

ABSTRACT

The Relationship of Maternal and Maternity Care Provider Characteristics to the Diagnosis of Labor Dystocia

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Background: To decrease the overall cesarean rate, recent efforts have focused on reducing non-emergent and otherwise low-risk cesarean births. Labor dystocia, the slowing or cessation of labor progression, is the leading indication for a primary cesarean birth. Although nonclinical factors have been linked to the incidence of labor dystocia, less is known about the relationship of those factors with the observed characteristics of the dystocia diagnosis. The purpose of this study was to determine whether 1) provider gender or years of practice and 2) maternal personal characteristics are associated with specific attributes of a labor dystocia diagnosis. Methods: This retrospective case series included all singleton, cephalic births ending in an unplanned primary cesarean exclusively due to labor dystocia between May 2014 and December 2017 at a for-profit, urban Texas health facility (n=291). Variables of interest were duration of labor and cervical dilation at the time of dystocia diagnosis. Mean values were compared among individual providers, provider gender, and years of practice, as well as maternal race/ethnicity, education, marital status, insurance type, age and body mass index to

determine any relationships of significance. Logistic regression was used to determine the likelihood of diagnosis occurring before 6 centimeters cervical dilation, and Cox proportional hazard models were applied to determine risk of earlier diagnosis among comparative maternal and provider characteristics. Results: After adjusting for cervical ripening and epidural use in a multiple regression analysis, provider years of practice remained significantly associated ($p=0.0003$) with duration of first stage labor. Maternal obesity was associated with a reduced first stage cervical dilation and second stage duration. Government insurance status was consistently associated with a less advanced cervical dilation at the time of diagnosis ($p=0.0003$). A majority of subjects (59%) received a dystocia diagnosis before 6 centimeters of cervical dilation. Conclusions: There were significant relationships between provider years of practice and labor duration before a dystocia diagnosis. Economically disadvantaged and obese women experienced a diagnosis at a less advanced cervical dilation. Providers should be informed of who is at risk of earlier labor dystocia diagnoses and encouraged to adhere to the recommended diagnosis threshold of six centimeters.

The Relationship of Maternal and Maternity Care Provider
Characteristics to the Diagnosis of Labor Dystocia

by

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DEDICATION

To my husband, Wes, who has been a constant encouragement throughout this endeavor

CHAPTER ONE

Introduction

Background

Almost one in three infants were delivered via cesarean section in the United States in 2016 (Martin et al., 2018). Among women who are deemed “low-risk” (defined as nulliparous with singleton, vertex fetal presentation, and gestation greater than 37 weeks), the cesarean rate was 25.8% in 2016 (Martin et al., 2018). The cesarean rise and prevalence have attracted more investigation because a cesarean delivery is riskier than a vaginal birth. Health concerns for the mother include the risks of major surgery and recovery, future fertility problems, and the complications anticipated by any subsequent cesarean deliveries. The newborn is at greater risk for neonatal complications and possible separation from the mother prompted by those complications, as well as compromises in the gut microbiome composition which have been linked to long-term obesity and auto-immune risks. The high cesarean rate also contributes to the burden of health care costs in the United States.

Statement of the Problem

Labor dystocia is the leading indication for a woman’s first cesarean birth. The definition of labor dystocia is defined as “slower progress than normal” or “complete cessation of progress” (Caughey et al., 2014, 181). Its diagnosis is dependent on multiple subjective factors and is often ambiguously defined and applied in practice. Therefore,

researchers have concluded that its incidence is too frequent and is impacting the overall cesarean rate (Barber, Lundsberg, et al., 2011).

Statement of the Purpose

The purpose of this study was to identify factors outside of a medical indication that are associated with the attributes of a labor dystocia diagnosis. These nonmedical factors include maternal sociodemographic characteristics such as education, marital status, insurance type and race and ethnicity, as well as the personal characteristics of age, parity and body mass index. Health care provider characteristics examined included gender and duration of professional practice.

Statement of the Significance

Previous research has been used to describe relationships associated with the incidence of labor dystocia, specifically that personal characteristics such as being older, privately insured, African-American, and less educated were linked with a higher incidence of labor dystocia. However, there is a need to better understand the application of labor dystocia. This study is one of few attempts to evaluate real-world practice applications of labor dystocia, and whether those definitions are related to demographic factors beyond medical indication. This study may be used to highlight the need for a larger scale study, as an analysis of how the specific attributes of the dystocia diagnosis are linked with personal maternal or provider characteristics has not yet been published in the body of literature on this topic.

To redefine normal labor progression, the Consortium on Safe Labor determined that labor dystocia should not be diagnosed before 6 cm of cervical dilation (Zhang,

Landy et al., 2010). The American College of Obstetrics and Gynecology (ACOG) endorsed these guidelines and included them in its consensus statement recommendations (Caughey et al., 2014). To address the primary cesarean rate, practitioners need to be aware of who is at greater risk for a premature labor dystocia diagnosis.

Research Questions and Hypotheses

1. Are maternal demographic and personal characteristics associated with specific attributes of a labor dystocia diagnosis?

Hypothesis 1: Women who are younger, obese, African-American, unmarried, less educated, or privately insured will experience a shorter duration of labor before a labor dystocia diagnosis.

Hypothesis 2: Women who are younger, obese, African-American, unmarried, less educated, or privately insured will receive a labor dystocia diagnosis at a less advanced cervical dilation.

Hypothesis 3: Women who are younger, obese, African-American, unmarried, less educated, or privately insured will be more likely to meet the ACOG dystocia diagnosing guidelines of at least six centimeters dilation.

2. Are provider characteristics associated with specific attributes of a labor dystocia diagnosis?

Hypothesis 1: Female providers will be associated with longer durations of labor and more centimeters of cervical dilation.

Hypothesis 2: Providers with fewer years of practice will be associated with longer durations of labor and more centimeters of cervical dilation.

Hypothesis 3: Female providers and providers with fewer years of practice will be more likely to meet the ACOG dystocia diagnosing guidelines of at least six centimeters dilation.

Limitations

The results of this study were limited by several factors. First, the study took place at one health facility utilized by patients within one obstetric practice, thus limiting its generalizability. Due to the limited sample size, the clustering of within-provider effects could not be statistically analyzed. Next, the study's primary outcome variable, the duration of labor, is based on the definition of onset of labor. As frequently noted in obstetric literature, duration of labor is difficult to define (Carlhall, Källén & Blomberg, 2013; Neal et al., 2015; Zhang, Landy et al., 2010), as it often relies on the woman's subjective experience of identifying the point at which contractions intensify. Medical records include the onset of labor time based on the subjective appraisal of consistency of intense contractions and cervical dilation.

Often, the rupture of membranes was applied by the study site to signal the onset of labor. However, there is scant precedence for using rupture of membranes (ROM) as the onset of active labor (Impey, Hobson & O'Herlihy, 2000). Further, attempting to define a "normal" labor progression is inherently flawed because of the varying individual health profiles of women and the variability of birth events such as induction, augmentation, epidural anesthesia use and coexisting birth complications. However, this study will be designed to adequately account for potential confounding variables.

Delimitations

Certain criteria will be applied as delimitations to subject inclusion in the study. First, only observations in which the outcome was a primary (versus repeat) cesarean will be included. Any cesareans occurring electively, that is, a planned cesarean for any non-medical reason, will be delimited. And finally, records of cesarean birth with an indication for any other reason than labor dystocia or a related cause, including multiple gestation, breech, or fetal intolerance of labor was delimited from the study. This includes cesarean deliveries due to a combination of labor dystocia and any other indication.

Terminology

Cervical ripening: the softening, thinning and dilation of the cervix to increase the rate success of a labor induction (ACOG, 2009).

Labor dystocia: childbirth labor characterized by either slower than normal progression or a complete cessation of labor (Caughey et al., 2014).

Vertex: a fetal presentation where the head is presenting first in the pelvic inlet (ACOG, 2013).

Nulliparous: a woman with a parity of zero (ACOG, 2013).

Multiparous: having one or more pregnancies in which gestation exceeds 20 weeks (ACOG, 2013).

First stage of labor: the latent and active phases of labor, characterized by the full dilation of the cervix (Friedman, 1972).

Latent phase: the onset of labor, as perceived by the laboring woman, until a marked shift in labor's intensity (Friedman, 1972).

Active phase: characterized by an increase in the rate of change of cervical dilation (Caughey et al., 2014).

Second stage of labor: the time from which the cervix is fully dilated until the delivery of the infant (Caughey et al., 2014).

Rupture of membranes: a rupture or perforation of the amniotic sac (ACOG, 2013).

Parity: The number of pregnancies in which gestation exceeds 20 weeks (ACOG, 2013).

Journal Selection

To comply with the Baylor Graduate Program's manuscript dissertation format, two manuscripts were written based on the results of this study. The first manuscript will be used to answer the research questions involving the relationship between the duration of labor before a labor dystocia diagnosis and patient demographic factors, including race, education, ethnicity, age, and parity, as well as the health factor of prenatal BMI. The second manuscript will be used to identify relationships between the length of trial of labor and health care provider characteristics, including years of practice and gender of the attending provider. I personally generated the content of this dissertation and relied on the multiple edits of my co-authors, Eva Doyle, Ph.D. and Kelly Ylitalo, Ph.D.

Once completed, the manuscripts will be submitted to *Obstetrics & Gynecology*, the official publication of the American College of Obstetrics and Gynecology, as well as *The American Journal of Obstetrics and Gynecology*. These periodicals currently have impact factors of 5.426 and 4.704, respectively. All journal submissions of this study will name Eva Doyle, Ph.D., and Kelly Ylitalo, Ph.D. as co-authors. Dr. Doyle contributed with the study inception and design, and Dr. Ylitalo designed and proofed the data analysis. I generated the content, and both co-authors provided multiple revisions.

CHAPTER TWO

A Review of the Literature

Epidemiology

Prevalence

Almost one in three infants were delivered via cesarean section in the United States in 2016 (Martin et al., 2018). This rate increased over 50% between 1997 and 2007 (Hamilton, Martin & Ventura, 2009; Menacker & Hamilton, 2010). Since its peak in 2009, the rate has decreased slightly (Martin et al., 2018). In 2016, cesareans occurring in what would otherwise be considered a low-risk birth, (defined as nulliparous, vertex presentation, singleton birth, and at gestation greater than 37 weeks), declined from 27.5% in 2010 to 25.7% (Martin et al., 2018). The cesarean rise and prevalence have attracted more investigation because of the accompanying health risks for mother and baby.

Cesarean Risks

As with any major surgery, cesarean surgery is accompanied by additional morbidity and mortality risk for mother and baby (MacDorman, Declercq, Menacker & Malloy, 2006; Xie et al., 2015). Venous thromboembolism was significantly more likely (Tepper et al., 2014), and Kramer et al (2013) found that amniotic fluid embolism was 15 times more likely. Infection affected 4% to 20% of cesarean mothers (Conroy et al., 2012), requiring additional postpartum treatment or possible re-hospitalization. The risk

of obstetric hemorrhage was two to three times greater for cesarean than vaginal birth (Al-Zirqi et al., 2009). Practitioner error, including accidental lacerations to adjacent organs or misplacing objects in the abdominal cavity, was also a possible outcome. Further, the cesarean mother is more likely to experience breastfeeding difficulties (Hobbs et al., 2016).

Long-term concerns include the increased likelihood of future placental problems. The uterine scar has been associated with the incidence of placenta previa and placenta accreta in future births (Keag, Norman, & Stock, 2018). Cesarean women are more likely to experience future infertility or miscarriage (O'Neill et al., 2014) and have a higher risk of hysterectomy for current or future pregnancies (Bodelon, Bernabe-Ortiz, Schiff & Reed, 2009). Cesarean deliveries are also a barrier for breastfeeding duration and make it less likely for a woman to meet her breastfeeding goals (Perrine et al., 2012; Zanardo et al., 2010).

Cesarean delivery also carries risks for the infant, including a greater likelihood of mortality (Xie et al., 2015). A vaginal birth optimizes newborn respiratory function. Therefore, cesarean deliveries are accompanied by a greater incidence of respiratory distress, as well as neonatal hypoglycemia, than are vaginal births (Karlstrom, Lindgren & Hildingsson, 2013). Cesarean infants are less likely to be exclusively breastfed (Lindau et al., 2015) or breastfed for longer duration (Perrine et al., 2012). Accidental lacerations affected at least 1% of cesarean newborns (Alexander et al., 2006). In recent years, research has focused on the importance of the optimal foundation of the infant microbiome (Azad et al., 2013; Jakobsson et al., 2014; Madan et al., 2016), which is the composition of microorganisms in the infant gut (Marchesi & Ravel, 2015). Therefore,

cesarean infants, who did not receive exposure to vaginal bacteria, have a greater incidence of asthma (Tollånes, Moster, Daltveit & Irgens, 2008) and are at an increased risk of obesity (Huh, Oken, Weiss & Gillman, 2012).

