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What is the slowest-yet-normal cervical dilation rate among nulliparous women with spontaneous labor onset?

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Abstract

Objective—To integrate research literature that has provided insights into the cervical dilation rate that may best describe the slowest-yet-normal dilation rate among nulliparous women when beginning with criteria commonly associated with active labor onset.

Data Sources—A literature search from 1950 through 2008 was conducted using the Medline electronic database, reference lists from identified articles, and other key references.

Study Selection—Research reports written in English with a focus on the cervical dilation and/or labor duration of low-risk, nulliparous women with spontaneous labor onset.

Data Extraction—Classic and contemporary research literature was reviewed and organized under the following subheadings: Friedman Studies; Partograph Studies; Active Management of Labor Studies; Additional Studies.

Data Synthesis—An integrative review of the literature approximated the slowest-yet-normal cervical dilation rate for nulliparous women when beginning with criteria commonly associated with active labor.

Conclusions—The slowest-yet-normal linear dilation rate approximates 0.5 cm/hr for low-risk, nulliparous women with spontaneous labor onset when starting at dilatations traditionally associated with active labor onset. However, this linear rate must be evaluated judiciously in light of the physiological acceleration of dilation that occurs during typical labor. Given this, cervical dilation for this population is likely slower than 0.5 cm/hr in earlier active labor and faster in more advanced active labor. Faster dilation expectations (e.g., 1 cm/hr) likely contribute to an overdiagnosis of dystocia (“slow, abnormal progression of labor”) in contemporary practice and, subsequently, to an overuse of interventions aimed at accelerating labor progress.

Keywords

Pregnancy; Parturition; Labor; Obstetric; Labor Onset; Labor Stage; First

Callout 1

slowest-yet-normal linear dilation approximates 0.5 cm/hr for nulliparous women with spontaneous labor onset when beginning at dilatations commonly associated with active labor onset.

Callout 2

Unrealistically fast expectations of cervical dilation likely contribute to the overdiagnosis of dystocia and the overuse of labor accelerative interventions to correct the slow progress.

Callout 3

Unnecessary risk is imposed on the mother and fetus when interventions are used in an attempt to accelerate an already adequate cervical dilation rate.

The rate of cervical dilation (cm/hr) in the first stage of labor is the basis of decision making for clinicians providing care to laboring women. Once dilation is progressive or active, attempts to accelerate labor may be justified if the dilation rate becomes slower than the accepted minimum rate for the population. However, the main interventions used by clinicians in an attempt to accelerate labor, amniotomy and oxytocin augmentation, are used at such high rates in contemporary practice that they are more the rule than the exception. This is concerning because oxytocin is the drug most commonly associated with preventable adverse perinatal outcomes (Clark, Simpson, Knox, & Garite, 2009). While it is undeniable that some labor care providers use labor accelerative interventions injudiciously, the major underlying factor leading to our high intervention rates may be that common expectations of cervical dilation are unrealistically fast. The unfortunate reality is that any overuse of labor accelerative intervention imposes unnecessary risk on the unwitting mother-fetal unit.

In the past decade, investigators have reported that labor duration among nulliparous women is significantly longer than traditionally believed when beginning at dilatations commonly associated with active labor onset through complete dilatation (Albers, Schiff, & Gorwoda, 1996; Albers, 1999; Jones & Larson, 2003; Zhang, Troendle, & Yancey, 2002). Therefore, the slowest cervical dilation rate that is still within normal limits for nulliparous women remains in question since labor duration and cervical dilation rates are highly related. The purpose of this review is to integrate the extant research literature to provide insights into the cervical dilation rate best described as the slowest-yet-normal cervical dilation rate during active labor among low-risk, nulliparous women with spontaneous labor onset.

