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Clinical Indicators Proposed to Measure the Quality of Obstetric Care During Childbirth: A Systematic Review of Published and Unpublished Literature

By

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An abstract of
a thesis submitted to the Faculty of the
Rollins School of Public Health of Emory University
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Abstract

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Increasingly comprehensive maternal morbidity and mortality data in the United States has revealed stagnating or worsening rates of poor maternal outcomes during childbirth, including stark disparities based on maternal race and ethnicity. This prompts a call to action to improve obstetric care across the nation and review clinical indicators that have been proposed to measure the quality of care during childbirth. This systematic review of the literature examines both published and unpublished literature from both domestic and international sources to compile a comprehensive list of proposed clinical quality indicators for obstetric care. The indicators are then categorized by clinical area, and descriptive characteristics of indicators are presented. A total of 93 unique clinical indicators are identified, covering a range of clinical areas including induction and augmentation of labor, elective delivery, vaginal birth, vaginal birth after cesarean, perineal care, cesarean section, and maternal morbidity and mortality. A discussion of the indicators centers on the advantages and disadvantages of specific indicator characteristics, as well as the variations in indicator characteristics based on the indicator source (published versus unpublished literature, United States versus international). The paper concludes with implications and recommendations for clinicians and policymakers, and outlines opportunities for further research.

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Table of Contents

CHAPTER 1: Introduction

Rationale

The increasingly comprehensive maternal morbidity and mortality data in the United States has illuminated worsening trends in maternal outcomes in recent decades, as well as revealed persistent racial and ethnic disparities in both morbidity and mortality. This necessitates a call to action to improve the quality of obstetric care in the U.S. Currently, no standard set of clinical quality of care indicators exists in the U.S. to routinely monitor practices and outcomes in obstetrical care. This merits a pressing need to review available obstetric care indicators that can be easily integrated into clinical practice and reported to encourage quality improvements in obstetrics in the U.S.

Problem Statement

According to the World Health Organization (WHO), the U.S. maternal mortality ratio increased by 65% between 1990 and 2010, in contrast to a global maternal mortality decline of 47% during the same time period (WHO, 2012). Despite the fact that the U.S. spends more on healthcare than any other country in the world, including an estimated annual $86 billion in childbirth-related care representing the largest proportion of hospitalization expense, it currently maintains a higher maternal mortality ratio than 49 other countries in the world (Bingham et al., 2011). Surveillance efforts by the Centers for Disease Control and Prevention (CDC) have drawn attention to the lack of decline in the national maternal mortality ratio over the past 3 decades (CDC, 2013a), as well as worsening rates of severe maternal morbidity during childbirth and postpartum (Callaghan et al, 2012). The U.S. pregnancy-related mortality ratio rose from 7.2 per 100,000 live births in 1987 to 17.8 per 100,000 in 2009 (CDC, 2013a). The extent to which

improved ascertainment of maternal deaths has influenced this rise is unknown (CDC, 2013a), yet, by and large, there is no evidence to suggest that the U.S. is making progress toward reducing maternal mortality (Bingham et al., 2011; Joint Commission, 2010; WHO, 2012).

In addition, while attention must be focused on improving national obstetric outcomes overall, quality improvement efforts should address the important and significant variations in maternal mortality and morbidity based on race, ethnicity, and nativity (i.e. country of birth) (Bryant et al, 2010; CDC, 2013; Creanga et al., 2012; Russo et al., 2008). According to a recent study, U.S.-born non-Hispanic black women were nearly 5.2 times more likely to die from pregnancy-related complications than U.S.-born non-Hispanic white women (35.2 deaths per 100,000 live births vs. 9.1 deaths per 100,000 live births) (Creanga et al., 2012). Although infants born to both U.S.- and foreign-born Hispanic women have better neonatal outcomes when compared with infants born to U.S.-born non-Hispanic white women (Bryant et al., 2010), U.S.- and foreign-born Hispanic women giving birth in the U.S. are more likely to die from pregnancy-related complications than their U.S.- and foreign-born non-Hispanic white counterparts (9.6 deaths per 100,000 live births and 11.6 deaths per 100,000 live births vs. 9.1 deaths per 100,000 live births and 7.5 deaths per 100,000 live births, respectively) (Creanga et al., 2012). Non-Hispanic black women in the U.S. have higher obstetric case fatality rates when compared with non-Hispanic white women -- in other words, black women are more likely to die from the same obstetric complication that a white woman survived (Bryant et al., 2010; Creanga et al., 2012; Tucker et al, 2007).