Cesarean surgery also contributes to the burden of increased health care costs, with an average cost nearing \$50,000 compared to the \$30,000 cost of a vaginal delivery (Rosenthal, 2013), and increases the duration of the mother's hospital stay (Silver et al., 2006).

Cesarean Disparities

The Centers for Disease Control and Prevention defined the primary cesarean as the “first cesarean delivery regardless of parity” (Osterman & Martin, 2014, 2). In the United States, having had a prior cesarean is the leading indication for a cesarean delivery (Boyle et al., 2013). Considering the additional long-term risks of a cesarean birth for mother and baby, the method of birth is a contributing factor to long-term health disparities (Roth & Henley, 2012). Cesarean deliveries are unequally distributed among different racial and ethnic populations. African-American women experienced significantly higher rates of cesarean deliveries in multiple studies (Getahun et al. 2009; Edmonds, Yehezkel, Liao & Moore Simas, 2013; Martin et al., 2018; Mathews et al., 2011; Zhang, Troendle et al., 2010), even after adjusting for health risk factors (Aron et al., 2000; Huesch & Doctor, 2015), with one exception (Witt et al., 2015). Non-Hispanic white women have been noted to have lower odds of primary cesarean delivery in one study (Edmonds, Hawkins & Cohen, 2014), and Hispanic women have been characterized with the lowest rate in another study (Getahun et al., 2009).

In addition to race and ethnicity, other demographic factors have been associated with a woman's risk of cesarean delivery. The level of maternal education was inversely associated with the primary cesarean risk (Cesaroni et al., 2008). Increased age was positively associated with cesarean risk, after adjusting for confounding factors (Bayrampour & Heaman, 2010; MacDorman et al., 2008; McClelland et al., 2017). Aron et al. (2000) found that not having insurance was linked with lower cesarean rates, and other researchers have found that privately insured women experienced higher cesarean rates than Medicaid-insured women (Henke et al., 2014; Kozhimannil, Shippee, Adegoke & Virnig, 2013).

Systemic Factors

There has been evidence in recent years of a shift in how practitioners and their organizations approach birth. The elective use of obstetric interventions in the absence of a medical reason has been cited as contributing to the primary cesarean rate (Main et al., 2006; Romano & Lothian, 2008). Individuals equipped with surgical expertise performed more surgery than family physicians (Avery, Graettinger, Waits & Parton, 2014). Further, wide variations in cesarean rates among obstetricians within a single institution have been observed (McClelland et al., 2017). Midwives, who tend to adopt an expectant management approach that avoids the routine use of intervention outside of a medical indication (Caughey et al., 2009), produced a lower cesarean rate than physicians in a controlled study (Nijagal, Kuppermann, Nakagawa & Cheng, 2015). A higher concentration of obstetricians in a geographic area was linked with higher cesarean odds for privately insured women (Henke et al., 2014). The reverse was also true for midwives – the more midwives in a geographic area the lower the cesarean risk, but only

for privately insured women (Henke et al., 2014). Male physicians were significantly more likely to perform cesarean surgery (Haberman et al., 2014; McClelland et al., 2017). Years of practice among providers has been negatively associated with incidence of cesarean birth. The Hawthorne Effect negatively affected cesarean incidence in randomized controlled trial; during a period of auditing obstetric practice, the cesarean rate of 36.8% was reduced to 26.5% (Scarella, Chamy, Sepúlveda & Belizán, 2011).

Facility culture may also influence cesarean incidence. Women birthing at private hospitals in the United Kingdom were 20% more likely to have a cesarean birth than those at public hospitals (Dahlen et al., 2014). Fitzwater et al. (2015) demonstrated that within one facility whose population risk profile had remained constant, the recent cohort was more than twice as likely to receive a cesarean than its counterpart a decade earlier. These results suggest a change in hospital birthing culture that has been echoed by other studies. Kozhimannil, Law and Virnig (2013) found that the cesarean rate varied greatly among different facilities. This variability was not linked to the risk profile of a facility's population in another study (Kozhimannil, Arcaya & Subramanian, 2014).

Calls for Reform

Due to health and associated cost concerns, key organizations have issued recommendations for health professionals to actively reduce the cesarean rate. Members of the World Health Organization stated that cesarean rates higher than 10% are not linked with reduced maternal and infant mortality (2015), and other researchers have concluded similarly (Ye et al., 2014). As one of its Healthy People 2020 objectives, leaders of the U.S. Department of Health and Human Services called to reduce the primary cesarean rate among low-risk women from 26.5% to 23.9%. The leading hospital

accreditation organization, The Joint Commission, included a hospital's cesarean rate as one of the Perinatal Core Measures that comprise its accountability ratings. In 2014, The American College of Obstetrics and Gynecology (ACOG) issued a consensus document that included clinical recommendations for reducing the primary cesarean rate (Caughey et al., 2014). Its application has been shown to significantly reduce the primary cesarean incidence (Lombard & Archil, 2016). These calls for change have led to a closer examination of nonclinical factors that are linked with higher cesarean delivery outcomes.

The patient profile has not changed; birthing women are not necessarily more high-risk (MacDorman et al., 2008; Witt et al., 2015). The cesarean's peak in the last decade has elicited efforts to determine reasons for its rise. The most common indication for a cesarean section is having had a prior cesarean (Barber et al., 2011). For that reason, recent attention has shifted to identifying modifiable factors that can prevent the first cesarean.

Labor Dystocia Etiology

The most common indication for the primary cesarean is labor dystocia, which occurs in at least 35% of primary cesarean deliveries (Boyle et al., 2013; Kjaergaard et al., 2009). Labor dystocia is commonly characterized by either slower than normal progression or a complete cessation of labor (Caughey et al., 2014). Dystocia results from abnormalities involving at least one of the following – the *power* of the uterine functioning, the *passenger* (characteristics of the fetus), and the *passage*, or pelvic characteristics (ACOG, 2003). Specifically, dystocia encompasses many clinical events, including arrest of descent, arrest of dilation, malposition, failure to progress, stalled

labor, prolonged active phase and fetopelvic or cephalopelvic disproportion, or an incompatibility between the fetal head and the pelvis (ACOG, 2003; Lowe, 2007).

The risk factors for labor dystocia have been thoroughly investigated. A woman's early admission (cervical dilation <3 cm) into the hospital increased her likelihood of dystocia (Main et al., 2006). Similarly, dilation at admission was inversely related to a woman's chance of having a cesarean (Kominiarek et al., 2015). Efforts to artificially invoke or augment labor increased the risk of dystocia (Cheng, Delaney, Hopkins & Caughey, 2009). A combination of induction and augmentation has also been found to increase primary cesarean risk (Main et al., 2006).

Labor dystocia has also been linked to sociodemographic characteristics and body size. Older women were more likely to experience stalled labor (Treacy, Robson & O'Herlihy, 2006). Associations with race and ethnicity have also been established (Greenberg et al., 2006). African-American women were not only more likely to experience stalled labor, they were also more likely than non-Hispanic white women to receive a dystocia diagnosis earlier - during the first stage of labor (Edmonds, Yehezkel, Liao & Moore Simas, 2013). Body mass index (BMI) has also been directly related with incidence of labor dystocia (Kawakita et al., 2016).

Non-medical circumstances may influence how physicians define and apply labor dystocia. For example, physicians who earned a flat salary unrelated to the procedures they performed were less likely to diagnose prolonged labor (Spetz et al., 2001). At one facility, physicians with the highest quartile of cesarean rates diagnosed labor dystocia twice as frequently (Díez, Requena, Rosel & Pons, 2016). In a 2007 review, Lowe added the influence of health care provider decision-making and the sociopolitical environment

as additional factors contributing to the incidence of dystocia. Huesch and Doctor (2015) found that the complex dynamics of patient-physician communication and patient beliefs might also explain racial variations of cesarean incidence. Physicians with more years of practice have been observed to expect faster rates of labor progression than their less experienced counterparts (White, Lee & Beckmann, 2016)

Labor dystocia diagnoses are defined by “abnormal” labor progression. The Friedman (1954) defined a “normal” active labor progression as a cervical dilation >1.2 cm/hour for nulliparous women and >1.5 cm/hour for multiparous women. More recent investigations have been used to assert that labor actually progresses more slowly than Friedman’s model (Suzuki, Horiuchi, & Ohtsu, 2009; Zhang, Landy et al., 2010; Zhang, Troendle & Yancey, 2002), and that there is a wide variability of labor progression rates of unproblematic labors (Ferrazzi et al., 2015; Incerti et al., 2011).

It is difficult to apply a universal norm when there are inconsistencies in the labor progression of different populations. Maternal age, marital status and pre-pregnancy BMI have been associated with longer first stages of labor, for example (Cheng et al., 2010; Debiec et al., 2009). Labor duration also differs among racial and ethnic groups (Greenberg et al., 2006). The application of a single standard labor curve for all low-risk nulliparous women is problematic (Debiec et al., 2009), and has likely contributed to the incidence of unplanned cesareans deliveries due to labor dystocia (Neal, Lowe, Patrick et al., et al., 2010). For example, dystocia due to arrest of cervical dilation was identified as one of the two leading causes for the primary cesarean rate increase between 2003 and 2006 (Barber et al., 2011).

Conclusion

According to data from the Consortium on Safe Labor, a multisite retrospective study on U.S. childbirth practices from 2002 to 2008, 10% of primary birthing women experienced cesarean surgery due to failure to progress (Boyle et al., 2013), indicating the need to objectively define the diagnosis and thus decrease its occurrence. The subjective nature of labor dystocia suggests that further examinations of dystocia could decrease the cesarean rate to meet or exceed Health People 2020 goals. Researchers have investigated the incidence of primary cesarean among groups with various social characteristics (Bayrampour & Heaman, 2010; Getahun et al., 2009). Other studies have been used to analyze variations in labor patterns by race and ethnicity (Greenberg et al., 2006), age (Treacy et al., 2006), education level (Cesaroni et al., 2008) or insurance status (Henke et al., 2014). Disparities in birth outcomes among different groups have also been reported (Zhang et al., 2002; Zhang et al., 2013).

Despite the established links between inequitable incidences of cesareans among demographic groups, no investigations have been made into the specific attributes of labor dystocia among those groups. Although labor dystocia as an outcome has been studied, the qualities of labor dystocia, namely cervical dilation and labor duration, have not been related to personal patient or physician characteristics. Therefore, the purpose of this research study is to evaluate the patient and physician characteristics associated with duration of labor and cervical dilation before an unplanned cesarean section due to labor dystocia. Our first research hypothesis is that women who are younger, obese, African-American, unmarried, less educated, or privately insured will experience a shorter duration of labor and have less advanced cervical dilation at dystocia diagnosis.

The second hypothesis is that a shorter duration of labor and a less advanced cervical dilation at the time of dystocia diagnosis will be related to male and more experienced health care providers.

CHAPTER THREE

Methods

Study Purpose and Design

The cesarean birth increases morbidity and mortality for mother and infant, and the risks are multiplied with each additional cesarean birth. Identifying modifiable ways to reduce the incidence of the primary, or first, cesarean birth and thus avoid future cesarean births, is a public health priority. Labor dystocia is the leading indication for the primary cesarean. Therefore, the purpose of this study was to describe the application of labor dystocia diagnoses at one for-profit, urban Texas hospital. It was a retrospective case series based on secondary data extracted from electronic medical records (EMR). Regression and hazard analyses were used to 1) identify relationships between length of trial of labor, cervical dilation at decision time, and subjects' demographic characteristics, and 2) identify relationships between length of trial of labor, cervical dilation at decision time, and provider characteristics.

Research Questions and Hypotheses

1. Are maternal demographic and personal characteristics associated with specific attributes of a labor dystocia diagnosis?

Hypothesis 1: Women who are younger, obese, African-American, unmarried, less educated, or privately insured will experience a shorter duration of labor before a labor dystocia diagnosis.

Hypothesis 2: Women who are younger, obese, African-American, unmarried, less educated, or privately insured will receive a labor dystocia diagnosis at a less advanced cervical dilation.

Hypothesis 3: Women who are younger, obese, African-American, unmarried, less educated, or privately insured will be more likely to meet The American College of Obstetrics and Gynecology (ACOG) dystocia diagnosing guidelines of at least six centimeters dilation.

2. Are provider characteristics associated with specific attributes of a labor dystocia diagnosis?

Hypothesis 1: Female providers will be associated with longer durations of labor and more centimeters of cervical dilation.

Hypothesis 2: Providers with fewer years of practice will be associated with longer durations of labor and more centimeters of cervical dilation.

Hypothesis 3: Female providers and providers with fewer years of practice will be more likely to meet The American College of Obstetrics and Gynecology (ACOG) dystocia diagnosing guidelines of at least six centimeters dilation.

Sample and Subjects

The sample consisted of women who gave birth at a for-profit, urban Texas health center between May 1, 2014 and December 31, 2017, a sample period of 44 months.