Background

Clinical expectations of cervical dilation among nulliparous women continue to be heavily influenced by the research of Dr. Emanuel Friedman, which began over a half-century ago. Additional knowledge about dilation rates during labor for this population can also be gleaned from the classic publications borne from two of the most widespread labor assessment/management strategies, the partograph and the active management of labor protocol. More contemporary work has also been done in this area. Integrating these bodies

of research should assist in identifying the slowest-yet-normal dilation rate for low-risk, nulliparous women with a spontaneous labor onset.

Via a Medline database search, we sought research published between 1950 and 2008 in the English language with a focus on the cervical dilation and/or labor duration of low-risk, nulliparous women with spontaneous labor onset. Secondary references from identified articles and other key references were also considered. We reviewed the identified research and organized selected publications under the following subheadings: Friedman Studies; Partograph Studies; Active Management of Labor Studies; Additional Studies.

Friedman Studies

Friedman reported that cervical dilation during labor follows a sigmoid (S-shaped) curve for most women, varying only in slope (Figure 1) (Friedman, 1954,1955,1978;Friedman & Kroll, 1969,1971). Although Friedman used square-graph paper with time on the *x*-axis and dilatation on the *y*-axis to hand-record labor progression in his earliest work (Friedman, 1954,1955), he subsequently introduced a computer program to analyze labor progression and applied it to thousands of labors (Friedman & Kroll, 1969,1971). To be included in these studies, the following 4 known points were required (Figure 1): time of labor onset (Point A); at least 1 cervical examination finding dilatation to be between 3.0 and 6.0 cm (Point C); at least 1 cervical examination finding dilatation to be between 6.5 and 9.0 cm that is also at least 1 cm more advanced than Point C (Point D); time of delivery (Point G). These points were used to approximate other critical points shown in Figure 1, if unknown, to form the representative sigmoid curve for which Friedman gained recognition.

For nulliparous women, Friedman reported that the active phase of labor approximates the time from 2.5 cm cervical dilatation through complete dilatation, approximated at 10 cm (Point B to F) (Friedman, 1954, 1955, 1978; Friedman & Kroll, 1969, 1971). Use of 2.5 cm dilatation as the onset of active labor was an aggregate estimate and was, therefore, not strictly applicable to any individual woman. Active phase labor was further divided into three sub-phases, i.e., an acceleration phase, a phase of maximum slope, and a deceleration phase. Friedman described the *acceleration phase* as a rapid change in the slope of cervical dilation approximating the time needed for the cervix to dilate from 2.5 cm to 4 cm, and the *phase of maximum slope* as a period of rapid cervical dilation progressing linearly from approximately 4 cm to 9 cm cervical dilatation. Friedman reported the mean and slowest-yet-normal (i.e., mean – 2 standard deviations) cervical dilation rates in the *phase of maximum slope* to be 3.0 and 1.2 cm/hr, respectively (Friedman, 1955, 1978). The deceleration phase was identified when the rate of dilation once again slowed as full dilatation was reached. For the aggregate of all labors, this phase approximated the time needed for the cervix to dilate from 9 cm to 10 cm. Friedman included data from some women without a spontaneous labor onset and some who were not low-risk by modern standards.

In his various studies, Friedman reported modestly different means for active labor duration among nulliparous women. These means ranged between 4.4 and 4.9 hours (Friedman, 1954, 1955, 1978; Friedman & Kroll, 1971). Active labor duration for nulliparous women was 11.7 hours at the mean + 2 standard deviations, often considered the upper limit of 'normal' (Friedman, 1955, 1978; Friedman & Kroll, 1971). Durations of the deceleration phase were also provided in many of Friedman's works. However, durations of the phase of maximum slope and acceleration phase must be estimated through simplistic calculations (Table 1). It becomes clear that between 45-53% of active phase duration is spent in the acceleration phase when dilation only changes from 2.5 cm to 4 cm for the aggregate (Friedman, 1955, 1978; Friedman & Kroll, 1971). Moreover, active phase labor (acceleration phase + phase of maximum slope + deceleration phase) has a mean slope

