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'ACTIVE LABOR' DURATION AND DILATION RATES AMONG LOW-RISK, NULLIPAROUS WOMEN WITH SPONTANEOUS LABOR ONSET: A SYSTEMATIC REVIEW

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Abstract

Objective—Laboring women are often admitted to labor units under criteria commonly associated with the onset of active phase labor, i.e., cervical dilatation of 3–5 cm in the presence of regular contractions. Beginning with these criteria through complete dilatation, this systematic review describes labor duration and cervical dilation rates among low-risk, nulliparous women with spontaneous labor onset.

Methods—Studies published in English (1990–2008) were identified via MEDLINE and CINAHL searches. Data were abstracted and weighted 'active labor' durations (i.e., from 3–5 cm through complete dilatation) and linear dilation rates were calculated.

Results—Eighteen studies (n = 7009) reported mean 'active labor' duration. The weighted mean duration was 6.0 hrs and the calculated dilation rate was 1.2 cm/hr. These findings closely parallel those found at the median. At the statistical limits, the weighted 'active labor' duration was 13.4 hrs (mean + 2 SD) and the dilation rate was 0.6 cm/hr (mean − 2 SD).

Conclusions—Nulliparous women with spontaneous labor onset have longer 'active' labors and, hence, slower dilation rates than are traditionally associated with active labor when commonly used criteria are applied as the starting point. Revision of existing active labor expectations and/or criteria used to prospectively identify active phase onset is warranted.

Keywords

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

INTRODUCTION

Labor is "the presence of uterine contractions of sufficient frequency, duration, and intensity to cause demonstrable effacement and dilation of the cervix."[1] Attempts to define the norms and limits of labor duration have yielded variable results, undoubtedly because labor does not readily lend itself to measurement. Not only is prospectively defining the onset of labor a

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significant challenge, but evaluating its progression remains limited to rudimentary cervical examinations performed episodically. Attempts to divide the continuum of labor into stages and phases only add to the complexity. Moreover, multiple fixed factors such as parity, maternal weight, and fetal weight as well as commonly employed interventions (e.g., oxytocin augmentation, epidural use) may significantly affect the duration of labor.

In spite of measurement difficulties, a better understanding of the norms and slowest acceptable limits of labor duration and rates of cervical dilation is important because this knowledge is the backbone of clinical decision making in the intrapartum setting. Optimally defining these indices from the point of typical spontaneous labor admission forward is especially pertinent because, once admitted to the hospital, women are closely monitored to ensure adequate progress. Therefore, the purpose of this systematic review was to describe the clinical parameters of 'active labor' duration and rates of cervical dilation beginning with clinical criteria commonly used as prospective evidence of the onset of active phase labor through complete cervical dilatation. The focus is on nulliparous women without chronic medical conditions or pregnancy complications who were admitted for spontaneous labor onset.

BACKGROUND

In contemporary practice, most providers aim to admit women to the labor unit when cervical dilation is expected to become more rapid, i.e., at the onset of the active phase. Authors of contemporary texts report that the active phase reliably begins between 3 cm and 5 cm, in the presence of regular uterine contractions.[2] Investigators have recently reported that cervical dilation follows a hyperbolic pattern, increasing over time, without a distinct point of dilation acceleration.[3] This lack of a distinct point when dilation acceleration begins precludes the identification of a true, traditionally-defined active phase onset. Even when assuming active phase labor does exist as a measurable entity, the variability between women in its onset limits the prospective use of specific dilatations in differentiating the active phase from the latent phase.

Peisner and Rosen[4] found that roughly 75%, 50%, and 25% of regularly contracting, low-risk, nulliparous women admitted for spontaneous labor at 3, 4, and 5 cm, respectively, do not dilate at rates indicative of active labor although these cervical dilatation measurements are most often associated with active phase onset. Such findings lead to one or both of the following conclusions: [1] expected rates of cervical dilation during traditionally defined active phase labor are overly stringent; and/or [2] many women are admitted for labor prior to the onset of the active phase of labor yet are managed as though they are in the active phase.

Expectations of the duration of the active phase as well as rates of cervical dilation during the active phase largely stem from research published by Friedman beginning in the 1950s.[5–9] Although these studies included some nulliparous women who did not have a spontaneous labor onset and some who were not low-risk by contemporary standards, Friedman reported that labor in nulliparas typically follows a near-identical sigmoid curve varying only in slope. A woman's active phase began with a *retrospectively* identifiable acceleration of cervical dilation and ended at complete dilatation that, for the aggregate, was the time from 2.5 cm to 10 cm. For nulliparous women, the active phase averaged 4.6–4.9 hours[6,8,9] although the average time needed to dilate from 4 cm to 10 cm was only approximately 2.6 hours.[6,9] At the mean + 2 SD, active phase labor was 11.7 hours.[6,8,9] Based on these studies by Friedman, when dilation is between 4–9 cm (termed the 'phase of maximum slope'), nulliparous women dilate at a mean rate of 3.0 cm/hr whereas the slowest acceptable rate is 1.2 cm/hr.[6,9] Unfortunately, these aggregate active phase dilation rate estimates are of limited prospective use for individual women because the dilatation at which active labor begins varies widely

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among women. In 1996, Friedman himself wrote "…the majority of patients are in active-phase labor by the time the cervix reaches 4 cm, but many are not."10

Philpott and Castle[11] and the World Health Organization[12] have contributed to this literature, finding that 21.8% and 30.9% of nulliparous women, respectively, dilate at rates averaging < 1cm/hr at or after 3 cm dilatation. In addition, data from these studies and others show that 10.3–11.7% of low-risk nulliparas in spontaneous labor dilate at rates slower than 0.5–0.6 cm/hr after 3 cm dilatation.[11–14] This suggests that intervention to accelerate labor should not be considered until rates of cervical dilation fall below these limits.