Secondary maternal and provider data were gathered from existing electronic medical records (EMR). Chart records were selected for inclusion based on the following criteria: unscarred uterus, singleton birth, vertex presentation, gestation greater than 34 weeks, and a birth event ending in an unplanned cesarean after a trial of labor. Next, records

were excluded if the cesarean was planned, or if the cesarean indication was due to fetal intolerance, multiple gestation, or any other medical condition that eliminated the possibility of a trial of labor. The resulting sample size was 301 subjects.

The sample's racial and ethnic composition primarily consisted of African-American, non-Hispanic white, and Hispanic women. Race and ethnicity, as well as level of education, were notated according to the description provided by the birth mother on the infant's birth certificate. Seven observations for race and ethnicities other than African American, white and Hispanic were excluded from inclusion. Education levels were classified as high school diploma or less, some college, or college degree. Marital status was intended to serve as a proxy for social support (Eskander et al., 2016), and women were coded as either married or single. Finally, insurance status was categorized as either government-insured (e.g. Medicaid) or privately insured. Subjects who had both types of insurance were coded as having government insurance because these individuals met the income requirement to be eligible for this coverage. Because of the known differences in labor according to parity, the sample was stratified according to parity during analysis. Although due to the limited number of multiparous subjects, statistical analysis of this population was limited.

Study Site

The study site served a mid-size urban community and facilitates approximately 1,300 births annually. A medical staff of eleven obstetricians and one certified nurse-midwife assisted the deliveries during the study period. During evening and weekend hours, the on-call physician attended deliveries. During the weekday, the primary obstetrician of the patient attended deliveries.

The study site is one of two for-profit health facilities that serve the surrounding community. Both facilities have a similar patient composition in that they serve a mixed population of all income levels, as there is no other county or public hospital in the area. This is in contrast to what is often observed in urban healthcare, where within one community, health care quality can vary significantly for low-income or minority recipients (Baicker, Chandra & Skinner, 2005). The study site's patient composition closely reflects its surrounding community, including racial/ethnic, education level and BMI characteristics. See Table 3.1 for community characteristics.

Design

Secondary data collection was used in this retrospective case series study. The first outcome variable, duration of labor, was defined as the length of time in hours between labor's onset and the diagnosis of labor dystocia and was calculated by subtracting the labor onset time from the diagnosis time. The second outcome variable, final cervical dilation, was the dilation documented at the time of labor dystocia diagnosis. Duration of second stage was also collected when applicable. Predictor variables included race and ethnicity (African-American, Hispanic or Non-Hispanic white), insurance status (private or government) education level (high school or less, some college, or college degree or higher), parity, age, and body mass index (BMI) measured at first prenatal appointment.

Procedure

Institutional Review Board (IRB) approval was granted by the participating health facility and Baylor University. The principal investigator retrieved retrospective patient demographic and outcome variable data from all electronic medical records that met the

inclusion criteria on-site at the health care facility using Epic Software. Data points were manually entered into worksheets designed for this study. The collected data was then re-entered into a comma-delineated file using Microsoft Excel. This comma-delineated file was imported into the statistical software for the analysis phase. An external research assistant, trained and approved to use Epic software, conducted a review of 5% of the patient data to verify collection accuracy. Results of this external audit were matched with values observed in the initial round of data collection. Inconsistencies in interpretations of EMR data were resolved by consensus between the primary investigator and the external auditor. One data entry error was noted out of 225 datapoints (0.0044%). All personal patient information was de-identified in compliance with health care privacy laws and IRB guidelines prior to the data transfer to Baylor University.

Security

The primary investigator was trained in Collaborative Institutional Training Initiative (CITI) and Health Insurance Portability and Accountability Act (HIPAA) guidelines and obtained administrative approval to access the EMR system. All data was collected and stored on a password-encrypted computer at the study site. These security procedures were used by the third-party auditor assigned with confirming data accuracy. This individual also received HIPAA training, and password access to the EMR system.

Printed copies of data collection were stored in a locked private office at the study site. Data was manually entered into a comma-delineated file. Upon completion of data collection, identifying patient information was removed, and patients were assigned a code number to form the working data set used in analysis. Only this working data set,

with no identifying patient information, was transferred to Baylor University for analysis. Identifying patient information did not leave the health care facility, and only aggregate data from the analysis was presented.

Measures

Independent Variables

Personal descriptors were collected for each subject, including age, parity, race, ethnicity, marital status, type of insurance, completed level of education and BMI at first prenatal appointment. Characteristics of the birth's attending health care provider included gender and number of years in practice.

Birth Event Variables

To determine intervals between certain events, several time points were extracted from the EMR: time of admission, time of synthetic oxytocin administration, time of rupture of membranes, time of epidural anesthesia administration, and time of cesarean decision. Cervical dilation at cesarean decision was also collected from the EMR, as well as the length of the second stage of labor, when applicable. To ensure accuracy of timing for births events longer than 24 hours, dates for these events were also recorded. Use of cervical ripening, which exclusively involved the intracervical Foley catheter, was also collected.

An additional variable was created based on the timing of the start of synthetic oxytocin administration in relation to the onset of labor (a positive or negative number in minutes). Because the timing of interventions such as medication and induction influence the length of labor (Lowe, 2007), accommodating the timing of these events increased the validity of the analysis.

The primary indication for cesarean, as documented by the attending provider, was also recorded. To limit possible confounding labor influences such as fetal intolerance of labor, only observations in which labor dystocia was the only indication for cesarean were analyzed. Labor dystocia is a broad term used to describe multiple events related to the slowing or cessation of labor. In this study, labor dystocia included failure to progress, arrest of dilation, and arrest of descent, which has been applied previously in the literature (Neal et al., 2015).

Multiple criteria can be used to identify the onset of active labor, characterized by an increase in the rate of change of cervical dilation (Caughey et al., 2014). Historically, researchers have used either the onset of painful consistent contractions, change in cervical dilation, cervical dilation of 3-5 cm, or a combination of any of these three as the signal of the onset of active labor (Cheng et al., 2009; Cheng et al., 2010; Greenberg et al., 2006;). Defining the onset of labor was a subjective decision made by the attending labor and delivery nurse at the study site and was based on any one or more of multiple factors, including rupture of membranes or cervical dilation of four centimeters accompanied by consistent and intense contractions.

Data Analysis

This study was a retrospective observational study based on secondary data extracted from electronic medical records. Data analysis was conducted by the primary investigator using SAS Version 9.4, and a probability value of <0.05 was considered statistically significant. Frequencies (PROC FREQ) were used to describe categorical variables, including parity, race and ethnicity, education level, marital status, insurance type, and provider gender. Means and standard deviations (PROC MEANS, PROC

UNIVARIATE) were used to describe continuous variables, including age, pre-pregnancy BMI, provider years of practice, durations of first and second stages of labor, and dilation at time of labor dystocia diagnosis.

Generalized linear models (PROC GLM) were used to identify relationships between cervical dilation at decision time, and subjects' personal and provider characteristics. First, a bivariate analysis was used to individually identify relationships between these characteristics and dilation and labor duration. Next, variables that were statistically significant in bivariate models were included in a multivariate regression model. These analyses were also adjusted by covariates, including cervical ripening, epidural use and duration, and synthetic oxytocin use and duration and stratified by parity.

Cox proportional hazards regression (PROC PHREG) was used to explore relationships between labor duration and maternal and provider characteristics. The statistically significant relationships were integrated into a full model that adjusted for covariates such as the lengths of epidural and synthetic oxytocin exposures. ACOG issued recommendations for the labor dystocia diagnosis in otherwise unproblematic labors that include reaching six centimeters of cervical dilation during first stage, and a three-hour duration of second stage for nulliparas (Caughey et al., 2014). A logistic analysis (PROC LOGISTIC) was used to determine the likelihood of meeting this criteria for personal and provider characteristics of interest.

Data analysis was conducted in two phases, first for maternal personal characteristics, then repeated for the investigation of provider relationships. The primary outcome variables, duration of labor and cervical dilation, functioned identically in each

set of analyses. However, maternal personal and demographic characteristics used to address the first research question were replaced by attending provider gender and years of practice for the second research question.

CHAPTER FOUR

The Association of Maternal Personal Characteristics and Attributes of the Labor Dystocia Diagnosis

Abstract

Background: Labor dystocia is the leading indication for a primary cesarean birth. The subjective nature of its diagnosis may be contributing to its overuse.

Objective: The purpose of this study was to determine if maternal traits are associated with specific attributes of labor dystocia diagnosis, namely cervical dilation and duration of labor.

Study Design: This study was a retrospective investigation of 291 primary cesarean births due to labor dystocia occurring at an urban Texas hospital between May 2014 and December 2017. Maternal demographic and personal characteristics in relation to final cervical dilation and duration of trial of labor were analyzed using linear and logistic regression models, as well as Cox proportional hazard models.

Results: Personal maternal characteristics were not associated with the duration of first stage before a labor dystocia diagnosis. However, among nulliparous women, having government insurance ($p=.0003$) was linked with less advanced cervical dilation at the time of diagnosis, after adjusting for use of cervical ripening and epidural anesthesia. Obese nulliparous women had an increased hazard of earlier second stage dystocia diagnosis than normal weight women (HR 2.6, 95% CI 1.3-5.1). A majority (59%) of the first stage dystocia diagnoses occurred before 6 cm dilation.

Conclusion: Clinicians should be aware of tendencies of an early labor dystocia diagnosis among obese women and women with government insurance. Linking maternal characteristics to specific attributes of labor dystocia contributes to the understanding of potential overuse of primary cesarean surgeries. Results of this study can inform a larger scale investigation of maternal traits linked with characteristics of a dystocia diagnosis.

Introduction

Despite slight recent declines, nearly one in three births occurs via a cesarean delivery in the United States (Martin et al., 2018). Resulting health concerns for the mother include the risks of major surgery and recovery, future placental irregularities, and the possibility of complications in future pregnancies (Keag, Norman, & Stock, 2018). The newborn is at greater risk for neonatal complications (Karlstrom, Lindgren & Hildingsson, 2013), as well as compromises in the gut microbiome composition, which is a risk factor for childhood obesity (Huh et al., 2012), and asthma (Tollånes, Moster, Daltveit & Irgens, 2008). The inequitable distribution of cesarean deliveries exacerbates existing health disparities. For example, after adjusting for co-morbidities, a disproportionate number of African-American women experience cesareans compared to Hispanic and non-Hispanic white women (Martin et al., 2018). Age and body mass index (BMI) are positively related to cesarean risk (McClelland et al., 2017; Declercq et al., 2015), and level of education is inversely related to cesarean risk (Cesaroni et al., 2008).

The most common indication for a cesarean delivery is having experienced a prior cesarean delivery (Boyle et al., 2013). Therefore, recent efforts have been aimed at reducing the primary cesarean incidence. Labor dystocia, the slowing or cessation of labor's progress, is the most frequent reason for the primary cesarean (Boyle et al., 2013).

However, its diagnosis is subjective and non-emergent, likely contributing to overuse (Neal et al., 2015). For these reasons, labor dystocia has been named as a modifiable factor towards cesarean reduction (Caughey et al., 2014).

The incidence of labor dystocia is more frequent among certain demographic characteristics, including African-American race and older age, even after adjusting for comorbidities (Edmonds, Yehezkel, Liao & Moore Simas, 2013; Treacy, Robson & O’Herlihy, 2006). This inequitable distribution of dystocia diagnoses suggests that there are non-clinical factors contributing to its occurrence. Due to the inherently subjective nature of the diagnosis, there is a need to describe how labor dystocia is applied among various maternal characteristics.

Although the incidence of labor dystocia has been studied, the qualities of labor dystocia diagnoses, namely the final cervical dilation and labor duration, have not been evaluated in relation to personal patient characteristics. Therefore, the purpose of this study was to evaluate the nonclinical maternal characteristics associated with duration of labor and cervical dilation before an unplanned cesarean section due to labor dystocia.

Materials and Methods

This retrospective case series study involved the collection of secondary data to identify associations between personal maternal characteristics and attributes of labor dystocia diagnoses. The sample consisted of women who had given birth between May 2014 and December 2017 at a for-profit Texas health facility that averages 1,300 births annually. Births were attended by a single obstetric practice consisting of 11 board-certified obstetricians and one certified nurse midwife (CNM), who had exclusive attending privileges at the health facility. Obstetricians attended their own patient births

during weekday business hours, and off-hours births were attended by the obstetrician on call. The CNM primarily attended her patients' births, regardless of the timing.

Sample inclusion criteria were unscarred uterus, singleton birth, >34 weeks gestation, and a labor concluding with a primary cesarean indicated exclusively for labor dystocia. The indication of labor dystocia included all related diagnoses - arrests of descent or dilation, cephalopelvic disproportion, malposition, failed induction, and failure to progress, all of which have previously been applied in the literature (Lowe, 2007). Diagnoses that included both fetal intolerance and labor dystocia diagnosis were excluded from the final study sample due to likely confounding circumstances. Cesarean deliveries for indications of breech, multiple gestation, or scheduled cesareans without a trial of labor were also excluded from this study.