Moreover, severe morbidity during childbirth increased by 75% between 1998 and 2009, most significantly for hemorrhage requiring blood transfusion, and severe maternal morbidity occurs about 50 times more frequently than maternal death (Callaghan et al., 2012). This

increase in severe maternal morbidity nationally is likely due to the interplay of multiple factors. The clinical presentation of the childbearing population in the U.S. is changing – women delay childbearing and are more likely to have chronic diseases, obesity, and multiple births, all of which contribute to a higher risk of obstetric complications (Callaghan et al., 2012; CDC, 2013a; Joint Commission, 2010). Dramatic rises in the rates of cesarean delivery (56% between 1996 and 2008) and induction of labor (143% between 1990 and 2008) have increased the risk of complications from childbirth without improving maternal or infant outcomes (Bingham et al., 2011; Gould et al., 2004; Korfine, 2011). In fact, data show that the opposite is true. The unwarranted overuse of medical interventions during delivery hospitalizations increases the risk of both maternal and infant morbidity (Bingham et al., 2011). Of note, obstetrically low-risk women giving birth to their first child have had the largest absolute increase in cesarean delivery rate. Additionally, the rise of cesarean deliveries in this population increases the maternal risk level for subsequent pregnancies. The decision to perform a cesarean section in this sub-population of women depends more on physician preference than medical indication (Berkowitz et al., 1989; Goyert et al., 1989; Luthy et al., 2003; Main et al., 2006). Furthermore, elective induction of labor has been associated with a two-fold increase in the risk of cesarean delivery and with longer length of hospital stay during the delivery hospitalization (Glantz, 2005; AAFP, 2000).

Recognition of lagging performance and disparities in obstetrical outcomes has led professional and major healthcare organizations to call for the development and implementation of maternity quality improvement projects (Bingham et al., 2011; Joint Commission, 2010; Lawrence et al., 2012). A 2012 statement from the Society for Maternal Medicine published in the *American Journal of Obstetrics and Gynecology* entitled "Quality Patient Care in Labor and

Delivery: A Call to Action" includes a push to establish standardized indicators to monitor the quality of obstetric care. The nation's most prominent perinatal and medical organizations endorsed the statement, including the American Academy of Family Physicians (AAFP), the American Academy of Pediatrics (AAP), the American College of Nurse Midwives (ACNM), the American College of Obstetricians and Gynecologists (ACOG), the American College of Osteopathic Obstetricians and Gynecologists (ACOOG), the Association of Women's Health, Obstetric, and Neonatal Nurses (AWHONN), and the Society for Maternal-Fetal Medicine (SMFM) (Lawrence et al, 2012).

A host of healthcare quality organizations, professional societies, and state-level perinatal quality collaboratives have developed or endorsed various quality indicators related to maternal care during childbirth (AHRQ, 2011; Bailit, 2007; CDC, 2013b; Main, 2009). Beginning on January 1, 2014, the Joint Commission will require all hospitals with more than 1,100 births per year to collect and report data on five perinatal quality measures established by the Joint Commission as a mandatory component of hospital accreditation (Zibrat, 2013). Two of these five measures, (PC-01: Elective delivery and PC-02: Cesarean section) relate specifically to the quality of obstetric care during childbirth, while the remaining three measures focus primarily on quality of care as it relates to the fetus, newborn, and infant (PC-03: Antenatal steroids, PC-04: Health care-associated bloodstream infections in newborns, and PC-05: Exclusive breast milk feeding) (Joint Commission, 2011). Apart from the Joint Commission measures, no cohesive set of quality indicators has been proposed and widely accepted for routine monitoring and evaluation of obstetric care in the US (Bryant et al., 2010; Mann et al., 2006). This lack of nationally-accepted obstetric care indicators amounts to a gap in oversight of the practice of obstetrics resulting in the failure to report and review many adverse obstetrical events that occur

during childbirth and hindering possibilities for quality improvement (Bingham et al., 2011; Lawrence et al., 2012; Mann et al., 2006).