The aforementioned studies[5–9,11–14] have informed worldwide obstetrical practice over the past half-century although clinical practice expectations of labor duration and rates of cervical dilation among nulliparous women continue to be largely based on Friedman's research.[5–9] Unfortunately, the onset of Friedman's traditionally defined active labor dilation and its differentiation from earlier labor can only be discerned retrospectively.

More recently, investigators such as Albers[15,16], Zhang et al[3], and Jones and Larson[17] found that normal 'active phase' labor in nulliparous women lasts longer than previously thought, thus calling into question the standards that have been used since the work of Friedman. Hence, the measures of central tendency that best define labor length and cervical dilation rates after a *diagnosis* of active phase labor onset among low-risk nulliparae are in question as are the statistical limits of these measures.

Identifying the norms and limits of post-admission cervical dilation rates remains critical to the assessment of labor progress and consideration of labor accelerative intervention. Clinicians often use a cervical dilatation of 3–5 cm in the presence of regular uterine contractions as prospective evidence of active labor onset. Beginning with these criteria through complete dilatation, the aim of this systematic review was to describe labor duration and cervical dilation rates among low-risk, nulliparous women with spontaneous labor onset.

METHODS

MEDLINE and CINAHL searches were performed with each search limited to human research published in health science journals between 1990 – 2008 in the English language and with available abstracts. First, the keyword *nulliparous* (searched in 'All Text') was cross-searched with each of the following keywords (searched in 'Abstract'): *labor (labour) length*, *labor (labour) duration*, *active phase*, and *active labor (labour)*. Next, the keyword *nulliparas* (searched in 'All Text') was cross-searched with each of the aforementioned 'Abstract' keywords. Manual searches were not used to avoid introducing selection bias. It was anticipated that this search strategy would yield a representative cross-section of the practices and interventions that exist in modern obstetrical practice (e.g., those with or without oxytocin augmentation, artificial rupture of the amniotic membranes, epidurals, etc.).

The MEDLINE and CINAHL searches yielded 375 unique titles with abstracts. First-level screening of each abstract was performed by the first author (JLN) and the title was retained for second-level screening if the following criteria were met: (1) the publication was an original prospective or retrospective research study; (2) strictly nulliparous groups or sub-groups with a singleton fetus at ≥ 36 weeks gestation and spontaneous labor onset were included or there was no evidence to the contrary; (3) study subjects were 'low-risk' at study entry based on their description in the abstract (e.g., without medical condition, pregnancy complication, or diagnosed labor abnormality) or there was no evidence to the contrary. After first-level screening, 212 publications remained and all but one were successfully retrieved either electronically or manually for second-level screening.

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Publications undergoing second-level screening (n = 211) were evaluated in full-text against systematic review exclusion criteria that were established *a priori*. The first identified exclusion criterion found within any given publication eliminated that study from the review. The second-level screening exclusion criteria and the number of publications eliminated by each are as follows: 1) no strictly nulliparous study group or sub-group (n = 15); 2) documented inclusion of multiple gestations or non-cephalic presentations (n = 0); 3) documented inclusion of women with chronic medical conditions (e.g., hypertension, diabetes, asthma, HIV, American Society of Anesthesiologist Physical Status Classification II or higher) or pregnancy complications (e.g., hypertensive disorders, gestational diabetes) (n = 20); 4) < 36 weeks gestation (n = 4); 5) inductions of labor including the use of pre-labor cervical ripening techniques (n = 42); 6) no identifiable mean, median, or absolute cervical dilatation between 3–5 cm at study enrollment or randomization (n = 78); 7) labor duration from 3–5 cm through complete cervical dilatation indeterminable from study data (n = 25); and 8) study database was previously used by another publication qualifying for systematic review (note: only the earliest publication was included in these cases) (n = 2). On a few occasions, publications could be neither excluded based on their full-text review nor immediately included because not all potential exclusion criteria were addressed. In these cases, authors were directly contacted for minor clarifications such as dilatation at 'active labor' onset[18–21] and whether all women had a spontaneous labor onset.[20]

Twenty-five publications remained after second-level screening (Table 1).[15–39] These studies were included without consideration of their results and, because intervention outcomes were not being compared, there was no need to exclude any based on threats to internal validity. Data from each publication including dilatation (cm) at the onset of 'active labor' and 'active labor' duration were abstracted and entered into an SPSS 17.0 (SPSS Inc., Chicago, IL) database. The difference between cervical dilation at 'active labor' onset and complete dilatation was divided by 'active labor' duration to yield a linear cervical dilation rate (cm/hr) for each study group. This method was used because raw data were unavailable. Subsequently, results from each study were aggregated to yield weighted 'active labor' durations and rates of dilation. Weighting, based on the number of subjects (*n*) in each study, was used to assure that the studies with smaller sample sizes did not disproportionately affect the systematic review results. The results are irrespective of any treatment received. Thus, they provide composite data representative of the diverse care patterns in contemporary practice.