approximating 1.6 cm/hr when viewed linearly (Friedman, 1954, 1955, 1978; Friedman & Kroll, 1971) (Table 2). This is vastly different from the means of 3.0-3.7 cm/hr reported for the phase of maximum slope in these same studies. At the mean – 2 standard deviations, cervical dilation in Friedman's active phase approximates 0.6 cm/hr $[(10 \text{ cm} - 2.5 \text{ cm}) \div 11.7 \text{ hours}]$ (Friedman, 1955, 1978; Friedman & Kroll, 1971). Thus, the rate of cervical dilation at the mean – 2 standard deviations for the entirety of active labor (i.e., from 2.5 cm to 10 cm) is half the rate reported by Friedman for the phase of maximum slope (i.e., 0.6 cm/hr and 1.2 cm/hr, respectively). The '1 cm/hr rule' commonly applied in clinical settings was borne from Friedman's work representing the slowest-yet-normal dilation from the phase of maximum slope onset through complete dilatation.

Partograph Studies

In the 1970s, Philpott and Castle introduced a graphic tool called a 'cervicograph' to aid in the early detection of abnormal labor progress (Philpott, 1972; Philpott & Castle, 1972a). The cervicograph has since become the central feature of the labor assessment tool called the partograph. The cervicograph was composed of alert and action lines and displayed time (hrs) on the *x*-axis and cervical dilatation (cm) on the *y*-axis (Figure 2). The alert line was graphically straight and linearly represented a rate of 1 cm/hr. If the dilation rate crossed to the right of the alert line (i.e., progressed < 1 cm/hr), arrangements were made to transfer the parturient from peripheral level care to a more intensive care center. The action line was drawn parallel to the alert line but was 4 hours to the right (Figure 2). Once this line was reached, more aggressive management interventions such as oxytocin augmentation were initiated in an attempt to correct slow labor progress.

Philpott and Castle evaluated their cervicograph in low-risk, primigravid African women ($n = 624$) with cervical dilatations of ≥ 3 cm on admission and found that 21.8% ($n = 136$) crossed the alert line (i.e., dilated < 1 cm/hr) while 10.9% ($n = 68$) crossed the action line (Philpott & Castle, 1972a, 1972b). These findings are interesting because the alert line, derived from Friedman's work, was meant to represent the cervical dilation rate of the slowest 10% of primigravid patients in the active phase (Philpott, 1972; Philpott & Castle, 1972a). Instead, it represented > 20% of the sample. Indeed, it was the action line rather than the alert line that represented the slowest 10.9% of primigravid women in this trial (Philpott & Castle, 1972a; Philpott & Castle, 1972b). Since enrollees had cervical dilatations of ≥ 3 cm upon study admission, it was not possible for the action line to be crossed until cervical dilation became slower than 0.64 cm/hr. Rates of cervical dilation necessary to remain left of the action line would be even slower for women admitted at dilatations beyond 3 cm. An important point of interest is that women whose labors were left and right of the alert line at delivery had significantly different mean admission dilatations (5.2 and 3.8 cm, respectively; $p < 0.001$) (Philpott & Castle, 1972a). Thus, admissions occurring later in labor are seemingly more likely to progress efficiently because dilation rates progressively accelerate throughout the majority of active labor (Friedman, 1954, 1955, 1978; Studd, 1973; Studd & Duiagnan, 1972; Zhang et al., 2002).

The World Health Organization (WHO), under the Maternal Health and Safe Motherhood Program, has produced and promoted the use of a labor partograph to detect abnormal labor early and prevent prolonged labor (WHO, 1994a, 1994b, 1994c, 1994d). This partograph closely resembles the cervicograph developed by Philpott (Philpott, 1972; Philpott & Castle, 1972a). With this tool, the first 'active' labor dilatation is plotted directly on the alert line and cervical dilation over time is closely assessed from that point forward. No intervention is typically indicated for labors remaining on or to the left of the alert line except amniotomy which can be performed at any time after active labor onset. If dilation moves between the alert and action lines, transfer to a more intensive care center is indicated although intervention such as oxytocin augmentation is not performed unless complications develop.