Purpose Statement

The overarching purpose of this research project is to identify and assess currently proposed clinical indicators for measuring the quality of obstetric care. Specifically, the paper provides a comprehensive list of indicators developed and endorsed by key U.S.- and internationally-based organizations, as well as those proposed in the published literature. This research project seeks to address the following two research questions. First, what clinical indicators have been proposed for evaluating the quality of obstetric care during childbirth? Second, what aspects of clinical care are these measures capturing?

Significance Statement

Poor obstetrical outcomes result in women's lives being needlessly lost or significantly altered by disease and disability. About half of maternal deaths in the U.S. are preventable through improved attention to the quality of care women receive during pregnancy and delivery (Berg et al., 2005). Some have noted that the lack of action to reversing current maternal mortality and morbidity trends "is not just a matter of public health, but a human rights failure" (Bingham et al., 2011). In addition, the over four million delivery hospitalizations represent the single largest proportion of annual hospital admissions in the U.S (Bailit, 2007). Improving obstetric outcomes stands to have not only a significant health impact, but also a considerable economic impact as we struggle to contain healthcare costs as a nation (Bailit, 2007; Callaghan et al., 2012).

The use and monitoring of quality of care indicators is one of the most common methods for measuring the quality of healthcare, and their inclusion in quality improvement projects has been shown to lead to improved outcomes (Donabedian, 1966; Watts et al., 2012; Young et al., 2012). Employing standardized, reliable clinical indicators would permit measuring change, and hopefully progress, toward agreed-upon benchmarks, high quality obstetrical practices, and improved outcomes nationwide, we (Bailit, 2007; Rice Simpson, 2006). a comprehensive overview of proposed obstetric quality indicators will help researchers and decision-makers in health facilities and/or public health agencies monitor both obstetrical care practices and childbirth outcomes.

Definition of Terms

The key terms used in conducting this research project are defined below. *Quality of healthcare* is defined in accordance with the Institute of Medicine as "the degree to which health services for individuals and populations increase the likelihood of desired health outcomes and are consistent with current professional knowledge" (IOM, 2013). *Quality of care during childbirth* refers to the care received during the period of hospitalization for delivery. For women giving birth in out-of-hospital settings, this includes the time period during which they received medical care for labor, delivery, and in the immediate postpartum period. *Health facility* refers to a hospital or birth center where deliveries take place.

Using the Agency for Healthcare Research and Quality (AHRQ) definitions*, clinical quality measures* refer to "measures used to assess the performance of individual clinicians, clinical delivery teams, delivery organizations, or health insurance plans in the provision of care to their patients or enrollees" (NQMC, 2013). Use of the term *clinical quality indicator* in this

paper will reflect this definition as well, and the terms "indicator" and "measure" will be used interchangeably throughout the paper. A *process measure* refers to "a health care-related activity performed for, on behalf of, or by a patient," while an *outcome measure* refers to "a health state of a patient resulting from health care" (NQMC, 2013). The term *composite measure* refers to an indicator that "summarizes two or more related measures or survey questions (or 'items')" (NQMC, 2013). Composite measures often involve a scoring system or include a "bundle" of items to be measured as components of the indicator. The AHRQ definition will also be used for the term *administrative data* to refer to "data such as enrollment or eligibility information, claims information, and managed care encounters [….] for hospital and other facility services, professional services, prescription drug services, laboratory services, and so on, gathered from billing codes or other coding systems" and "information that is collected, processed, and stored in automated information systems" (NQMC, 2013).