'Active labor' was defined as the onset of clinical criteria commonly used as prospective evidence of active phase onset through the diagnosis of complete cervical dilatation. Most investigators used between 3–5 cm dilatation in the presence of contractions as their definition of the onset of the active phase of labor. Importantly, the definition of 'active labor' onset used in this systematic review, based on prospectively applied clinical criteria, is inherently different from Friedman's definition of active phase onset. According to Friedman, an individual's active labor begins at the point in time when the rate of dilation begins to become progressively more rapid.[5,6,9] If discernible, such a point can only be identified retrospectively.

RESULTS

The mean duration of 'active labor' was reported in 18 studies[15–17,19,23–31,33,35–37,39] (Table 2). For nulliparous women in these studies (n = 7009), there was a weighted mean cervical dilatation of 3.7 ± 0.4 cm at 'active labor' onset. The weighted mean duration of 'active labor' was 6.0 hours and the weighted mean rate of cervical dilation, based on linear calculations, was 1.2 cm/hr. For studies providing an 'active labor' duration standard deviation (n = 4300) [15–17,19,23–28,37,39], the calculated weighted 'active labor' duration at the mean + 2 SD was 13.4 hours. In these same studies, the weighted cervical dilation rate at the mean – 2 SD was

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0.6 cm/hr. Perhaps, the finding best indicating that the duration of normal 'active labor' varies widely is that the weighted mean of the standard deviations was 3.5 hours.

In eight studies included in this systematic review, the authors reported the median duration of 'active labor' either in addition to a reported mean[39] or exclusively (Table 3).[18,20–22,32,34,38] Among participants in these studies (n = 4516), there was a weighted mean cervical dilatation of 4.0 ± 0.2 cm at 'active labor' onset. Based on provided median values, the weighted median duration of 'active labor' was 5.4 hours and the average rate of cervical dilation in 'active labor' was 1.2 cm/hr.

Commonly used labor interventions such as epidural analgesia and amniotomy were used in many of the included studies as were varying labor management strategies such as the active management of labor (AML). Based on the studies included this systematic review, a stratified *post hoc* analysis was used to compare 'active labor' between study groups receiving and not receiving epidurals. These groups were found to differ very little on 'active labor' parameters. An additional stratified *post hoc* analysis was used to compare AML with other types of labor management. It was found that average 'active labor' duration was shorter in the AML group (4.87 v. 6.32 hrs, respectively) while the average and 'slowest acceptable' dilation rates were more rapid (1.6 v. 1.1 cm/hr and 0.8 v. 0.4 cm/hr, respectively). An inability to isolate other interventions received and not received in an ample number of study groups (e.g., amniotomy v. membrane preservation) precluded additional meaningful *post hoc* analyses.

DISCUSSION

We found that when spontaneously laboring, low-risk, nulliparous women are admitted for labor under criteria broadly associated with active phase onset (i.e., between 3–5 cm with regular uterine contraction), average 'active labor' is longer than Friedman first suggested more than half a century ago. In Friedman's works, the active phase encompassed the time from 2.5 cm to 10 cm and averaged 4.6–4.9 hours.[6,8,9] However, when starting at approximately 4 cm dilatation, Friedman's aggregate active phase data indicated that half of nulliparous women reached full dilatation in 2.6 hours[6,9] whereas we found that 'active labor' is roughly 6 hrs from this point forward. We found the standard deviation of 'active labor' duration for nulliparous women to be 3.5 hours which is consistent with Friedman's findings wherein the standard deviation of active labor duration ranged between 3.4–3.6 hours.[6,8,9] Therefore, the difference in 'active labor' duration at mean + 2 SD between Friedman's works [6,8,9] and our systematic review (11.7 and 13.4 hrs, respectively) stems from the discrepancy in calculated mean 'active labor' duration.

In studies by Albers[15,16] and Jones and Larson[17], the investigators specifically aimed to identify the duration of *spontaneous* 'active labor' (i.e., no oxytocin, no epidurals, no operative deliveries) among low-risk, nulliparous women delivering vaginally. Defining 'active labor' as the time necessary for the cervix to dilate from 4 to 10 cm, these investigators reported that spontaneous 'active labor' lasts 6.2–7.7 hours on average with wide variability. The mean 'active labor' duration of 7.7 hours reported by Albers[15,16] in two consecutive studies was longer than the 'active labor' durations reported by most of the other studies included in the present systematic review. This is possibly because there were no attempts to accelerate cervical dilation in her studies. Although the goal of this systematic review was to provide collective 'active labor' data representative of the diverse care patterns in contemporary practice, we recognize that nulliparous 'active labor' progressing to vaginal birth without oxytocin augmentation or epidural analgesia is increasingly less common. Therefore, we performed a *post hoc* analysis and found that the overall findings of our systematic review remained stable even when the data from Albers'[15,16] and Jones and Larson's[17] studies were

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not included. Thus, these spontaneous 'active labor' studies did not disproportionately affect the results of our systematic review.