Movement to or across the action line indicates a need for full medical assessment with the possibility of augmentation, termination of labor, or supportive therapy. Partograph use has been credited with decreasing rates of prolonged labor, augmented labor, cesareans, and intrapartum fetal deaths (WHO, 1994a, 1994d).

A large multicenter trial ($n = 35,484$) on the impact of partography on labor management and outcomes was conducted by the WHO in the early 1990s (WHO, 1994a, 1994d). Data were reported on a subgroup of low-risk, term nulliparous women with spontaneous labor onset admitted in 'active' labor, i.e., cervix ≥ 3 cm with uterine contractions ($n = 2397$) (WHO, 1994a). Of these women, 30.9% ($n = 741$) crossed the alert line (i.e., dilated < 1 cm/hr) and 11.7% ($n = 281$) reached or crossed the action line (i.e., dilated < 0.64 cm/hr) which is similar to the 10.9% rate reported by Philpott and Castle (1972a, 1972b). Based on admission cervical dilatations of 3, 4, or 5 cm, low-risk nulliparous women without augmentation had linear dilation rates of only 0.12, 0.35, and 0.53 cm/hr, respectively, at the 10th percentile (WHO, 1994a). At the 25th percentile, these dilation rates were 0.69, 0.91, and 1.0 cm/hr, respectively.

When comparing low-risk nulliparous women who remained left of the alert line through delivery ($n = 1656$), those delivering between the alert and action lines ($n = 460$), and those crossing the action line ($n = 281$), outcomes of partograph monitored labors began to differ mainly when the action line was crossed. Among these groups, vaginal birth rates were 99%, 95%, and 74%, respectively, while there were no differences in other meaningful outcomes such as postpartum hemorrhage (WHO, 1994a). Apgar scores were more likely to be < 7 at 1 minute in each subsequent group (5.4%, 12.8%, and 20.0%, respectively). It must, however, be kept in mind that the majority of these labors were assessed without the advanced monitoring capabilities commonly available in industrialized countries.

Since this aforementioned study, the WHO changed their definition of active labor onset from 3 cm to 4 cm dilatation (WHO, 2007). Orji (2008) used this modified partograph to study low-risk, term, nulliparous Nigerian women in spontaneous labor ($n = 259$) who were managed by midwives. In total, 34.8% of these nulliparas crossed the alert line averaging < 1 cm/hr dilation while 18.5% reached or crossed the action line dilating at ≤ 0.6 cm/hr. There were no cesareans among women whose labors remained left of the action line although the cesarean rate was 87.5% when labor moved to the action line or beyond.

Active Management of Labor Studies

Progression of nulliparous cervical dilation can be gleaned from the multifaceted labor management program *active management of labor* (AML) that was pioneered by O'Driscoll and colleagues with the goal of shortening nulliparous labor to manage patient flow in a high-volume maternity hospital (O'Driscoll, Meagher, & Boylan, 1993; O'Driscoll, Stronge, & Minogue, 1973). True AML components include antenatal preparation for childbirth, a strict diagnosis of *spontaneous* labor onset, provision of one-on-one labor support provided by midwives, routine amniotomy, routine cervical assessments, oxytocin augmentation if cervical dilation is < 1 cm/hr, and peer review of assisted deliveries. "The word 'active', in this context, refers to the nature of the involvement of the consultant obstetrician; it certainly is not intended to convey [that the obstetrician] intervenes more often" (O'Driscoll et al., 1993, p.16). With AML, the slowest acceptable rate of dilation is defined as 1 cm/hr. Women with slower rates promptly receive oxytocin augmentation to correct supposed inefficient uterine action (O'Driscoll et al., 1973, 1993). In their early work, the founders of AML reported that 55% of primigravid women required oxytocin augmentation (O'Driscoll et al., 1973). A recent systematic review of 7 randomized, controlled AML trials reported that 62% of 2242 nulliparous women randomized to AML care received oxytocin augmentation (Brown, Paranjothy, Dowswell, & Thomas, 2008). These rates of uterine