CHAPTER 2: Methods

Overview

To address the proposed research questions, a systematic review of both published and unpublished (or "gray") literature was performed. Using the study inclusion and exclusion criteria described below, clinical obstetric quality of care indicators were abstracted from the literature, and a comprehensive list was compiled. Indicators were then classified into the following groups based on the care processes or outcomes they measured: 1) labor induction or augmentation or elective delivery, 2) vaginal birth, 3) vaginal birth after cesarean, 4) perineal care, 5) cesarean section, 6) maternal morbidity and mortality, 7) miscellaneous, and 8) composite measures. This study did not require Review by the Institutional Review Board (IRB)

as the research did not involve human subjects and did not utilize any potentially identifiable personal data.

Procedures

An electronic literature search was conducted using MEDLINE, Embase, Web of Knowledge, and CINHAL databases. Details regarding database-specific search strategies used are shown in Table 1 below. The process of identification and selection of relevant published and gray literature is presented in Figure 1 below. To be considered for inclusion, clinical indicators had to relate specifically to the quality or safety of maternal care during the period of hospitalization for childbirth, be designated as a process or an outcome measure, or a composite of process and/or outcome measures, and be amenable to use with either administrative data or medical records. By implication, indicators were excluded if they related to the quality or safety of care for the fetus or newborn or care outside of the period of hospitalization for childbirth, were not process or outcome indicators or composites of such, and could not be assessed using administrative data and/or medical records. To be included in the review, articles had to specifically aim to propose quality indicators and to provide sufficient detail regarding the assessment of proposed indicators. For example, articles that measured the impact of guidelines or interventions, focused on preventability or avoidability of adverse events, or proposed categorization schemes for medical errors or adverse events were not eligible for inclusion.

Websites of key organizations were searched to identify obstetric quality of care indicators meeting study inclusion/exclusion criteria. A variety of organizations' websites were searched, including all 42 U.S. state-based perinatal quality collaboratives; 13 quality assurance or quality promotion organizations; 9 professional organizations or international bodies; and 2