We also found that rates of cervical dilation during 'active labor' from 4 cm dilatation forward are much slower than those reported by Friedman. Friedman determined that nulliparous women dilate at a mean rate of 3.0 cm/hr between 4 cm and 9 cm with a slowest acceptable rate of 1.2 cm/hr.[6,9] In comparison, when using criteria broadly associated with active phase onset as the starting point, we found that only half of nulliparous women dilate at ≥ 1.2 cm/hr during 'active labor'. Our 'slowest acceptable' rate (mean − 2 SD) approximated 0.6 cm/hr. The 'active labor' dilation rate findings of our systematic review closely align with those by Zhang et al who reported that it takes approximately 5.5 hours for nulliparas to dilate from 4 cm to 10 cm.[3] This equates to 1.1 cm/hr when viewed linearly. Our findings also align with those of Philpott and Castle[11,13] and the World Health Organization[12] wherein up to 31% of nulliparous women dilate slower than 1 cm/hr at or after 3 cm dilatation. Furthermore, our findings confirm those of Perl and Hunter[14] 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.

There are two possible interpretations of our findings. First, assuming that the clinical criteria commonly associated with active phase onset accurately define 'true' active phase onset, it can be concluded that current duration and dilation rate expectations of the active phase of labor are overly stringent for low-risk, nulliparous women. Under this assumption, revision of existing active phase norms and limits are warranted. Alternatively, assuming that traditional expectations of retrospectively-identified active labor are well-defined, it can be concluded that many women admitted to labor units in presumed active labor may not yet be actively dilating. For these women, active labor will be perceived to be longer and rates of dilation will seemingly be slower. Some combination of these two interpretations may also exist. These scenarios may, in part, explain the high rates of intrapartum interventions used to accelerate labor in contemporary practice. No matter which assumption bears more weight on the results of this review, nulliparous women admitted for labor under criteria generally associated with active phase onset should be held to no stricter cervical dilation expectation than those derived from extant research using these same criteria.

Rates of cervical dilation during 'active labor' are intimately linked to the topic of labor dystocia. Dystocia is characterized by the "slow, abnormal progression of labor."[1] Albeit a nebulous diagnosis, dystocia has been identified as the leading indication for primary cesarean deliveries[1,2], accounting for as much as 50% of all cesareans performed in nulliparous women.[40] Among term, low-risk women giving birth for the first time *and* with a vertex presenting fetus, a cesarean rate of 25% was reported by the Centers for Disease Control and Prevention in 2005.[41] Because dystocia is the original indication leading to most repeat cesareans, it follows that the majority of cesareans in the United States are related to the diagnosis of dystocia.[2] At present, the total cesarean rate is higher than ever before at 31.8%.[42] This is of concern because the best birth outcomes for mothers and babies reportedly occur with cesarean rates of 5–10% while rates higher than 15% are associated with more harm than good.[43,44]

In clinical practice, dystocia is generally defined as a delay in cervical dilation progression beyond which accelerative interventions such as oxytocin augmentation may be justified. Multiple definitions of dystocia, based on cervical dilation rates, exist. Perhaps the most common definition stems from the multifaceted labor management program *active management of labor* (AML) that was pioneered by O'Driscoll and colleagues with the goal of shortening primigravid labor.[45,46] Following the diagnosis of labor, AML accepts 1 cm/hr as the slowest acceptable rate of dilation; slower rates receive prompt accelerative interventions

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to correct presumed inefficient uterine action.45 Clinical trials of AML have consistently demonstrated that a majority of women dilate at < 1 cm/hr at some point during labor evidenced by high oxytocin augmentation rates. A recent systematic review of randomized, controlled AML trials reported that 62% of nulliparous women (n = 1393/2242) randomized to AML care received oxytocin augmentation.47 The rates of uterine stimulation with AML suggest that the clinical expectations of cervical dilation for nulliparous cervical dilation have surpassed normalcy.

Cervical dilation during 'active' labor is often conceptualized linearly, a conceptualization that likely contributes to the high frequency of dystocia diagnoses and subsequent intervention. In reality, dilation patterns during labor are not linear. Some investigators have concluded that a sigmoid pattern develops[5–7,9] while data from other studies suggest that a hyperbolic pattern lacking a deceleration phase predominates.[3,12] In either scenario, cervical dilation rates accelerate throughout the majority of labor. For example, Zhang et al found that slopes of cervical dilation progressively steepen with each passing centimeter. Median rates of dilation between 3–4, 4–5, 5–6, 6–7, 7–8, 8–9, and 9–10 cm were 0.4, 0.6, 1.2, 1.7, 2.2, 2.4, and 2.4 cm/hr, respectively.[3] At the 5th percentile which is used to define the slowest normal dilation rate, these dilation rates were 0.1, 0.2, 0.3, 0.5, 0.7, 0.8, and 0.7 cm/hr, respectively. Before 7 cm dilatation, it was not uncommon for there to be no change in dilatation for > 2 hours. When viewed linearly from 3 cm to 10 cm dilatation, calculations based on Zhang et al[3] data find the median and 5th percentile *linear* dilation rates to be faster than the *actual* rates these investigators reported from one centimeter to the next (e.g., from 4 cm to 5 cm) until some point after 5 cm dilatation at which point the linear rates become slower than actual rates. Therefore, when expected rates of dilation in the 'active phase' are viewed linearly as is common in contemporary practice, the likelihood of accelerative intervention is much greater in earlier 'active' labor. The rates of cervical dilation found in this systematic review are not exempt from this issue. While the cervical dilation rate at the mean – 2 SD was 0.6 cm/hr, progression in the earlier part of 'active labor' will typically be slower than this average while progression in more advanced 'active labor' will typically be more rapid. Although more complex, utilizing a hyperbolic labor curve in prospective clinical decision-making may lead to fewer diagnoses of dystocia and facilitate more discriminate use of labor accelerative interventions.