Among 5,081 births during the study period, 1,625 (32.0%) were delivered via cesarean surgery. Electronic medical records (EMR) were retrieved by the primary investigator for all births that met inclusion criteria, resulting in a sample size of 301 subjects. Seven subjects self-identified as Asian, but these were omitted from analysis due to the statistically insufficient number. Two observations were omitted because labor onset time was not designated, and rupture of membranes did not occur before the dystocia diagnosis. One outlier was detected with a duration of labor > 60 hours, or greater than 10 standard deviations, and was omitted from data analysis. Any other missing data was addressed by casewise deletion by the statistical software before calculating values. The final sample size included 291 observations. To verify the accuracy of data collection, an external research assistant pulled the data of a random sample of 5% (n=15) of observations from the EMR and compared the results to the

author's dataset. Inconsistent results between the auditor and the primary investigator due to differing interpretation of the EMR notes were collectively re-examined amongst the team. Consensus was reached, and the auditor identified one data entry error out of 225 datapoints. Internal review board approval of the study protocol was granted by Baylor University and the study site facility.

Independent variables included parity, age, BMI at first prenatal visit, race (African-American, non-Hispanic white), ethnicity (Hispanic), marital status (married or not married) and level of education (high school degree or less, some college, or college degree or higher). Race/ethnicity, marital status, and level of education were self-reported by the mother in the neonate's birth certificate within the EMR. The patient's insurance type was classified as either private or government. The government classification included those covered by only government insurance or by a combination of private and government insurance, indicating the mothers in the latter category had met the income requirement to be eligible for government insurance. Only 9.6% of the sample (n=28) were multiparous, which limited the meaningfulness of analysis of this population.

The administration of cervical ripening (yes/no), which exclusively involved the intracervical Foley catheter, was also collected, as were intrapartum durations of synthetic oxytocin and epidural anesthesia exposures. A majority of the sample received oxytocin administration or augmentation (94%, n=274). Using labor's onset as a threshold, the timing of oxytocin administration in relation to labor's onset (in positive or negative minutes) was created as a covariate. The American College of Obstetrics and Gynecology (ACOG) criteria for labor dystocia includes ruptured membranes (Caughey et al., 2014), which occurred in all subjects before the labor dystocia diagnosis.

Duration of labor and cervical dilation at time of labor dystocia diagnosis were the primary variables of interest. The time of labor's onset was entered by the attending maternity nurse and retrieved from the maternal EMR, as was the time of labor dystocia diagnosis. At the study site, onset of labor was a subjective determination by the maternity nurse based on any or several factors, including rupture of membranes, active labor status as indicated by progressive cervical change, and dilation of at least four centimeters. If a specified time of onset was unavailable, the time of membrane rupture was used instead (Cheyne et al., 2008). Duration of labor was the period of time in minutes between the onset of labor and the labor dystocia diagnosis. Each provider was independently authorized to determine cesarean indications. The final cervical dilation was noted by either the attending provider or nurse in the EMR at the time of diagnosis.

Descriptive statistics, including frequencies, means and standard deviations, were generated. A bivariate analysis was applied to identify preliminary associations of maternal characteristics with final cervical dilation and labor duration. Statistically significant relationships at the $\alpha=0.05$ level were then employed into three independent iterations of multiple regression models. The purpose of these models was to determine relationships that were still significant among covariates. Cervical ripening and epidural anesthesia were adjusted for in two of the three models.

The Consortium on Safe Labor has discouraged diagnosing labor dystocia before six centimeters of cervical dilation (Zhang, Landy et al., 2010). Logistic regression was used to identify traits linked with the likelihood of diagnosis meeting this dilation benchmark. Multiparous subjects were grouped with nulliparous women in the logistic regression analyses, as the Consortium on Safe Labor recommendations apply to all

women, regardless of parity. Lastly, Cox proportional hazards were used to generate hazard ratios and quantify the risk relationship between maternal traits and the duration of labor. SAS Version 9.4 and Microsoft Excel 2016 was used to conduct all data analyses, and a p-value <0.05 was considered statistically significant.

Results

Among 5,081 live births between May 2014 and December 2017, 301 births met inclusion criteria. Labor dystocia was the leading indication for 40% of the primary cesareans performed during the study period. See Figure 4.1 for selection criteria. Because only seven subjects self-identified as Asian, these observations were omitted. An additional two observations were omitted because the onset of labor was not designated in the EMR. A final observation was omitted because its duration of labor exceeded 60 hours and was deemed a statistical outlier. Of the remaining sample size of 291 observations, 263 were nulliparous (90%). Most nulliparous subjects (81%) and multiparous subjects (78%) used epidural anesthesia during labor. Use of cervical ripening was similar for each parity, 51% for nulliparas and 50% for multiparas. The mean time of day for the dystocia diagnosis was 5:08 pm (± 5.7 hours). See Table 4.1 for descriptive characteristics of the sample, and Table 4.2 for the sample composition by race/ethnicity and insurance type.

Among women of all parity diagnosed with labor dystocia during the first stage, mean duration was 698 minutes (SD $\pm$ 252) minutes, and final cervical dilation averaged 5.5 (SD $\pm$ 1.7) centimeters. Synthetic oxytocin was used for induction or augmentation in 94% (n=274) of the observations. See Table 4.2 for categorical mean outcomes and bivariate regression results.

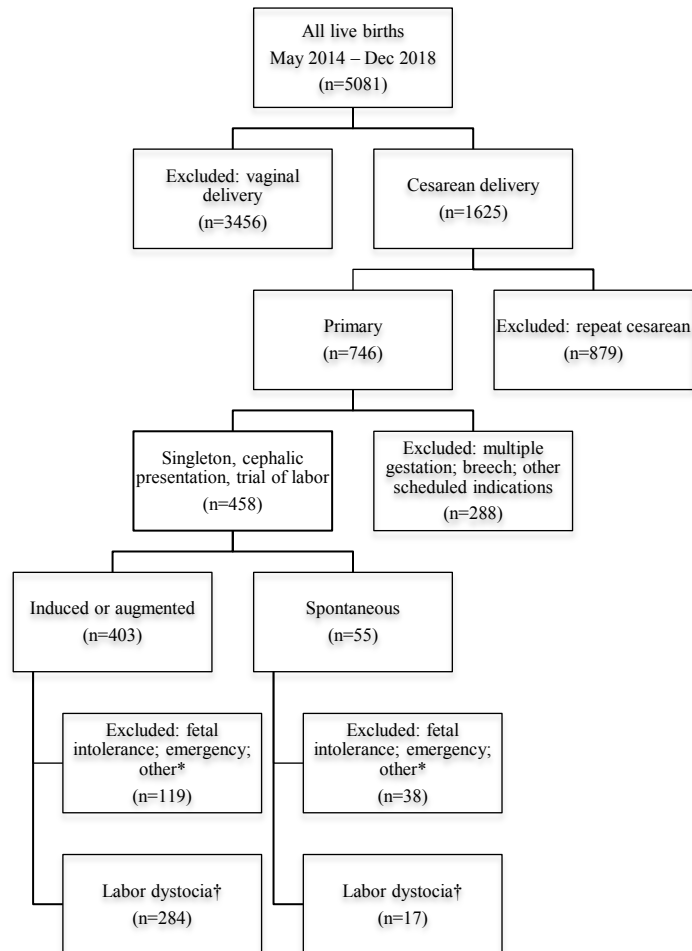


Figure 4.1. Selection criteria.

*Includes cesarean indications for a combination of fetal intolerance and labor dystocia.

†Includes indications of arrests of descent and dilation, failure to progress, cephalopelvic disproportion, malposition, and failed induction.

Table 4.1. Maternal characteristics

Characteristics	n (%)
Nulliparous	263 (90.4)
Race / ethnicity	
Non-Hispanic white	181 (62.2)
African-American	37 (12.7)
Hispanic	73 (25.1)
Education	
High school diploma or less	172 (59.1)
Some college	48 (16.5)
College degree or higher	71 (24.4)
Private insurance	146 (51.8)
Married	136 (46.7)
Age $\geq$ 35 years	23 (7.9)
Body mass index (BMI)	
Normal	55 (18.9)
Overweight	95 (32.7)
Obese	141 (48.5)
Cervical ripening	149 (51.2)
Synthetic oxytocin exposure	274 (94.2)
Epidural anesthesia	234 (80.4)
First stage dystocia diagnosis	222 (76.3)
Second stage dystocia diagnosis	69 (23.7)

Note. BMI according to first prenatal visit; Race/ethnicity, education and marital status were self-reported; cervical ripening method was exclusively the intracervical Foley catheter. The sample size was n=291.

Table 4.2. Distribution of race/ethnicity by insurance type (n=291)

Insurance Type	Non-Hispanic White n (%)	African American n (%)	Hispanic n (%)	Total
Private	115 (63.5)	6 (16.2)	25 (34.2)	146
Government	62 (34.3)	30 (81.0)	44 (60.3)	136
Self-pay*	4 (2.2)	1 (2.7)	4 (5.5)	9
Total	181 (100.0)	37 (100.0)	73 (100.0)	291

*omitted from analysis

Table 4.3. First stage mean outcomes by maternal characteristics

Characteristic	n	Duration (minutes)		<i>P</i>	Cervical dilation (cm)		
		Mean	SD		Mean	SD	<i>P</i>
Parity†							
Nulliparous	203	705.5	256.4	0.1899	5.5	1.7	0.2070
Multiparous	19	626	196.3		6	1.7	
Race / ethnicity							
Non-Hispanic white	124	707.4	250.7	0.9911	5.6	1.7	0.1719
African-American	26	703.1	279.3		5.0	1.4	
Hispanic	53	702.2	263.0		5.3	1.8	
Education							
High school diploma or less	126	703.6	256.3	0.9818	5.3	1.6	0.1033
Some college	34	704.2	284.3		5.9	1.7	
College degree or higher	43	712.2	238.8		5.7	1.8	
Type of insurance							
Private	93	712.0	247.6	0.6618	5.9	1.8	0.0004*
Government	106	696.0	266.9		5.1	1.5	
Marital status							
Unmarried	117	709.2	278.1	0.8116	5.3	1.6	0.2032
Married	86	700.5	224.9		5.6	1.9	
Age							
< 35 years	186	702.8	251.9	0.6151	5.4	1.7	0.7388
≥35 years	17	735.5	308.7		5.6	1.8	
Body mass index (BMI)							
Normal	35	754.4	314.4	0.0957	5.5	1.8	0.1207
Overweight	63	740.6	285.0		5.8	1.9	
Obese	105	668.1	209.7		5.2	1.5	
Cervical ripening							
No	89	744.9	284.7	0.0531	5.9	2	0.0027*
Yes	114	674.8	228.5		5.1	1.4	
Epidural anesthesia							
No	40	738.3	290.6	0.3674	4.8	1.7	0.0064*
Yes	163	697.4	247.6		5.6	1.7	
Synthetic oxytocin administration							
No	5	744.2	260.2	0.7334	6.8	2.9	0.0744
Yes	198	704.5	256.9		5.4	1.7	

Note. The sample size was n=203. †The sample size was n=222. All other categories reflect nulliparous outcomes. *Results significant at the $\alpha = .05$ level.

Among nulliparous women diagnosed during first stage, government insurance, younger age, obese BMI, use of cervical ripening, and no epidural anesthesia were each significantly associated with a less advanced final cervical dilation. There were no relationships between predictor variables and the duration of first stage before diagnosis. Duration of first stage labor and the timing of synthetic oxytocin were significantly related in an initial bivariate analysis. However, after adjusting for oxytocin administration occurring 280 minutes after onset, the timing was no longer significant ($P=0.6599$). Among nulliparous women diagnosed during second stage ($n=60$), an obese BMI was the only maternal characteristic related to a shorter length of second stage ($P=0.0031$). Race/ethnicity, marital status and level of education were not related to dystocia attributes in this study. An analysis of non-Hispanic white versus non-white, (a grouping of African-American and Hispanic) women again rendered no relationships to labor duration or dilation before a diagnosis.

Variables significant during bivariate analysis (age, pre-pregnancy BMI and insurance type) were incorporated into a series of independent multiple regression models. Only insurance type remained significantly associated with dilation after adjusting for epidural use and cervical ripening. See Table 4.3 for multiple regression results.

A logistic regression analysis was used to examine the likelihood of meeting ACOG's labor dystocia criteria of 6 cm of cervical dilation for first stage (Caughey et al., 2014). Among women of all parity who were diagnosed during first stage, a majority (59%, $n=131$) received a labor dystocia diagnosis before the recommended 6 cm cervical dilation. Among all subjects, government insurance status and the use of cervical ripening

were associated with a reduced likelihood of a diagnosis occurring after 6 cm. Older age and epidural anesthesia use were associated with a greater likelihood of meeting the ACOG criteria. After stratifying for use of epidural anesthesia and adjusting for cervical ripening, private insurance and older age remained more likely to receive a diagnosis after 6 cm of cervical dilation. Results are displayed in Table 4.4.