stimulation indicate that a majority of nulliparous women managed under the AML care package dilate at < 1 cm/hr at some point after the diagnosis of labor. Prompt acceleration of labor with AML precludes knowledge of the slowest-yet-normal rate of cervical dilation for nulliparous women.

Additional Studies

In the past 20 years, several other researchers found that common expectations of labor progression (e.g., 1 cm/hr) may be overly stringent. Kilpatrick and Laros (1989) reported that nulliparous women delivering spontaneously without the use of oxytocin or anesthesia ($n = 2302$) require 8.1 ± 4.3 hours to progress from the onset of regular, painful contractions to full dilatation. When defining active labor as the time necessary for the cervix to dilate from 4 to 10 cm, Albers, Schiff, & Gorwoda (1996), Albers (1999), and Jones & Larson (2003) reported that low-risk nulliparous women delivering vaginally have spontaneous labors without oxytocin, epidurals, and operative deliveries that last between 6.2-7.7 hours at the mean and up to 13.4-19.4 hours at the mean + 2 standard deviations (SD). Viewed linearly, active labor dilation rates in these studies ranged from 0.8-1.0 cm/hr at the mean and from 0.3-0.5 cm/hr at the mean - 2 SD. These findings confirm those of Perl and Hunter (1992) who suggested that labors progressing at ≥ 0.5 cm/hr, in the absence of other problems or symptoms, be considered within normal limits. In their study, 10.3% of term, nulliparous women with a spontaneous labor onset ($n = 52$ of 505) progressed at < 0.5 cm/hr. Taken together, these findings suggest that interventions aimed at accelerating labor are questionable until rates of cervical dilation fall below 0.5 cm/hr.

Zhang and colleagues (2002) have also provided compelling evidence that the duration of first-stage labor and the pattern of labor progression among low-risk, term, nulliparous women ($n = 1162$) with a spontaneous labor onset differs markedly from Friedman's work. These researchers report the median duration of labor as 7.3 hrs from admission at about 3.5 cm to complete dilatation (90th percentile = 13.7 hrs) despite 50% of the sample receiving oxytocin augmentation. Moreover, slopes of cervical dilation (cm/hr) progressively steepened with each passing centimeter. Median dilation rates for each centimeter of progression between 3 and 10 cm were 0.4, 0.6, 1.2, 1.7, 2.2, 2.4, and 2.4 cm/hr, respectively. At the 5th percentile, these dilation rates were 0.1, 0.2, 0.3, 0.5, 0.7, 0.8, and 0.7 cm/hr, respectively. These point-by-point dilation rates significantly differ from the statistical limit of 1.2 cm/hr within the 4 to 9 cm phase of maximum slope reported by Friedman (Friedman, 1955, 1978). Indeed, at the 5th percentile, the dilation rates reported by Zhang and colleagues never exceeded 1 cm/hr. Even at the median, rates faster than 1 cm/hr were only evident after 5 cm dilatation. It was also common for there to be no perceivable change in dilatation for > 2 hours during the period before 7 cm dilatation.

Discussion

When beginning with criteria commonly associated with active labor onset (e.g., 3 to 5 cm and regular contractions), the extant research indicates that the slowest-yet-normal, linear dilation rate approximates 0.5 cm/hr for low-risk, nulliparous women with spontaneous labor onset. This rate is achievable for approximately 80-90% of this population. Commonly applied linear expectations such as 1 cm/hr are unrealistically fast.