A matter of statistical and, perhaps, clinical relevance is that labor duration may not hold to a statistically normal curve. Specifically, there is a tendency for longer labors to positively skew the statistical distribution.[3] Hence, it is possible that median labor duration may be a superior measure of central tendency with half of the population falling above and half below this value compared to the mean labor duration which is more influenced by long labors. If 'active labor' duration is positively skewed, median duration will be shorter than the mean duration. This finding was borne out modestly in the present systematic review wherein the median and mean active phase labor durations were 5.4 and 6.0 hours, respectively. However, it must be kept in mind that dilatation at 'active labor' onset was also slightly more advanced in studies reporting *median* durations compared to studies reporting *mean* durations (4.0 v 3.7 cm, respectively) which likely contributed to the shorter median labor duration.

Our goal was to describe 'active labor' duration and rates of cervical dilation for low-risk, nulliparous women with spontaneous labor onset irrespective of any intervention. Because we did not have raw data from each study included in this review, our methodology was limited to aggregate estimates. For example, we averaged the mean 'active labor' durations provided in each study to obtain an overall estimate for the aggregate. While these aggregate estimates may introduce bias, knowledge that an inverse relationship exists between cervical dilatation and 'active labor' duration minimizes the extent of this bias.

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Our findings also are meant to reflect the diverse care patterns in contemporary practice. Many of the studies in this systematic review included women who received common labor interventions such as epidural analgesia, amniotomy, and oxytocin augmentation. Other studies included women whose labors were managed under AML protocols. Such interventions and labor management strategies may affect labor duration. For example, several research teams have reported that epidural analgesia lengthens the first stage of labor among nulliparous women[27,28,48] although others have not found such a relationship.[26,34] We found that 'active labor' parameters differed very little between women with and without epidurals. AML also reportedly shortens 'first stage labor' by 1.56 hrs when compared to 'routine' care (95% CI: –2.17 hrs, –0.96 hrs).[47] Our results comparing AML with other types of labor management found this to be true as average 'active labor' duration was shorter in the AML group while the average and 'slowest acceptable' dilation rates were more rapid. Because care patterns vary widely between providers, institutions, and regions, our findings are only meant to broadly represent the 'active labor' parameters of low-risk, nulliparous women with a spontaneous onset of labor. They should not be strictly applied to any individual.

Discussions about where the maximum active phase of labor duration should be drawn would be moot if there were a clear point where incidences of perinatal morbidities sharply rise. Such a point has not yet been identified. Moreover, the extent to which the relationship between prolonged labor and labor morbidity is causal is by no means certain. It remains unclear if the risks associated with longer labors are more related to time in labor or to the interventions commonly applied to shorten labor. This issue is especially pertinent since a large number of women are likely admitted to the hospital, often inadvertently, before traditionally defined active labor onset. Strategies are needed to aid clinicians in the prospective identification of active labor onset. Until such strategies are available, progress that is slower than is traditionally associated with active labor should be a reason for evaluation rather than for intervention. More outcome-based research in this area is needed.

CONCLUSION

Among healthy, low-risk, nulliparous women at term with a spontaneous labor onset, the 'active phase' of labor lasted an average of 6.0 hours while the average linear rate of cervical dilation during this period was 1.2 cm/hr. These findings closely parallel those found at the median. At the statistical limits, the weighted 'active labor' duration was 13.4 hrs (mean + 2 SD) and the dilation rate was 0.6 cm/hr (mean − 2 SD). While these labor parameters are not intended to precisely define labor expectations for nulliparous women, they do indicate that contemporary expectations of 'active labor' are overly stringent for this population when criteria traditionally associated with active labor onset are used as the starting point. Revision of existing active labor expectations and/or revision of criteria used to prospectively identify active phase onset is warranted and efforts to do so must supersede efforts to change labor to fit existing expectations.

