at the population level.

**Key words:** first stage, labor, second stage

Unintended consequences

When obstetric providers perceive abnormalities in labor progress in the first stage of labor, we intervene, with the intent to optimize outcomes. Although measures such as artificial rupture of membranes with intrauterine pressure catheter placement and oxytocin augmentations are used in an attempt to correct abnormal progress in the first stage, cesarean delivery is commonly used. The 100% increase in the cesarean rate in the last 30 years (from 16.5% in 1980 to 32.8% in 2010)\textsuperscript{1} has been multifactorial, meaning the entire rise cannot be blamed solely on the use of the flawed Friedman curves. However, recent data have demonstrated that one of the most common reasons for first cesarean is abnormal labor or arrest.\textsuperscript{4}

Zhang et al\textsuperscript{5} in 2010 described the pattern of modern cesarean delivery, and specifically as it relates to labor progress, among 228,668 women. They observed that a large proportion of women undergoing cesarean for diagnoses of failed labor progress did so at disappointingly early dilations and after a relatively short time interval after their previous cervical examination. For example, among nulliparous women undergoing cesarean for labor failure, 38% of those in spontaneous labor and 63% of those being induced had their cesarean performed at or before 6 cm dilation was reached. If the observations in cesarean for arrest diagnoses since the modern correction
in shape of the labor curve are correct, then we find ourselves faced with perhaps an even greater challenge than the scientific discoveries that question accepted truths: changing our behavior. Some have been resistant to implementing Zhang’s curve because of concerns that this modern curve is the result of modern obstetrical practices such as the high rate of cesarean, change in rates of obesity, and increased epidural use. Although this criticism is thoughtful, we believe it is unfounded. The increased use of interventions that may affect labor progress argue for (rather than against) the need for newer standards to reflect contemporary practice. Furthermore, the same basic patterns of labor progress were replicated when Zhang et al applied the same methodology to data from the 1960s. This suggests that the differences stem more from differences in the methodology used in older studies than from differences in patients.

Reconsidering current clinical standards

We find in major texts in obstetrics, such as Williams Obstetrics, the suggestion of a clinical standard to examine women every 2-3 hours while in labor, and references to prior work that standard protocols for the management of labor resulted in improved outcomes. One practical consideration we are challenged with now is whether the recommendations for intervals of cervical assessment should be revisited. For example, might we consider longer intervals between cervical assessments, such as prior to 6 cm, when we now estimate that demonstrable change, even in women who will ultimately deliver a normal infant vaginally, might take many hours? Similarly, if the majority of women will reach complete dilation, regardless of parity, within 30 minutes of having an examination of 9 cm, should the recommended intervals of cervical examination be shorter in the later part of the active phase of labor?

Attempts have been made in the recent past to alter earlier guidelines for diagnosing arrest of labor. Based on a prospective protocol evaluation, Rouse et al reported that extending the minimum period of oxytocin augmentation for active-phase labor arrest from 2 to at least 4 hours was effective and safe. Most recently Spong et al published a summary of expert opinions from the consensus conference on Preventing the First Cesarean, highlighting the consequences of a disconnect between old labor management despite modern curves as well as recommendations for possible new standards for definitions of abnormal labor and arrest.

We might also consider the opportunity to make changes in the practice of labor management further upstream. That is, perhaps our generation of data that is no longer likely to be clinically useful other than leading to temptation of an iatrogenic arrest disorder diagnosis, such as cervical examinations every 2 hours prior to 6 cm dilation, is no longer a reasonable practice pattern based on our current evidence. Furthermore, we might consider that some of the best data regarding active labor management used definitions of labor and labor progress that do not precisely reflect our current understanding of the labor curve. Thus, additional research regarding optimal labor management strategies in the new labor paradigm is likely warranted.

Other unresolved aspects of labor management in the first stage such as the optimal timing of artificial rupture of membranes, efficacy, and safety of different oxytocin protocols also deserve further study.

Does one size fit all?

Several recent publications have described inherent differences in the progress of the first stage of labor based on specific patient characteristics or clinical conditions. For example, our published data demonstrate that labor progress to complete cervical dilation is slower in women undergoing induction compared with those laboring spontaneously. Other factors, such as maternal obesity, gestational age during labor, and even fetal sex have been shown to have an impact on median labor progress. Thus, the progress made by Zhang et al in describing the overall expected median progress for a population is only the beginning. The observed shifts in labor curves associated with individual factors must be further investigated and translated into an integrated and clinically useful tool that can be used by clinicians at the individual patient’s bedside.