Consideration must be given to two specific realities before a slowest-yet-normal cervical dilation rate can be defined in a way that is meaningful in clinical practice. First, labor care providers generally aim to admit low-risk women to the birthing unit at the onset of active labor, when the rate of cervical dilation is anticipated to increase. Unfortunately, truly progressive labor can only be determined retrospectively. The reality then is that laboring women are often admitted under criteria commonly associated with active labor onset,

which is suggested to reliably begin between 3 cm and 5 cm, in the presence of uterine contractions (Cunningham, Leveno, Bloom, Hauth, Rouse, & Spong, 2010, p.388). However, these criteria may not describe active labor onset for many women. Peisner and Rosen (1986) found that 75%, 50%, and 25% of regularly contracting, low-risk, nulliparous women admitted for spontaneous labor ($n = 1060$) *do not* dilate at rates indicative of active labor at 3, 4, and 5 cm, respectively when using Friedman's minimally acceptable rate of dilation in the phase of maximum slope (i.e., 1.2 cm/hr) as the threshold for differentiating latent and active labor. In the mid-1990s, Friedman himself wrote that "...the majority of patients are in active-phase labor by the time the cervix reaches 4 cm, but many are not" (Friedman, 1996, p.319).

In light of the above discussion, applying Friedman's dilation expectations to all women admitted under criteria commonly associated with active labor is inappropriate because his aggregate expectations of active labor progression are based only on women known to be in active labor retrospectively. The clinical dilemma is that many women are inadvertently admitted prior to progressive labor yet held to dilation expectations of active labor. This is a significant and underappreciated shortcoming in obstetrical care because those admitted early are more prone to interventions during labor (e.g., oxytocin augmentation) and are more than twice as likely to be delivered via cesarean (Bailit, Dierker, Blanchard, & Mercer, 2005; Holmes, Oppenheimer, & Wen, 2001; Impey, Hobson, & O'Herlihy, 2000; Main et al., 2006; McNiven, Williams, Hodnett, Kaufman, & Hannah, 1998; Mikolajczyk, Zhang, Chan, & Grewal, 2008; Rahnama, Ziaei, & Faghihzadeh, 2006).

A second reality to be considered is that cervical dilation is not *linear*; instead, dilation rates progressively accelerate throughout the majority of active labor (Friedman, 1954, 1955, 1978; Studd, 1973; Studd & Duiagnan, 1972), if not all of it (Zhang et al., 2002, 2010). Thus, linear conceptualizations of cervical dilation are fundamentally flawed leading to expectations that are likely unrealistically fast in earlier labor for low risk, nulliparous women. Overly stringent dilation expectations likely contribute to early, unnecessary, and potentially harmful attempts to accelerate labor progress. Zhang et al., (2002) findings can be used to illustrate the shortcomings of viewing cervical dilation linearly. From 3 cm forward, calculations based on their data demonstrate that dilation rates conceptualized as linear are faster than actual rates until some point after 5 cm dilatation when the linear rates become slower than actual rates (Figure 3). Thus, interventions aimed at correcting 'slow' labor are much more likely in earlier active labor when linear dilation expectations are less likely to be met. Bearing this in mind, the linear finding in our integrative review must be evaluated judiciously in light of the physiological acceleration of dilation during typical labor. The slowest-yet-normal rate is likely < 0.5 cm/hr in earlier 'active' labor and > 0.5 cm/hr in more advanced labor for nulliparous women with spontaneous labor onset. Basing cervical dilation expectations on a hyperbolic labor curve may greatly improve prospective clinical decision-making.