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Table 1

25 Studies included in systematic review

Trial	N	Trial Type	Inclusion/Exclusion Criteria[a]	Qualifying Groups/Sub-groups
Fraser et al, Canada & US, 1993 [22]	925	Prospective, randomized	**Inclusion:** Intact membranes; normal fetal heart rate. **Exclusion:** Suspected IUGR; severe pre-eclampsia; IDDM; ≥ 6 cm at admission; maternal distress too great to permit informed consent.	Routine early amniotomy v conservative membrane management after admission at ≥ 3cm [e]
Cammu et al, Belgium, 1994 [23]	110	Prospective, randomized	**Inclusion:** Low-risk; 3–5 cm at admission; ruptured membranes with clear fluid; no dystocia at inclusion	Bathing v non-bathing with AML
Cammu et al, Belgium, 1994 [24]	1000	Prospective, observational	**Inclusion:** No contraindications for labor; maternal height ≥ 150 cm; one or more antenatal care visits	Unaugmented v augmented labor with AML but without epidural[e]
Albers et al, US, 1996 15	347 [b]	Retrospective, record review	**Inclusion:** Low-risk; non-Hispanic white, Hispanic, or American Indian; ≤ 4 cm at admission (for active phase analyses). **Exclusion:** Medical problems (e.g., hypertension, gestational diabetes, asthma, membranes ruptured > 24 hrs); oxytocin augmentation; epidural analgesia; operative delivery.	No treatment
Cammu et al, Belgium, 1996 [25]	306	Prospective, randomized	**Inclusion:** Normal cardiotocogram and clear amniotic fluid at admission; maternal height ≥ 150 cm; one or more antenatal outpatient clinic visits.	AML v selective intervention
Bofill et al, US, 1997 26	100	Prospective, randomized	**Inclusion:** Healthy. **Exclusion:** Medical problems (e.g., IDDM, medicated chronic hypertension, PIH).	Epidural v narcotics for labor pain relief
Dickinson et al, Australia, 1997 [18]	497	Prospective, observational	**Inclusion:** Low-risk.	Epidural v non-epidural with modified AML
Alexander et al, US, 1998 [27]	199	Retrospective analysis of randomized trial	**Inclusion:** Normal pregnancy; augmented with oxytocin; non-operative vaginal delivery. **Exclusion:** Pregnancy complication; > 5 cm at admission.	Epidural v meperidine (IV) for labor pain relief
Clark et al, US, 1998 28	318	Prospective, randomized	**Exclusion:** Contraindication to labor; thrombocytopenia or coagulation disorder precluding epidural placement.	Epidural v meperidine (IV) during AML for labor pain relief
Thompson et al, US, 1998 [29]	641	Retrospective, chart review	**Inclusion:** Low-risk; 18–35 yrs old; prenatal care provided by study institution; black or Caucasian race. **Exclusion:** Drug or alcohol abuse; smoking; pre-eclampsia; hypertension; diabetes; > 7 cm at admission; pre-pregnancy weight > 100 kg; chronic medical condition; history of pelvic injury or major abdominal surgery; hospitalization during pregnancy; uterine myoma; active genital herpes; oligo- or polyhydramnios; incomplete medical record.	No epidural (no analgesia or parenteral opioids only) v low-dose epidural v high-dose epidural
Albers, US, 1999 [16]	806 [b]	Prospective, observational	**Inclusion:** Low-risk; ≤ 4 cm at admission; membranes ruptured < 24 hrs. **Exclusion:** Medical problems (hypertension, gestational diabetes, asthma, drug use); oxytocin augmentation; epidural analgesia; operative	No treatment

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Trial	N	Trial Type	Inclusion/Exclusion Criteria[a]	Qualifying Groups/Sub-groups
			delivery (cesarean, forceps, vacuum).	
Fontaine et al, US, 2000 [30]	100 [b]	Retrospective, chart review	**Inclusion:** < 6 cm at admission. **Exclusion:** Epidural use; other undefined reasons.	ITN v no ITN (IV narcotics or no analgesia)
Garite et al, US, 2000 [31]	195	Prospective, randomized	**Inclusion:** Uncomplicated pregnancy; 2–5 cm with or without ruptured membranes. **Exclusion:** Pre-eclampsia; cardiac or renal disease; chorioamnionitis, pyelonephritis, or febrile illness before randomization.	Isotonic IV fluids at 125 ml/hr v 250 ml/hr during labor
Sadler et al, New Zealand, 2000 [32]	651	Prospective, randomized	**Exclusion:** Evidence of fetal distress at admission; severe cardiac disease; uterine scar; contracted pelvis; elective cesarean.	AML v routine labor management
Sharma et al, India, 2001 [33]	150	Prospective, randomized	**Inclusion:** Healthy; 18–30 yrs old; intact membranes; dilatation of 4 cm with partially effaced cervix; established contractions. **Exclusion:** Medical, surgical, or obstetric complications (e.g., pre-eclampsia, antepartum hemorrhage); dilatation > 5 cm.	Drotaverine hydrochloride (IM) v valethamate bromide (IM) v unmedicated group
Zhang et al, US, 2001 [34]	1088	Retrospective, chart review	**Inclusion:** < 7 cm at admission; admission to delivery duration ≥ 3 hrs; 18–34 yrs old; birth weight of 2.5–4 kg.	Before v after ‘on-demand’ epidural analgesia
Gurewitsch et al, US & Israel, 2002 [35]	908 [b]	Retrospective, comparative	**Inclusion:** Uncomplicated pregnancy; ≥ 3 first-stage cervical exams. **Exclusion:** Contraindication to labor; uterine scars; hydramnios; fetal anomaly.	No treatment
Jones et al, US, 2003 [17]	120 [b]	Retrospective, comparative	**Inclusion:** Hispanic; 15–44 yrs old; spontaneous vaginal birth. **Exclusion:** Cephalopelvic disproportion; prolonged membrane rupture; social or medical problems (substance abuse, hypertension, diabetes, asthma); oxytocin augmentation; regional anesthesia.	No treatment
Kaul et al, US, 2004 [36]	1671	Retrospective, comparative	**Inclusion:** Healthy; epidural during labor; oxytocin augmentation during labor as subgroup; elective IOL as subgroup. **Exclusion:** Past medical problems; complicated pregnancy; cesareans for fetal distress.	Oxytocin augmentation group [e]
Somprasit et al, Thailand, 2005 [37]	960	Prospective, randomized	**Inclusion:** Low-risk. **Exclusion:** Medical or surgical complications; contraindications to vaginal delivery or oxytocin use; fetal distress at admission; diabetes; PIH.	AML v conventional labor management
Vahratian et al, US, 2005 [38]	2200	Retrospective, chart review	**Inclusion:** Low-risk; elective IOL as sub-group. **Exclusion:** Diabetes; hypertension; prior infectious cardiovascular, pulmonary, renal, mental, or thyroid disorders; IUGR; uterine bleeding; oligohydramnios.	Spontaneous labor onset group [e]
Eslamian et al, Iran, 2006 [19]	300	Prospective, randomized	**Inclusion:** Uncomplicated pregnancy; 3–5 cm; intact membranes. **Exclusion:** Chorioamnionitis; febrile illness or pyelonephritis; pre-eclampsia; history of cardiac or renal disease.	Isotonic IV fluids at 125 ml/hr v 250 ml/hr during labor
Mikki et al, Israel, 2007 [39]	157 [b]	Prospective, randomized	**Inclusion:** Low-risk; intact membranes at admission; normal fetal heart rate. **Exclusion:** Advanced labor; IUGR; suspected macrosomia (> 4.5 kg); pre-clampsia; IDDM; antepartum hemorrhage.	Early amniotomy v intent to conserve membranes