Table 4.4. Summary of regression analysis of nulliparous characteristics associated with cervical dilation at the time of first stage labor dystocia diagnosis.

Characteristic	Bivariate Analysis	Multivariate Analysis		
		Model 1†	Model 2†	Model 3†
Race / ethnicity	0.1719	-	-	-
Education	0.1033	-	-	-
Insurance type	0.0004*	0.0115*	0.0155*	0.0003*
Marital status	0.2032	-	-	-
Age	0.0029*	0.0929	0.1152	-
BMI	0.0172*	0.0831	0.0203*	-
Cervical ripening	0.0027*	0.0027*	-	0.0006*
Epidural anesthesia (yes/no)	0.0064*	0.0245*	-	0.0152*
Epidural duration	<0.0001*	-	-	-
Synthetic oxytocin duration	0.0539	-	-	-
Synthetic oxytocin timing**	0.699	-	-	-

Note. The sample size was n=203. Table consists of p-values from each coefficients's Type III sum of squares generated using SAS Version 9.4 PROC GLM command.

†Model 1: incorporating statistically significant variables from bivariate analysis; Model 2: excluding birth event covariates; Model 3: significant variable and adjusting for birth event covariates.

*Results significant at the $\alpha = .05$ level.

**The timing of synthetic oxytocin administration in relation to the onset of labor.

Among nulliparous women, only use of cervical ripening was associated with an increased hazard of shorter first stage duration compared to women without cervical ripening (HR 1.41, 95% CI 1.06-1.86). However, after adjusting for duration of epidural

anesthesia and the timing of synthetic oxytocin administration, the hazard ratio for cervical ripening was no longer significant.

Among the 69 women diagnosed with labor dystocia in the second stage, 60 (87%) were nulliparous. The mean nulliparous length of second stage was 133 (± 52) minutes and 129 (± 101) minutes for multiparous women. BMI was the only maternal characteristic significantly related to the length of second stage for nulliparas. See Figure 4.2 for a display of the variables' linear relationship. According to the Cox proportional hazard model, the hazard of an earlier second stage dystocia diagnosis for obese subjects was higher than normal weight subjects (HR 2.6, 95% CI 1.3-5.1). Due to the small number of multiparas who experienced labor dystocia during second stage (n=9), analysis was not meaningful.

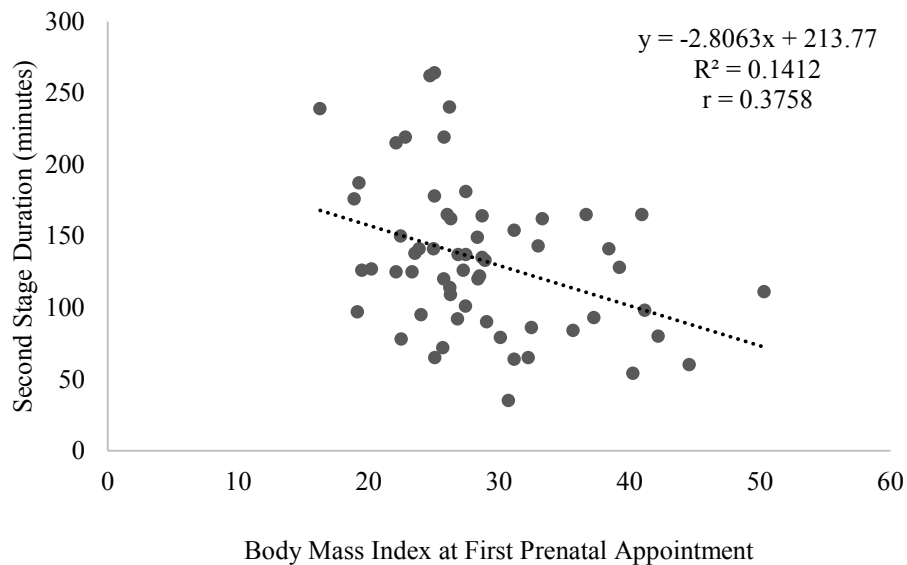


Figure 4.2. Mean duration of nulliparous second stage labor by maternal body mass index (n=60)

Table 4.5. Maternal characteristics associated with a first stage labor dystocia diagnosis occurring after 6 cm of cervical dilation

Characteristic	Bivariate Analysis OR (95% CI)	Model 1** OR (95% CI)	Model 2** OR (95% CI)
Race / Ethnicity			
Non-Hispanic white (Ref)	1.00	1.00	-
African-American	0.75 (0.34-1.65)	1.25 (0.51-3.06)	-
Hispanic	1.08 (0.58-2.02)	1.66 (0.81-3.41)	-
Education			
High school diploma or less (Ref)	0.83 (0.42-1.64)	1.57 (0.62-3.96)	-
Some college	0.95 (0.40-2.29)	1.14 (0.44-2.96)	-
College degree or higher	1.00	1.00	-
Type of insurance			
Private (Ref)	1.00	1.00	1.00
Government	0.52 (0.30-0.90)*	0.35 (0.17-0.76)*	0.66 (0.35-1.21)
Marital status			
Unmarried (Ref)	1.00	1.00	-
Married	0.80 (0.47-1.38)	1.09 (0.56-2.13)	-
Age	1.08 (1.03-1.13)*		1.07 (1.01-1.13)*
< 35 years (Ref)	1.00	1.00	1.00
≥35 years	1.17 (0.47-2.96)	0.99 (0.34-2.89)	-
Body mass index (BMI)	1.00 (0.96-1.03)		
Normal (Ref)	1.00	1.00	-
Overweight	1.30 (0.57-2.94)	1.25 (0.51-3.08)	-
Obese	1.14 (0.54-2.44)	1.39 (0.60-3.21)	-
Cervical ripening			
No (Ref)	1.00	1.00	1.00
Yes	0.46 (0.27-0.79)*	0.45 (0.25-0.80)*	0.45 (0.25-0.81)*
Epidural anesthesia			
No (Ref)	1.00	-	-
Yes	2.50 (1.19-5.27)*	-	-

Note. CI=confidence interval; OR=odds ratio, calculated from logistic regression. The sample size was n=222. *Results significant at the $\alpha = .05$ level. **Stratified by epidural anesthesia use.

Comment

The purpose of this study was to identify associations between maternal personal characteristics and attributes of the labor dystocia diagnosis in light of previous evidence that labor dystocia occurs disproportionately among demographic characteristics (Edmonds, Yehezkel, Liao & Moore Simas, 2013; Treacy, Robson & O’Herlihy, 2006). No maternal traits were associated with the duration of first stage labor before a dystocia diagnosis. Only birth interventions (no cervical ripening, duration of epidural and synthetic oxytocin exposures) were positively associated with length of first stage.

However, several personal maternal traits were associated with final cervical dilation at the time of diagnosis. Maternal BMI, younger age, and government insurance were associated with a less advanced cervical dilation. Insurance and BMI remained significantly associated with reduced dilation after adjusting for epidural anesthesia and cervical ripening use. The function of age in these findings is unique, as increased age has historically been related to slower labor progression (Treacy, Robson & O’Herlihy, 2006).

Government insurance has been linked with both an increased cesarean risk (Haberman et al., 2014), and a reduced cesarean risk (Henke et al., 2014; Kozhimannil, Shippee, Adegoke & Virnig, 2013). Because women must meet an income requirement to qualify for government assistance, this variable may serve as a proxy for low-income status (Mercier, Adeliyi Burcher, Horowitz & Wolf, 2018). The results reflected that low-income women received a dystocia diagnosis at a less advanced dilation than higher income women. This conclusion invites more questions about whether the events are due

to preference differences of low-income women or variations in provider decision-making biases and communication approaches (Huesch & Doctor, 2015). For example, low-income patients are less likely to report clear communication from their providers (DeVoe, Wallace & Fryer, 2009), and patients' views of sharing in medical decision-making may differ between socioeconomic levels (Murray, Pollack, White & Lo, 2007).

A majority of the study sample (81%) was overweight or obese at the first prenatal appointment, congruent with previous research findings that BMI is a labor dystocia risk factor (Lowe, 2007). Obese women have been observed to experience cesarean diagnoses earlier than normal weight women (Ellekjaer, Bergholt & Løkkegaard, 2017), and a greater incidence of labor dystocia (Roman et al., 2008), possible due to a slower progression of labor (Debiec et al., 2009). An inverse relationship was observed in this sample between initial BMI and cervical dilation in the first stage, as well as second stage duration, consistent with previous findings (Nuthalapaty, Rouse & Owen, 2004).

Associations between race/ethnicity and labor duration or final cervical dilation were not observed. This is in contrast to previous findings that African-American women were more likely to experience a labor dystocia diagnose earlier than non-Hispanic white or Hispanic women (Edmonds, Yehezkel, Liao & Moore Simas, 2013). However, the relatively small number of African-American women in this sample may have limited the statistical power in finding relationships to race / ethnicity. The conflation of race/ethnicity and income (noted by insurance type in this study) might be a better explanation (Braveman, 2012). A significantly higher proportion of Hispanic and African-American women were classified as having government insurance than white

women. This reiterates the importance of adjusting for income level when identifying links between race/ethnicity and labor dystocia.

A majority of the sample (94%) were either induced or augmented with synthetic oxytocin, which has been previously linked with increased cesarean risk (Baud et al., 2013). Nulliparous women have been observed to have a uniquely increased risk for labor dystocia when labor is induced (Kjerulff et al., 2017). A majority of subjects (51%) received cervical ripening before induction, which was accompanied by a 55% reduction in the likelihood to receive a diagnosis after 6 cm dilation. The use of cervical ripening itself may suggest that the subject's body was not showing signs of labor readiness, increasing the risk of labor dystocia. Vahratian et al. (2005) observed a slower labor progression and an increased cesarean risk in nulliparas with cervical ripening.

Similar to previous findings (Zhang, Troendle et al., 2010), a majority of subjects (58.6%) experienced a labor dystocia diagnosis before 6 cm, indicating a gap between evidence-based recommendations and practice at the study site. ACOG issued guidelines that encourage allowing for three hours of pushing for nulliparous women (Caughey et al., 2014), a large gap between the 134-minute average experienced by the sample in which 9 of the 60 (15%) nulliparas pushed for at least three hours.

The assessment of cervical dilation at this health facility was performed using a digit exam method by the provider, attending nurse, or both. This method has subjective flaws, with historical evidence of a variability of ≥ 2 cm occurring in 11% of laboring women and accuracy discrepancies based on the clinician's experience (Buchmann & Libhaber, 2007). Mid-level dilation (5-8 cm) has been associated with the highest degree of inter-rater variability (Buchmann & Libhaber, 2007; Nizard et al., 2009). This may be

problematic because, according to the results of this study, labor dystocia diagnosis is most commonly made during this range of dilation.

Variables of interest were based on critical measures such as reason for cesarean, onset of labor, cervical dilation, and dystocia diagnosis time. These values were extracted from the EMR documentation and were based on the appraisals of several members of the woman's care provider team. The reliance on individual judgments of these values is not only a limitation of this study, but also of obstetric decision-making that is often based on inherent subjectivity. BMI was based on the first prenatal appointment, which varied among the sample. The study was also limited by its small sample size. Nevertheless, we documented a complete obstetric event timeline for each observation. Finally, the use of a single facility precluded confounding by resource availability but may have limited generalizability. However, the uniqueness of the study site's demographically mixed and diverse population increases the results' relevance to other U.S. populations. The results may be used to inform a larger scale study that incorporates multiple sites, providing greater geographic and maternal diversity and thus yielding generalizability.

The results of this study underscore several factors that may contribute to the premature diagnosis of labor dystocia. First, the overwhelming use of synthetic oxytocin for induction or augmentation in this sample justifies further examination of the frequency of its use. Second, a gap exists between evidence-based recommendations and actual practice. Rigorous adherence to the Consortium on Safe Labor's 6 cm cervical dilation threshold and ACOG's second stage time extensions before diagnosis would reduce the overall labor dystocia incidence. Providers should be encouraged to wait until

objective labor dystocia criteria are met before diagnosis, and institutions must include dystocia guidelines among their perinatal safety measures. Finally, women should be educated about normal labor progression patterns and encouraged to take an active role in advocating for more time in labor if desired.

This investigation also highlights the disparities that exist within a labor dystocia diagnosis. Methods to facilitate cervical dilation such as delayed hospital admission and continuous labor support may be of particular importance for obese and economically disadvantaged women. These alternatives are a departure from the medicalized approach to labor but are among the ACOG recommendations to reduce labor dystocia (Caughey et al., 2014).