The expectation of cervical dilation during active labor is intimately linked to diagnoses of labor dystocia defined by the American College of Obstetricians and Gynecologists (ACOG) as "slow, abnormal progression of labor" (ACOG, 2003). If the slowest-yet-normal dilation rate is defined at a rate that is faster than physiologic reality (e.g., 1 cm/hr) many nulliparous women with normal labor progression are at risk of being misdiagnosed with dystocia. In these cases, interventions aimed at accelerating labor will likely be implemented and their inherent risks incurred by the mother-fetal unit. Dystocia is, indeed, recognized to be overdiagnosed (Cunningham et al., 2010, p.465), likely stemming from its nebulous definition. This is of significant concern because it is the leading indication for primary cesarean deliveries (ACOG, 2003; Cunningham et al., 2010), accounting for as much as 50% of all cesarean deliveries performed in nulliparous women (ACOG, 2000, p.20). When

making prospective labor care decisions, clinicians would benefit from a more specific definition of dystocia based on population-based criteria. The Society of Obstetricians and Gynaecologists of Canada (SOGC) (1995) has specifically defined dystocia as a period of ≥ 4 hours after ≥ 3 cm cervical dilatation and near 100% effacement during which the mean rate of dilation is < 0.5 cm/hr. The slowest-yet-normal finding in our integrative review closely aligns with this definition. However, it is possible that even the SOGC definition of dystocia is overly stringent. Using this definition, investigators found that 183 of 383 (48%) low-risk, nulliparous women with spontaneous onset were diagnosed with dystocia when amniotomy was not routinely performed after admission (Fraser, Marcoux, Moutquin, & Christen, 1993). Even the early amniotomy group in this study had a 33% dystocia rate.

Labor duration across a nulliparous population reportedly does not follow a normal (bell-shaped) statistical curve; instead, it is left-leaning (positively skewed) (Zhang et al., 2002). This indicates that an appreciable number of 'longer' labors are common. Because labor duration is highly related to and, in fact, dependent upon cervical dilation, it is unlikely that cervical dilation rates hold to a normal curve. Hence, the slowest-yet-normal cervical dilation rate found in this integrative review is not meant to be held to a strict statistical definition. However, the extant research indicates that approximately 80-90% of nulliparous women with a spontaneous labor onset should be innately capable of dilating at or faster than 0.5 cm/hr, on average, when starting at dilatations commonly associated with active labor onset.

Our integrative review focused on nulliparous women with spontaneous labor onset, thus, the slowest-yet-normal dilation rate found in this review should not be extended to labor inductions or to the spontaneous labors of multiparous women. Labor induction is a medical interruption of the natural course of pregnancy that is fundamentally distinct from physiologic labor that begins and progresses spontaneously.

The results of our review provide important and direct implications for clinical practice. First, only when expectations of cervical dilation are appropriately defined can labor accelerative expectations be appropriately used. When beginning at dilatations commonly associated with active labor onset, the slowest-yet-normal dilation rate for low-risk, nulliparous women with spontaneous labor onset approximates 0.5 cm/hr, on average. Faster expectations are not evidence based and likely contribute to the overuse of interventions to accelerate labor which, in turn, impose risk on the mother-fetal unit. In this light, the burden of demonstrating maternal/fetal benefits when using interventions to accelerate labor in nulliparous women who are dilating faster than 0.5 cm/hr rests on those advocating more aggressive intervention. Any potential benefit must be weighed against disadvantages, risks, iatrogenic consequences, and their attendant costs. Additionally, careful assessment of labor progression based on cervical change over time *prior* to labor admission must also be stressed to decrease inadvertent 'early' admissions which are associated with more intervention and more adverse outcomes (Bailit, Dierker, Blanchard, & Mercer, 2005; Holmes, Oppenheimer, & Wen, 2001; Impey, Hobson, & O'Herlihy, 2000; Main et al., 2006; McNiven, Williams, Hodnett, Kaufman, & Hannah, 1998; Mikolajczyk, Zhang, Chan, & Grewal, 2008; Rahnama, Ziaei, & Faghihzadeh, 2006). Nurses must play a central role in the careful evaluation cervical change over time in labor triage areas. All labor care professionals must bear in mind that no favors are being done for the laboring woman by purposefully admitting her prior to the onset of progressive labor.