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Trial	N	Trial Type	Inclusion/Exclusion Criteria[a]	Qualifying Groups/Sub-groups
Miquelutti et al, Brazil, 2007 [20]	107	Prospective, randomized	**Inclusion** [c]**:** Low-risk; 3–5 cm at admission; 16–40 yrs old. **Exclusion:** Elective cesarean; contraindications to upright positions.	Upright position v no particular position encouraged (control group)
Svärdby et al, Sweden, 2007 [21]	164	Prospective, observational	**Inclusion** [d]**:** Uncomplicated pregnancy.	No augmentation v active phase v second stage augmentation

AML = active management of labor; IDDM = insulin-dependent diabetes mellitus; IM = intramuscular; IOL = induction of labor; ITN = intrathecally-injected narcotics; IUGR = intrauterine growth restriction; IV = intravenous; PIH = pregnancy-induced hypertension.

[a] All studies included nulliparae carrying live, singleton, cephalic presenting fetuses at a minimum of 36 wks gestation with spontaneous labor onset. Mean, median, or absolute dilatation between 3–5 cm at study enrollment or randomization must have been identified

[b] Value represents nulliparous women only although this study also included primiparous and/or multiparous groups / sub-groups.

[c] Through contact with author, it was clarified that all labors had a spontaneous onset.

[d] Through contact with author, it was clarified that ‘primigravid’ rather than ‘primiparous’ women were included in the study.

[e] Study also included nulliparous sub-group(s) not qualifying for systematic review because dilatation at ‘active’ phase onset was < 3 cm, unknown, or labor was induced.

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Table 2

18 Studies with mean measures of 'active phase' duration in systematic review

Trial	Group / Sub-group	*n*	Dilatation at 'active phase' onset (cm)[a]	'Active phase' duration (hrs)		Rate of 'active phase' dilation (cm/hr)[c]	
				Mean (SD)	*Mean + 2 SD*	*Mean*	*Limit*
Cammu et al, 1994 [23]	Bathing group	54	3.8 (0.9)	4.07 (2.32)	8.71	1.5	0.7
	Non-bathing group	56	4.0 (1.0)	4.4 (2.83)	10.06	1.4	0.6
Cammu et al, 1994 [24]	Unaugmented labor, no epidural	477	3.7 (1.6)	2.53 (1.3)	5.13	2.5	1.2
	Augmented labor, no epidural	159	3.1 (1.2)	4.73 (1.75)	8.23	1.5	0.8
Albers et al, 1996 [15]	No treatment	347	4	7.7 (5.9)	19.4	0.8	0.3
Cammu et al, 1996 [25]	AML group	152	3.2 (1.1)	4.23 (2.35)	8.93	1.6	0.8
	Selective intervention group	154	3.2 (1.1)	4.72 (2.57)	9.86	1.4	0.7
Bofill et al, 1997 [26]	Epidural analgesia	49	4.2 (1.0)	6.25 (2.38)	11.01	0.9	0.5
	Narcotics	51	4.2 (0.9)	5.95 (2.55)	11.05	1.0	0.5
Alexander et al, 1998 [27]	Epidural group	126	4	7.9 (3.0)	13.9	0.8	0.4
	Meperidine (IV) group	73	4	6.3 (3.0)	12.3	1.0	0.5
Clark et al, 1998 [28]	Epidural group	156	4	5.18 (2.7)	10.58	1.2	0.6
	Meperidine (IV) group	162	4	4.57 (2.35)	9.27	1.3	0.7
Thompson et al, 1998 [29]	No epidural (with labor curve)	142	4	5.25 [d]	--	1.1	--
	Low-dose epidural (with labor curve)	172	4	6.0 [d]	--	1.0	--
	High-dose epidural (with labor curve)	72	4	6.5 [d]	--	0.9	--
Albers, 1999 [16]	No treatment	806	4	7.7 (4.9)	17.5	0.8	0.3
Fontaine et al, 2000 [30]	ITN	50	4	5.17 (--)	--	1.2	--
	No ITN	50	4	4.43 (--)	--	1.4	--
Garite et al, 2000 [31]	IV fluids at 125 ml/hr (vaginal delivery)	78	3.6 (--)	8.05 (--)	--	0.8	--
	IV fluids at 250 ml/hr (vaginal delivery)	91	3.8 (--)	6.88 (--)	--	0.9	--
Sharma et al, 2001 [33]	Drotaverine HCl IM group	50	4	2.94 [e]	--	2.0	--
	Valethamate bromide IM group	50	4	3.21 [e]	--	1.9	--