Decreasing the labor dystocia incidence is a public health priority, as it has significant implications in reducing maternal and infant health disparities. Changing the mindset about “normal” labor progression requires a socio-ecological approach that implements change at multiple levels – informed patients, evidence-based provider care, and institutional accountability. Fortunately, a clinical guideline that primarily consists of waiting to intervene is a low-barrier, immediately modifiable method of reducing the primary cesarean rate.

CHAPTER FIVE

The Association of Provider Characteristics and Attributes of the Labor Dystocia Diagnosis

Abstract

Objective: Labor dystocia is the leading indication for a primary cesarean birth, and its reduction is considered a modifiable approach to reducing the overall cesarean rate. Nonmedical factors have been linked with cesarean decision-making, which evokes the question of whether those factors are also related to labor dystocia. The purpose of this study was to determine whether provider gender or years of practice are associated with specific attributes of a labor dystocia diagnosis.

Methods: This retrospective case series study included all singleton, cephalic births ending in an unplanned primary cesarean solely due to labor dystocia between May 2014 and December 2017 at an urban Texas health facility (n=291). Mean duration of labor and cervical dilation at the time of dystocia diagnosis were compared between individual providers, provider gender, and years of practice using bivariate and multivariate logistic regression and Cox proportional hazards regression.

Results: Female providers ($p=0.0029$) and providers with fewer years of clinical practice ($p<.0001$) were associated with patients experiencing a longer trial of labor duration before a dystocia diagnosis. After adjusting for cervical ripening and epidural use, years of practice remained significantly associated with duration of labor in a multiple regression analysis ($p=.0332$). Neither provider trait, however, was related to the final cervical dilation at the time of diagnosis. Logistic regression revealed no

differences by gender or years of practice for the likelihood of a diagnosis occurring after six centimeters.

Conclusions: This study highlighted the gap between evidence-based recommendations for dystocia diagnosis and actual practice. Providers should be informed of the nonmedical variations in how labor dystocia is diagnosed. More experienced providers should be equipped with institutional resources and accountability to better integrate evidence-based recommendations into their practice.

Introduction

The leading indication for a cesarean delivery in the United States is having previously experienced cesarean surgery (Boyle et al., 2013). The primary cesarean rate, which measures cesareans among otherwise low-risk births, (defined as nulliparous, vertex presentation, singleton birth, and at gestation greater than 37 weeks), declined slightly from 26.8% in 2013 to 25.7% in 2016 (Martin et al., 2018). Recent commentaries have noted that the primary rate exceeds the threshold of medical benefit (Gregory et al., 2012). Improving labor management and reducing the influence of nonclinical factors have been suggested as target areas that may lower the primary cesarean rate in the United States (Boyle et al., 2013).

Nonclinical factors, including physician characteristics and practice styles, have been linked to a disproportionate cesarean incidence. For example, within one institution, variations between individual provider cesarean rates ranged from 9.9% to 75.6% (McClelland et al., 2017), and male physicians had higher cesarean rates than female physicians (Haberman et al., 2014; McClelland et al., 2017). Clinicians with surgical expertise were related to a greater likelihood of cesarean outcomes (Avery,

Graettinger, Waits & Parton, 2014). In contrast, family physicians were half as likely to perform a cesarean (Dawe et al., 2017). Rural areas and regions with a greater geographic concentration of obstetricians have both been associated with higher cesarean rates (Chang et al., 2016; Henke et al., 2014).

There is conflicting evidence about the role of provider's age, years of experience, and birth outcomes of their patients. Physicians with more years of practice may expect faster rates of labor progression than their less experienced colleagues (White, Lee & Beckmann, 2016), and these flawed expectations of normal labor progression have contributed to the rising cesarean rate (Lowe, 2007). In contrast, Klein et al. (2011) conducted an investigation of attitudes about cesarean deliveries and found that physicians under 40 years of age were less trusting of methods to reduce the cesarean incidence and more likely to fear perineal effects of a vaginal birth. These attitudes have also been associated with an increase in cesarean incidence (Neal, Lowe, Patrick et al., 2010).

The most common reason for the primary cesarean is labor dystocia, including arrest of descent or dilation (Boyle et al., 2013). Arrest of dilation was specifically identified as one of the two leading causes for the increase in primary cesarean rates between 2003 and 2006, causing 18% of the increase alone (Barber et al., 2011). Further, the application of Friedman's labor standard (1954) may have contributed to unrealistic expectations of what constitutes "normal" labor progression (Neal, Lowe, Patrick et al., 2010). In response, the Consortium on Safe Labor updated the understanding of contemporary labor patterns (Zhang, Landy et al., 2010). Based on their findings, the American College of Obstetrics and Gynecology (ACOG) issued recommendations that

more objectively defined labor dystocia criteria in order to reduce the primary cesarean rate (Caughey et al., 2014).

Although the outcome of labor dystocia has been linked to certain physician and organizational traits (Díez, Requena, Rosel & Pons, 2016; Lowe, 2007), there is a need to identify relationships between specific attributes of labor dystocia, namely cervical dilation and labor duration, with those provider traits. Investigating the role of dilation in provider decision-making is particularly important, as the slowing or cessation of dilation has accounted for the greatest increase in labor dystocia diagnoses (Barber et al., 2011). The purpose of this study was to determine associations of provider gender and years of practice to specific attributes of the labor dystocia diagnosis.

Materials and Methods

This study was a retrospective case series analysis examining labor dystocia characteristics associated with personal provider characteristics. Eleven board-certified obstetricians and one certified nurse-midwife (CNM) attended births between May 2014 and December 2017 at a single, urban, for-profit Texas health facility. The group collectively attends an average of 1,300 births annually and has exclusive attending privileges at the study site. All providers served at one obstetric clinic on weekdays and attended the births of their patients during those clinic hours. Evening and weekend births were typically attended by the on-call physician versus the patient's primary physician. The CNM was the exception, as she exclusively attended her patients' births. All providers independently made labor management decisions, including any labor dystocia diagnoses. Although the facility's cesarean rates are collected and reported to

the hospital accreditation organization, they are not routinely disseminated to the provider staff.

During the study period, the institution facilitated 5,081 live births, 1,625 (32%) of which were delivered via cesarean. Among the 746 primary cesarean deliveries, subjects were included in this study if they had an unscarred uterus, singleton gestation >34 weeks, and labor outcome of an unplanned cesarean. Primary cesarean deliveries due to breech, multiple gestation or any other scheduled indication were excluded from the sample. Because the outcomes of interest were exclusively attributes of labor dystocia, cesarean births due to fetal intolerance, an emergent indication, or any combination of these indications and dystocia, were excluded from the final study sample. Only cesareans indicated solely for labor dystocia, (including failure to progress, failed induction, arrests of descent or dilation, malpresentation, or cephalopelvic disproportion) were included in the sample. The final sample included 291 births that met the inclusion criteria. The study protocol was approved by the Internal Review Boards of the participating facility and Baylor University.

Independent variables included provider gender and provider years of practice since graduation from medical school. Dependent variables included duration of labor, defined as the time from labor's onset until the diagnosis of labor dystocia, and final cervical dilation at the time of diagnosis, measured by either the attending nurse or provider. The onset of labor was defined in the electronic medical record (EMR) by the attending nurse and was based on one or more of the following events: progressive cervical change, rupture of membranes, and cervical dilation of four centimeters or more. Onset of labor was not designated in 35 (12%) of the observations. Time of membrane

rupture, which has been previously applied in the literature (Cheyne et al., 2008; Hoffman et al., 2006), was used as a proxy for onset of labor in these cases and was consistent with the study site's documentation procedures.

Maternal characteristics such as age, parity, self-reported race / ethnicity, and body mass index (BMI) at the first prenatal appointment were also collected from the EMR to use as covariates in the statistical analysis. Cervical ripening was collected as a dichotomous variable and per the routine of the study site, exclusively involved the use of an intracervical Foley catheter. Durations of epidural anesthesia and synthetic oxytocin exposures were collected for each subject, as well. Due to the limited sample size of subjects who experienced a second stage dystocia diagnosis (n=69), analysis was directed exclusively at describing first stage diagnoses, unless noted otherwise.

Descriptive statistics, including frequencies, means and standard deviations of the sample, were generated. Observations were also grouped by attending provider to determine frequencies, means, and standard deviations of the dependent variables for each provider (n=12). A generalized linear model was used to determine any bivariate associations between provider traits and dystocia characteristics. Pearson's r correlation was also calculated to compare labor durations associated with each individual provider. Based on the bivariate analysis results, covariates were added to a multiple regression model to detect still-significant relationships.

The Consortium on Safe Labor updated the threshold of active labor from four to six centimeters of cervical dilation (Zhang, Landy et al., 2010). Based on this definition, ACOG published a consensus statement with guidelines for a labor dystocia diagnosis that included the six-centimeter dilation benchmark (Caughey et al., 2014). In this study,

logistic regression was used to explore provider traits associated with the likelihood of a dystocia diagnosis after the six-centimeter cervical dilation guideline. Finally, a Cox proportional hazard ratio was calculated to compare risk between levels of provider characteristics.

To confirm the consistency and accuracy of the data collection process, an external trained research assistant extracted a random selection of 5% (n=15) of observations from the EMR. These results were compared to the primary author's data collection values. The external auditor and the primary investigator collectively re-examined any conflicting datapoints within the original EMR to reach consensus. The auditor concluded that one data entry error out of 225 datapoints (0.44%) occurred. Because there are known variations in practice approaches between obstetricians and midwives (Nijagal, Kuppermann, Nakagawa & Cheng, 2015), each model with significant results was analyzed both with and without the CNM, and results were not affected. Therefore, all results reflected the inclusion of the CNM in the analyses. All data analysis was conducted in Microsoft Excel 2016 and SAS English Version 9.4, and a p-value <0.05 was considered statistically significant.

Results

Among 5,081 total live births at the study site between May 2014 and December 2017, 1,625 were delivered via cesarean (32%). Labor dystocia was the exclusive indication for 301 births, accounting for 6% of all births and 40% of primary cesarean deliveries during the study period. Among 12 providers, five were female (41.7%), and the mean years of practice since graduation from medical school was 14.2 (SD±7.2) years. Ten observations, including one statistical outlier, were omitted due to the limited

number of observations self-reported as Asian ($n=7$) and missing outcome variable data ($n=2$). The final sample size consisted of 291 observations. See Figure 5.1 for selection criteria.

Among the 291 subjects that met inclusion criteria, 90.4% were nulliparous, and 76% received a labor dystocia diagnosis during the first stage of labor. All subjects experienced a rupture of membranes before the dystocia diagnosis. Maternal characteristics are shown in Table 5.1. The mean duration of labor for all women (regardless of parity) experiencing dystocia during the first stage was 698.7 (SD $\pm$ 252.4) minutes, and the mean cervical dilation at the time of diagnosis was 5.5 cm (SD $\pm$ 1.7). The mean nulliparous length of second stage was 133 ($\pm$ 52) minutes and 129 ($\pm$ 101) minutes for multiparous women.