The second stage

If the first stage of labor represents an opportunity to improve practice and outcomes, the second stage is at least as important. Expectations of normal duration of the second stage have been guided for many years by findings of the Friedman study with minor modifications based on later studies, although forceps were liberally used (>50% in the Friedman study) to truncate the second stage. The recent document by Spong et al recommends extending prior proposed limits for diagnoses of arrest in the second stage by an hour. However, the impact of these recommendations on maternal and neonatal outcomes deserves investigation.

There is a paucity of quality published data to guide clinical management of the second stage of labor in modern practice to achieve optimal outcomes. For example, 2 questions encountered in every day practice that remain are: when should pushing start and how should women push? The largest randomized trial to date addressing second-stage management with passive descent vs immediate pushing at complete dilation, of 1862 nulliparous women, was reported in 2000. This study showed a reduction in composite birth morbidity associated with delayed pushing. Similarly, a meta-analysis reported in 2008 suggested that, compared with immediate pushing, delayed pushing was associated with increased spontaneous vaginal deliveries, decreased operative vaginal deliveries, and decreased duration of active pushing. Given these findings, the Association of Women’s Health, Obstetric and Neonatal Nurses published guidelines in 2008 recommending delayed pushing in the second stage of labor unless contraindicated by maternal or fetal condition.

Unfortunately, the studies cited in previous text have limited applicability to current obstetrical practice. For example, the significant findings in the largest trial were driven largely by a reduction in
midpelvic forceps deliveries, which are virtually obsolete in modern obstetric practice in the United States. The study also reported a significantly higher rate of abnormal cord pH when delayed pushing was used (4.5% compared with 1.8%, relative risk, 2.45; 95% confidence interval, 1.35–4.43), although the authors used an unconventional definition of abnormal cord pH (venous pH < 7.15 or arterial pH < 7.10.) and noted that the increase in abnormal cord pH did not translate into a demonstrable increase in neonatal morbidity and mortality.

The methodology of many of the other trials has also been challenged. An updated meta-analysis suggests no significant benefit of delayed pushing when only studies judged to be of high methodological quality are pooled. Furthermore, what is consistent across studies is that delayed pushing lengthens the second stage. Three recent publications suggest that as the second stage of labor continues, beyond the first hour, regardless of management approach, there is an associated dose-response increase in maternal and neonatal morbidities. Accordingly, the competing risks of longer second stage and a clinical management strategy that may not result in improved outcomes deserve further study.

Evidence on how women should push in the second stage is equally sparse. A recent meta-analysis of randomized trials comparing spontaneous pushing with Valsalva pushing in the second stage of labor included only 3 small studies characterized by the authors as “sparse, diverse, and some flawed.” The pooled analysis suggested that duration of the second stage was longer with spontaneous pushing, but no statistical differences were noted in operative deliveries (3 studies; 425 women; pooled relative risk, 0.70; 95% confidence interval, 0.34–1.43), perineal lacerations, postpartum hemorrhage, and neonatal outcomes. Although Valsalva pushing appeared to have a negative effect on urodynamic measures at 3 months, this was based on results of only 1 small study. Thus, studies on how best to manage the second stage of labor might offer as much, if not greater opportunity for research as the first stage. Such studies should include effects of the various management strategies, not just on efficacy and short-term outcomes but also on long-term consequences such as maternal pelvic floor morbidity.

Opportunity for practice change and research
In the coming years, we have the opportunity to use currently available data to make changes to practice that might optimize efficacy and safety of the most common clinical entity seen in obstetrics: labor. Small changes that improve outcomes have the potential to dramatically impact labor-associated morbidity at the population level, given the sheer frequency of its occurrence. For example, the recent summary document from Spong et al10 highlights the potentially significant impact misdiagnoses of labor arrest disorders can have on the primary cesarean rate and the opportunity changes in practice might offer our patients. However, much scientific work remains regarding optimal management of both the first and the second stage of labor to improve efficacy and safety.

These studies should focus on rigorous methodology rather than preconceived notions of the anticipated results. Although observational data can provide some insight, there is also high risk for selection bias and confounding in labor-related studies, such that randomized controlled trials should be used whenever possible to produce the best-quality evidence to guide clinical practice. We look forward to this new frontier with anticipation and hope.

REFERENCES