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Trial	Group / Sub-group	*n*	Dilatation at 'active phase' onset (cm)[a]	'Active phase' duration (hrs)		Rate of 'active phase' dilation (cm/hr) [c]	
				Mean (SD)	*Mean + 2 SD*	*Mean*	*Limit*
	Unmedicated group	50	4	5.94 [e]	--	1.0	--
Gurewitsch et al, 2002 [35]	No treatment	908	3.1 (1.5)	4.5 [d]	--	1.5	--
Jones et al, 2003 [17]	No treatment	120	4	6.2 (3.6)	13.4	1.0	0.5
Kaul et al, 2004 [36]	Oxytocin augmentation group	996	4 [3,4]	5.3	--	1.1	--
Somprasit et al, 2005 [37]	AML group	320	3.1 (1.2)	8.97 (4.05)	17.07	0.8	0.4
	Conventional labor management group	640	3.1 (1.4)	9.82 (4.4)	18.62	0.7	0.4
Eslamian et al, 2006 [19]	IV fluids at 125 ml/hr (vaginal delivery)	118	4 [b]	6.12 (1.75)	9.62	1.0	0.6
	IV fluids at 250 ml/hr (vaginal delivery)	123	4 [b]	3.93 (1.43)	6.79	1.5	0.9
Mikki et al, 2007 [39]	Early amniotomy	74	3 [3,4]	3.85 (1.83)	7.51	1.8	0.9
	Intent to conserve membranes	83	4 [3,4]	5.28 (2.27)	9.82	1.1	0.6
	Weighted values	*7009*	*3.7 (0.4)*	*6.0 (2.0)*	*13.4 (5.0)*	*1.2 (0.5)*	*0.6 (0.3)*

AML = active management of labor; HCL=hydrochloride, IM = intramuscular; ITN = intrathecally-injected narcotics; IV = intravenous; IQR = interquartile range.

[a] Group mean (SD), median [IQR], or absolute value shown when provided in study.

[b] Through contact with author, it was clarified that median dilatation was 4 cm at 'active phase' onset.

[c] Calculated based on assumption that the cervical dilation phase ends at 10 cm which approximates complete cervical dilatation.

[d] Value derived from graphical labor curve presented in study publication.

[e] Calculated based on mean rate of dilation provided in study publication.

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Table 3

8 Studies with median measures of 'active phase' duration in systematic review

Trial	Treatment	*n*	Dilatation at 'active phase' onset (cm)[a]	Median duration (hrs)	Rate of 'active phase' dilation (cm/hr)[b]
Fraser et al, 1993 [22]	Routine early amniotomy	390	3.8 (0.9)	4.33	1.4
	Conservative membrane management	383	3.8 (0.8)	6.42	1.0
Dickinson et al, 1997 [18]	Epidural analgesia group	257	4[c]	4.6	1.3
	Non-epidural group	240	4[c]	2.75	2.2
Sadler et al, 2000 [32]	AML group (vaginal delivery)	290	4.5 (1.8)	4.0	1.4
	Routine management (vaginal delivery)	299	4.5 (2.1)	4.83	1.1
Zhang et al, 2001 [34]	Before 'on-demand' epidural analgesia	507	4	6.0	1.0
	After 'on-demand' epidural analgesia	581	4	6.0	1.0
Vahratian et al, 2005 [38]	Spontaneous onset of labor group	1171	4	5.97	1.0
Mikki et al, 2007 [39]	Early amniotomy	74	3 [3,4]	3.5	2.0
	Intent to conserve membranes	83	4 [3,4]	5.0	1.2
Miquelutti et al, 2007 [20]	Upright position group	35	4[c]	6.5	0.9
	Control group	42	4[c]	5.42	1.1
Svärdby et al, 2007 [21]	No augmentation	50	4[c]	5.08	1.2
	Active phase augmentation	88	4[c]	7.32	0.8
	Second stage augmentation	26	4[c]	7.33	0.8
	Weighted values	*4516*	*4.0 (0.2)*	*5.4 (1.0)*	*1.2 (0.3)*

AML = active management of labor

[a] Group mean (SD), median [IQR], or absolute value shown when provided in study.

[b] Calculated based on assumption that the cervical dilation phase ends at 10 cm which approximates complete cervical dilatation.

[c] Through contact with author, it was clarified that 'active phase' onset was defined as 4 cm dilatation.