Bivariate analyses resulted in the detection of an association between female providers and longer first stage labor durations among nulliparous women ($P=0.0029$). This remained true when nulliparas were stratified by cervical ripening. Providers' years of practice were negatively related to duration of labor before a dystocia diagnosis ($P < 0.0001$). This result was consistent when duration means were calculated by individual provider ($r = 0.39$). See Figure 5.2 for the linear relationship of the two variables. There were no associations between provider gender or years of practice and cervical dilation at the time of diagnosis. Among birth interventions administered to nulliparous women, cervical ripening was significantly associated with a less advanced final cervical dilation ($P=0.0027$), but synthetic oxytocin exposure was not ($P=0.0744$). A chi-square analysis was used to determine that frequencies of cervical ripening and epidural anesthesia did

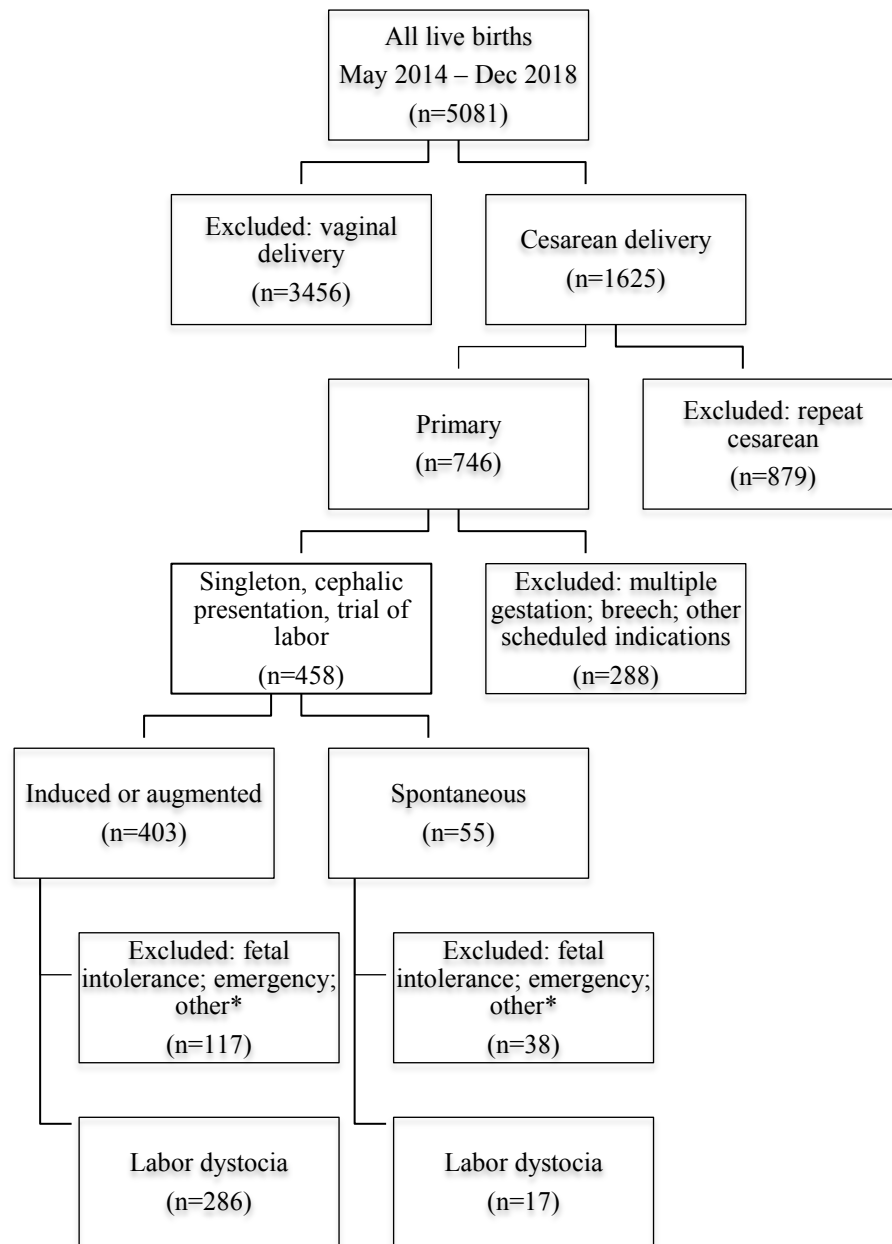


Figure 5.1. Selection criteria.

*Includes cesarean indications for a combination of fetal intolerance and labor dystocia.

Table 5.1. Maternal characteristics

Characteristic	n (%)
Nulliparous	263 (90.4)
Age $\geq$ 35 years	23 (7.9)
Body mass index (BMI)	
Normal	55 (18.9)
Overweight	95 (32.7)
Obese	141 (48.5)
Race / Ethnicity	
Non-Hispanic white	181 (62.2)
African-American	37 (12.7)
Hispanic	73 (25.1)
Cervical ripening	149 (51.2)
Synthetic oxytocin exposure	274 (94.2)
Epidural anesthesia	234 (80.4)
First stage dystocia diagnosis	222 (76.3)
Second stage dystocia diagnosis	69 (23.7)

Note. BMI according to first prenatal visit; Race/ethnicity was self-reported; cervical ripening method was exclusively an intracervical Foley catheter. The sample size was n=291.

not vary significantly between providers ($P=0.7461$ and $P=0.8191$, respectively). Results for bivariate analyses are displayed in Table 5.2.

Variables of significance in the bivariate analysis were incorporated into several multiple regression models to determine consistent relationships of significance. Among nulliparas diagnosed with dystocia during first stage, epidural duration, cervical ripening, and provider years of practice remained significantly associated with labor duration. Provider gender was significant only in the absence of provider years of practice in the model. When both independent variables were applied together, provider gender was no longer significant. See Table 5.3 for results of multiple iterations of independent models.

Table 5.2. First stage labor outcomes by independent variables (n=203)

Characteristic	n	Duration (minutes)			Cervical dilation (cm)		
		Mean	SD	P	Mean	SD	P
Parity†							
Nulliparous	203	705.5	256.4	0.1899	5.5	1.7	0.2070
Multiparous	19	626	196.3		6	1.7	
Provider gender							
Male	141	670.2	261.0	0.0029*	5.4	1.7	0.4102
Female	62	785.7	227.9		5.6	1.8	
Provider years of practice							
<10 years	28	792.5	286.3	0.0016*	5.6	1.8	0.7706
10 - 20 years	121	730.0	262.9		5.4	1.7	
> 20 years	54	605.5	191.5		5.6	1.6	
Cervical ripening							
No	89	744.9	284.7	0.0531	5.9	2	0.0027*
Yes	114	674.8	228.5		5.1	1.4	
Epidural anesthesia							
No	40	738.3	290.6	0.3674	4.8	1.7	0.0064*
Yes	163	697.4	247.6		5.6	1.7	
Synthetic oxytocin administration							
No	5	744.2	260.2	0.7334	6.8	2.9	0.0744
Yes	198	704.5	256.9		5.4	1.7	

Note. †The sample size was n=222. All other categories reflect nulliparous outcomes.

*Results significant at the $\alpha = .05$ level.

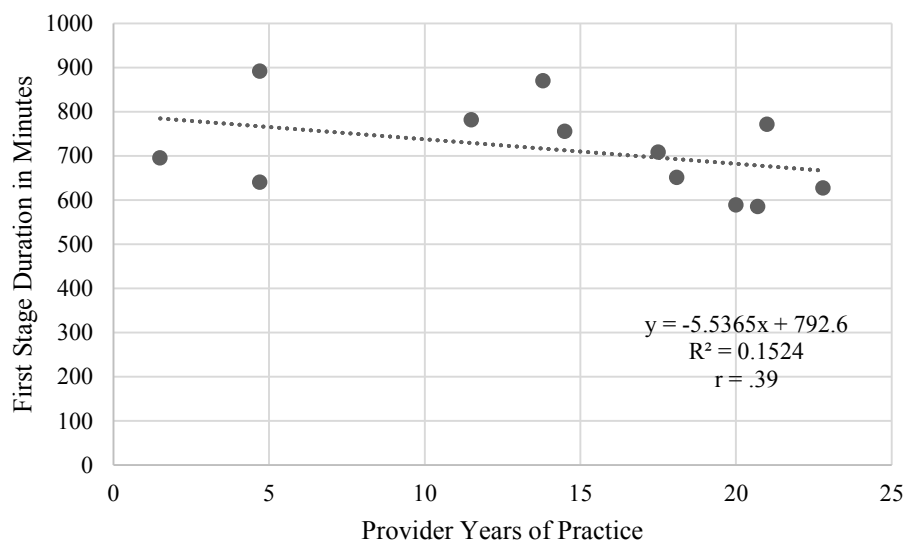


Figure 5.2. Mean Duration of Labor by Individual Providers' Years of Practice (n=12)

A majority of subjects (58.6%) received a labor dystocia diagnosis before the recommended six cm threshold. Among providers who were affiliated with the institution longer than one year, individual compliance with the ACOG recommendation ranged from 23.7% to 58.8%, and mean cervical dilation at the time of diagnosis ranged from 4.9 to 6.1 cm. Based on the logistic regression analysis, neither years of practice nor provider gender were related the likelihood of diagnosing dystocia before 6 cm. Only duration of epidural anesthesia and use of cervical ripening remained significantly associated with meeting the six cm dilation criteria.

Table 5.3. Bivariate and multivariate regression analysis of first-stage labor duration among nulliparas diagnosed with labor dystocia

Characteristic	Bivariate Analysis	Multivariate Analysis		
		Model 1	Model 2	Model 3
Provider gender	0.0029*	-	0.0029*	0.1784
Provider years of practice	<.0001*	0.0003*	-	0.0332*
Cervical ripening	0.0531	0.0409*	0.5165	0.0308*
Epidural anesthesia (yes/no)	0.3674	0.3311	-	0.2896
Epidural duration	<.0001*	-	<.0001*	-
Synthetic oxytocin duration	<.0001*	-	-	-
Maternal BMI	0.2432	-	-	-

Note. The sample size was n=203. Table consists of p-values from each coefficients's Type III sum of squares generated using SAS Version 9.4 PROC GLM command.

*Results significant at the $\alpha = .05$ level.

Using a Cox proportional hazards regression, female providers were independently a significant predictor of labor duration (HR=0.68; 95% CI=0.05-0.92). After stratifying by epidural use and adjusting for cervical ripening, women with female providers were 36% less likely to experience a labor dystocia diagnosis during first stage than those attended by male providers. Years of practice was also a significant predictor of duration (HR=1.05; 95% CI=1.02-1.07). After adjusting for epidural duration, provider gender and years of practice remained independently related to duration of first stage labor before diagnosis. However, when applied together, only provider years of practice remained a significant predictor of extended labor duration. See Table 5.4 for a comparison of independent Cox proportional hazard ratio models.

Table 5.4. Bivariate and multivariate hazard models of birth characteristics and active labor duration among nulliparas diagnosed with labor dystocia

Characteristic	Bivariate Analysis HR (95% CI)	Multivariate Analysis		
		Model 1† HR (95% CI)	Model 2† HR (95% CI)	Model 3† HR (95% CI)
Provider gender				
Male (Ref)	1.00	1.00	-	1.00
Female	0.68 (0.05-0.92)*	0.64 (0.47-0.87)*	-	0.81 (0.56-1.17)
Provider years of practice	1.05 (1.02-1.07)*	-	1.05 (1.02-1.08)*	1.04 (1.01-1.07)*
Cervical ripening				
No (Ref)	1.00	1.00	1.00	1.00
Yes	1.41 (1.06-1.86)*	1.43 (1.08-1.90)*	1.41 (1.06-1.87)*	1.43 (1.07-1.90)*
Epidural anesthesia				
No (Ref)	1.00	-	-	-
Yes	1.14 (0.80-1.61)	-	-	-
Epidural duration	1.00*	-	-	-

Note. CI=confidence interval; HR=hazard ratio, calculated from Cox proportional hazards multivariate regression. †Stratified by epidural anesthesia use. The sample size was n=203.

Discussion

The purpose of this study was to evaluate the relationship of health care provider characteristics and elements of the labor dystocia diagnosis. Provider traits, such as gender or years of experience, may influence provider decision-making and contribute to substantial variability in the primary cesarean rate. We found that years of practice were inversely related to the duration of labor before a dystocia diagnosis. Our results are consistent with previously published research findings that more experienced providers may have faster expectations of labor progression (White, Lee & Beckmann, 2016). Friedman's guideline of 1 cm of cervical dilation per hour (1954) has undoubtedly

contributed to the increase in labor dystocia and the overuse of other routine interventions (Neal, Lowe, Patrick et al., 2010).

Male providers had patients with shorter first stage durations. Although several studies have linked male providers with increased cesarean incidence (Haberman et al, 2014; McClelland et al., 2017), the question remains whether male providers are also associated with more labor dystocia incidence. We observed that female clinicians provided a 32% reduction of labor duration compared to the male providers. There were no significant differences between provider gender or years of practice in relation to final cervical dilation at the time of dystocia diagnosis.

During evening and weekend hours, the providers attended births on a rotating on-call basis. Although the incidence was not available in the data, presumably the cesarean diagnosis was often made by someone other than the provider who attended the woman prenatally. This circumstance could pose variations in patient-provider communication due to a lack of continuity of care. Future research efforts could include an examination of differences in birth outcomes assisted by primary versus on-call providers.

The overall cesarean rate of the study site (32.0%) mirrored the national cesarean delivery rate in 2015 (Martin et al., 2018). Among the labor dystocia outcomes in this sample, a majority (94.2%) were administered synthetic oxytocin during labor, and 51% received cervical ripening. The relationship between induction or augmentation and dystocia incidence is debated in the literature. Vahratian et al. (2005) observed a slower labor progression and increased cesarean risk in nulliparous women who were administered cervical ripening via intracervical Foley catheter. In comparison with

expectant management approaches, induction of labor was not observed to increase the cesarean risk (Stock et al., 2012). Other investigators have concluded a positive association between induction and cesarean incidence (Glantz, 2011), and specifically labor dystocia (Cheng et al., 2009).

There were several limitations to this study. A labor dystocia indication, as documented by the provider in the EMR, was required for inclusion in the sample. The outcome variables of onset of labor and the assessment of cervical dilation were also based on subjective evaluations recorded in the EMR. These are limitations of the study, as the values were subjective appraisals and may be influenced by individual biases or error. Next, the primary variable of interest, cervical dilation, has historically yielded low rates of interobserver reliability (Buchmann & Libhaber, 2007), which is possibly another limitation of this study. Continuous birth support has been cited as reducing the length of first stage labor (Hodnett et al., 2011), but this information was not available during data collection. The study offers limited generalizability due to its singular location and obstetric practice. However, the study site serves an economically and racially/ethnically diverse patient profile that reflects its surrounding community. This fact increases the study's relevance in that it reflects a "normal" population, not skewed in any one particular demographic characteristic. Its results can also serve as justification for a larger study of the application of labor dystocia in the context of nonclinical influences.