Conclusion

Our review of the relevant extant research concludes that the slowest-yet-normal linear dilation rate approximates 0.5 cm/hr for low-risk, nulliparous women with spontaneous

labor onset when starting at dilatations traditionally associated with active labor onset. However, this linear rate includes both the slower rate of earlier active labor and the physiological acceleration of dilation that is typical of advancing labor.

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Figure 1.
Friedman labor curve (Friedman & Kroll, 1969)
Legend

- Vertical axis (y-axis) = cervical dilatation (cm)
- Horizontal axis (x-axis) = time (hrs)
- Point A = time of labor onset
- Point B = approximate time of active phase onset
- Point B' = true active phase labor onset (if known)
- Point C = point between 3.0 and 6.0 cm dilatation
- Point D = point between 6.5 and 9.0 cm dilatation
- Point E = approximate time of deceleration phase onset
- Point F = true second stage onset (if known)
- Point F' = approximate time of second stage onset
- Point G = time of delivery
- x-intercept = used to estimate all missing points in the active phase (e.g., Points B, E, F')
- L = latent phase of labor
- AP = active phase of labor
- DP = deceleration phase of labor
- S = second stage of labor

Figure 2.
Cervicograph (adapted from Philpott & Castle, 1972a)

Figure 3.

Hyperbolic, median nulliparous labor curve with linear conceptualization

— — — — — Hyperbolic labor curve (median) (derived from Zhang et al., 2002)

————— Dilation conceptualized linearly (based on Zhang et al., 2002)

Table 1

Nulliparous active phase and sub-phase labor durations (hrs) based on Friedman data.

Author(s)	Acceleration Phase [†] (2.5-4 cm)	Phase of Maximum Slope* (4-9 cm)	Deceleration Phase (9-10 cm)	Active Phase (2.5-10 cm)
Friedman, 1955	Mean (2.33)	+	+	=
	Mean + 2 SD x	+	y	=
Friedman & Kroll, 1971	Mean (2.41)	+	+	=
	Mean + 2 SD x	+	y	=
Friedman, 1978	Mean (2.09)	+	+	=
	Mean + 2 SD x	+	y	=

Parentheses indicate values derived from Friedman's data that were not directly available through his published works. The duration of the phase of maximum slope was first calculated followed by acceleration phase duration.

* Phase of maximum slope durations were calculated based on slopes provided in each study, e.g., Friedman (1955) reported a mean maximum slope of 3.0 cm/hr; thus, because the phase of maximum slope involves a cervical change of 5 cm, the mean duration of the phase of maximum slope was calculated as (5.0 cm) ÷ (3.0 cm/hr) = 1.67 hrs.

† Acceleration phase durations were calculated as total active phase duration – deceleration phase duration – phase of maximum slope duration.

x Non-calculable acceleration phase secondary to limited data available in Friedman publications.

y Non-calculable deceleration phase secondary to limited data available in Friedman publications.

Table 2

Nulliparous active phase slope calculations based on Friedman data.

Author(s)	n	Active phase length (hrs)		Phase of maximum slope (cm/hr)		Active phase slope (cm/hr)*	
		Mean (SD)	Mean + 2 SD	Mean (SD)	Limit	Mean	Limit
Friedman, 1954	100	4.4 (1.9)	8.2	3.7 (2.1)	--	1.7	0.9
Friedman, 1955	500	4.9 (3.4)	11.7	3.0 (1.9)	1.2	1.5	0.6
Friedman & Kroll, 1971	4175	4.6 (3.6)	11.7	3.7 (5.7)	1.1	1.6	0.6
Friedman, 1978	--	4.6 (3.6)	11.7	3.0 (1.9)	1.2	1.6	0.6

* Calculated based on mean and statistical limit time required for the cervix to dilate from 2.5 through complete cervical dilatation (approximated at 10 cm).