A final limitation of the study was the inability to explore the inherent hierarchy of effects among individual providers. The study took place at a single study site with a limited number of providers, and therefore lacked the statistical power to explore the

similarity of births within the 12 providers. Future research should include a multi-level model to account for births clustered within providers.

Recent revisions of normal birth progression suggest that the rate of cervical change is slower than previously understood (Caughey et al., 2014; Neal, Lowe, Ahijevych et al., 2010), requiring more patience on the part of the provider in the absence of any other medical concerns. It is important to acknowledge that evidence has linked male providers with a tendency towards higher cesarean rates, and, in this case, shorter labor durations. An investigation of male and female provider perceptions of normal labor progression merits further exploration.

Over half of the women received a first stage diagnosis before six cm of dilation, indicating a disparity between ACOG recommendations and observed practice at the study site. Final cervical dilations of nulliparous women in the sample averaged less than six cm for 10 out of 12 providers, regardless of provider gender or years of practice. Mean duration of nulliparous second stage severely deviated from ACOG's recommended three hours of pushing. These findings highlight the gap between evidence-based recommendations and actual obstetric practice patterns.

Male providers and more experienced providers should be aware of the tendencies toward earlier dystocia diagnoses in an effort to decrease the primary cesarean incidence. Provider education should emphasize the importance of giving mothers more time in the absence of birth complications. Institutional accountability measures such as auditing and reporting provider cesarean incidence and indications has shown immediate results (Scarella, Chamy, Sepúlveda & Belizán, 2011). The benefits of delayed hospital admission and continuous labor support on labor's progression have been well

established (Main et al., 2006; Hodnett et al., 2011), and yet provider endorsement of these benefits is not yet the norm.

Adopting a more objective approach to the labor dystocia diagnosis is a public health priority with multiple ramifications. First, it would minimize the provider gender and years of experience correlations that were observed in this study. Next, a more accurate understanding of labor progression might decrease the use of unnecessary or premature interventions. Lastly, adherence to clearly defined labor dystocia guidelines would mitigate vague patient-provider communication. Patients would receive unbiased information to share in informed decision-making and perhaps advocate for more time.

Among all the indications for cesarean delivery, labor dystocia is the most modifiable in that the solution involves doing more of nothing. Understanding the nature of the dystocia diagnosis and its relationship to non-medical factors is fundamental in addressing its overuse and decreasing the cesarean rate in the United States to meet Healthy People 2020 goals.

CHAPTER SIX

Summary and Conclusion

Almost one in three births in the United States is delivered via cesarean (Martin et al., 2018), which is associated with greater morbidity and mortality than a vaginal delivery. Concerns for the mother include those associated with major surgery, including embolism (Tepper et al., 2014), infection (Conroy et al., 2012), and miscarriage, infertility, and placental abnormalities in subsequent pregnancies (O'Neill et al., 2014; Silver, Landon et al., 2006). The infant's risk of neonatal complications increases (Xie et al., 2015) as does obesity and asthma due to compromises in the newborn microbiome (Huh et al., 2012; Tollånes et al., 2008). Cesareans are also associated with reduced durations and exclusivity of breastfeeding (Hobbs et al., 2016). The recent rise of maternal mortality in the United States is in part due to the similar increase in cesarean surgery in the last few decades (Moaddab et al., 2018).

The leading indication for cesarean surgery is having a prior cesarean delivery (Boyle et al., 2013). Therefore, recent attention has focused on reducing the primary cesarean incidence. The leading indication for the primary cesarean is labor dystocia (Boyle et al., 2013), or the slowing or cessation of labor progression (Caughey et al., 2014). The diagnosis has historically been subjective and based on antiquated notions of how "normal" labor progresses (Neal, Lowe, Patrick et al., 2010). Recent commentaries suggest that the labor dystocia diagnosis, which accounts for 35% of all primary cesareans, is overused (Barber et al., 2011).

Although existing research consists of linking nonclinical maternal characteristics with the outcome of labor dystocia, there is no literature detailing those characteristics with specific attributes of the dystocia diagnosis. Due to the disparities in cesarean incidence and the fact that labor dystocia is the most common reason for the first cesarean, there is a need to understand factors that influence the dystocia diagnosis to curb health disparities at their onset. The purpose of this study was to identify relationships between provider and maternal personal factors and cervical dilation and labor durations within the dystocia diagnoses.

The study took place at a for-profit, urban Texas health facility between May 2014 and December 2017. A single obstetric practice, consisting of eleven obstetricians and one certified nurse midwife, attended 5,081 births during the study period. Secondary data was collected from EMR for all singleton, vertex presentation births resulting in a primary cesarean exclusively due to labor dystocia (n=291).

Primary variables of interest were cervical dilation at the time of diagnosis, duration of labor from its onset until time of diagnosis, and duration of second stage labor. Maternal demographic characteristics collected from the EMR included race/ethnicity, level of education, marital status and insurance type, in addition to personal characteristics of parity, age and body mass index (BMI) at the first prenatal visit. Provider characteristics were also collected for each observation, including provider gender and years of practice. The use of cervical ripening, the timing of synthetic oxytocin administration and the duration of epidural anesthesia exposure were collected for use as covariates.

The first study aim involved the investigation of nonclinical maternal characteristics associated with elements of the labor dystocia diagnosis. No maternal characteristics were associated with the duration of first stage of labor. However, government insurance was associated with a less advanced cervical dilation at the time of diagnosis, and an increased likelihood of receiving a diagnosis before 6 cm. Pre-pregnancy BMI was inversely related to the duration of second stage among nulliparous women. Race/ethnicity, marital status and level of education were not associated with cervical dilation or labor duration.

The second study aim was designed to examine provider characteristics associated with labor dystocia attributes. Female providers were related to a longer duration of first stage at the bivariate level, but this relationship was no longer significant after adjusting for cervical ripening and epidural exposure. Provider years of practice were inversely associated with labor duration of a first stage diagnosis in nulliparous women. There were no relationships between provider traits and cervical dilation at the time of diagnosis. Although the mean dilation for first stage diagnoses was <6 cm, the likelihood of a diagnosis occurring after 6 cm, regardless of parity, was not linked to any provider trait.

According to this study's findings, nonmedical characteristics of both mother and provider are related to elements of the labor dystocia diagnosis. The heightened risk of labor dystocia for the obese mother has been established (Roman et al., 2008). Our results reflected a likelihood of slower labor progression for obese mothers, as previously observed (Debiec et al., 2009). Applying government insurance as a proxy for socioeconomic status (Mercier et al., 2018), we observed a significantly less advanced cervical dilation at diagnosis for low-income women. Patient-provider communication is

possibly less effective for low-income nulliparous patients (DeVoe, Wallace & Fryer, 2009), or patients' views of sharing in medical decision-making may differ per income strata (Murray, Pollack, White & Lo, 2007).

More experienced providers expect a faster labor progression (White, Lee & Beckmann, 2016), which may explain the link between years of practice and shorter labor durations in this study. The Friedman labor curve (1954) was the standard reference for labor normality for decades and likely influenced the training periods of the current cohort of more experienced providers.

Concurrently with the beginning of the study, the American College of Obstetrics and Gynecology (ACOG) published recommendations stating that the labor dystocia diagnosis should occur after 6 cm of cervical dilation (Caughey et al., 2014). The essence of the guidelines was to allow women more time to labor in the absence of complications. However, the application of these recommendations was not observed in a majority of births in this study. Evidence-based maternity practice requires an updated understanding that cervical dilation is slower than previously defined (Zhang, Landy et al., 2010). Changing provider behavior to delay active management is challenging in a litigious health care environment that pressures rapid patient turnover. (Sakala & Corry, 2008).

Reducing the incidence of labor dystocia might best be presented from a social ecological perspective whereby change is implemented at multiple levels simultaneously in both moderate and ambitious actions. As incremental progress occurs, the spheres of influence interact on one another, multiplying the potential effects. This model is an apt

fit for the birth environment and can be used to design next steps interventions, the first of which involves the woman during her pregnancy.

Preconception health that includes the promotion of a healthy weight at pregnancy's onset should be a priority at every opportunity for women of childbearing age, and this health education should be accompanied by community resources that facilitate healthy behavior change. Empowering her to be an active participant during pregnancy and birth requires addressing the fear that so often clouds the antepartum period. Prenatal education can decrease fear of the birth event (Ip, Tang & Goggins, 2009), yet attendance at structured prenatal education events is on the decline (Declercq, Sakala, Corry, Applebaum & Herrlich, 2013). In recent years, more women are receiving their information online (Declercq et al., 2013), and relying solely on their provider and social network for information. Appealing and culturally competent prenatal education would increase its uptake, and updating the offerings is the responsibility of the institution. Contemporary education models, such as CenteringPregnancy, have been associated with reduced incidence of labor dystocia (Trudnak, Arboleda, Kirby & Perrin, 2013).

Women who did not receive prenatal childbirth education may not be exposed to the practice and significance of informed consent. Economically disadvantaged women in particular should be informed prenatally of normal labor progression and methods of encouraging labor progression, as well as be empowered to exercise their informed consent should they desire more time to labor.

Several studies have been used to endorse the efficacy of continuous labor support in encouraging labor progression and reducing the primary cesarean (Caughey et al.,

2014; Hodnett et al., 2011). Only 6% of all laboring women were accompanied by professional doulas in 2012 (Declercq et al., 2013). Responses from mothers who did not use a doula indicated that government-insured women were more likely to have desired a doula than privately insured women (Declercq et al., 2013). The utilization of this resource is hindered because it is funded by Medicaid in only two states, Oregon and Minnesota. ACOG's endorsement of continuous labor support (Caughey et al., 2014) should signal that providers should not only tolerate this practice but encourage it.

Committing to objective labor dystocia criteria for diagnosis is an immediate responsibility for practitioners. This change must be predicated on effective provider education that shifts practice away from antiquated models of labor progression toward updated definitions of normal based on the Consortium on Safe Labor's findings (Zhang, Landy et al., 2010). In the same way, providers should commit to delaying admission for women whose labor has not yet been established. Early admission is a known risk factor for labor dystocia (Lowe, 2007) and delaying admission is another example of an intervention with few structural barriers to implementation, only requiring a shift in thinking. In cases when women are not aware of the nature of normal labor progression, or when they do not possess the wherewithal to advocate for more time, it is the health care provider who is ethically tasked with advocating on behalf of the patient.

Every provider is responsible for the individual quality control of obstetric practice. Awareness of overall and primary cesarean rates is an obvious first step in delivering obstetric quality. For example, audit and feedback consists of simply tracking birth outcomes and reporting them back to the individual provider. Although the practice has been effective at reducing cesarean incidence (Chaillet & Dumont, 2007), it was not

practiced at the study site. The data remains private for each provider, unless the institution chooses to make it public, as administrators chose to do in a controversial but effective move to immediately reduce cesareans (Gorman, 2015).

At the institutional level, health care administrators should take the lead in establishing accountability measures to ensure the optimal quality of health care delivery. Measures reported to the Joint Commission, such as the primary and overall cesarean rates, need to be routinely disseminated to an institution's providers. Further, ACOG should exercise its distinguished role as an authority and urge providers to adopt the 6 cm threshold for labor dystocia. The move to eliminate elective inductions before 39 weeks serves as a model of a broad institutional commitment to change. This initiative began as a rapid-cycle process improvement plan at individual sites, expanded across healthcare systems, and eventually became the norm (Oshiro et al., 2013). The movement is a success story and models that objective labor dystocia diagnosing can be executed in a similar manner to achieve broad acceptance and adoption. Additionally, employing the use of a unit laborist has been effective at significantly reducing the incidence of labor dystocia (Iriye et al., 2013). Rethinking staffing structures may be an innovative approach of to reduce cesarean incidence at the organizational level.

Perhaps the most impactful contributor to the rise of labor dystocia is the widespread medicalization of birth. Nations with concerning cesarean rates have experienced a cultural embrace of the active management of labor (Boatin et al., 2018). Plagued by a fear of birth and flawed distrust of their capability of giving birth, women often embrace the cultural belief that their bodies are broken. They become willing to abdicate any inclination to trust the body's ability to give birth. This can only be

addressed by empowering them to become birth participants, to eradicate the incursion of fear so that it no longer dominates medical decision-making at every level.

This social ecological model solution is grounded in the notion that multiple spheres of care expedite change. Providers encourage the informing of patients, informed patients shape providers' practice by becoming active birth participants, and institutional systems provide the incentives to promote change. Among all the indications for cesarean delivery, labor dystocia is the most modifiable because the solution involves doing more of nothing.

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