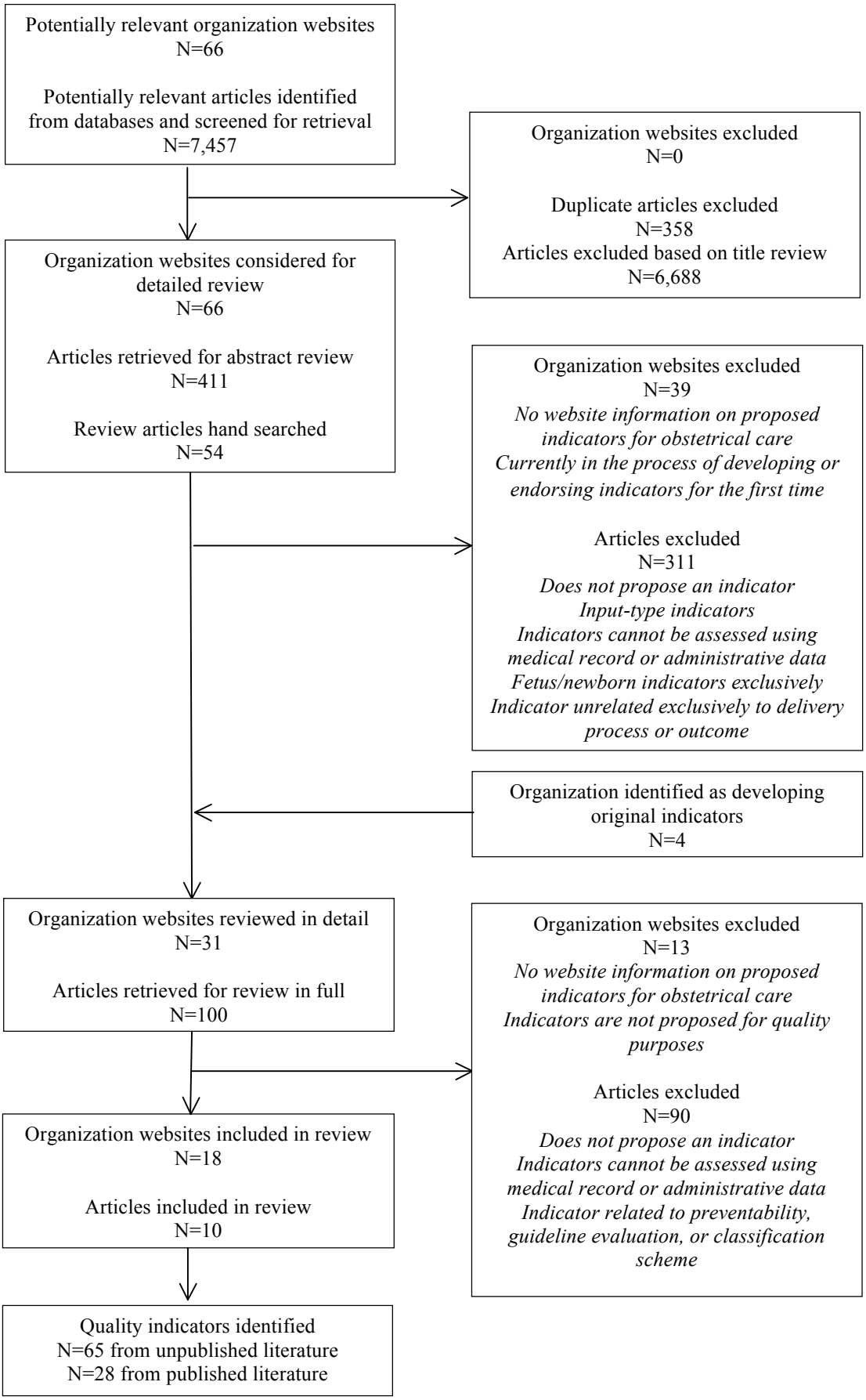
healthcare systems, for a total of 66 organizations. A complete listing of these organizations can be found in Table A1, and a brief description of the organizations included in the final review is provided in Table A2 (see Appendix). The search primarily focused on U.S.-based entities, but was expanded to include websites of key international entities (e.g. UN agencies).

Table 1. Components of the database search strategy for potentially appropriate articles included in the systematic review

Database	Years Included	Search Terms	Limits	Number of Hits
MEDLINE	January 1999 to February 2013	(obstetrics OR (pregnancy NOT prenatal NOT antenatal) NOT abortion NOT hormone NOT laboratory) AND ((quality indicator OR quality indicators) OR patient safety OR "quality assurance, health care" [MeSH term] OR (quality AND (measure OR measures OR measurement OR measuring)))	Humans, Female, English	6,684
CINAHL	January 1999 to February 2013	(CINAHL headings: clinical indicators OR quality of care research OR quality of health care OR quality assessment OR quality improvement OR United States Agency for Healthcare Research and Quality OR "quality indicator") AND Obstetrics (all text)	Humans, Female, English	126
Web of Knowledge	January 1999 to February 2013	Topic: obstetric* OR pregnancy AND Topic: quality indicator* OR patient safety OR quality assurance OR quality measure* NOT Topic: prenatal OR antenatal OR abortion OR hormone OR laboratory	English; Subject: obstetrics gynecology	543
Embase	January 1999 to February 2013	(*obstetrics/ OR *pregnancy outcome/) AND (*health care quality/ OR *patient safety/ OR *quality control/ OR quality measure$.mp OR quality indicator$.mp.) NOT (prenatal.mp. OR antenatal.mp. OR *abortion/ OR *hormone/)	Humans, Female, English	104

Two indicator databases were identified through the Agency for Healthcare Research and Quality (AHRQ) website, the National Quality Measure Clearinghouse (NQMC) and the Health and Human Services (HHS) Measure Inventory (AHRQ, 2013). The National Quality Measure Clearinghouse (NQMC) is a database for information on specific evidence-based health care quality measures and measure sets. The NQMC is sponsored by AHRQ, and its mission is to

Figure 1. Flow diagram depicting the process of literature review



provide an accessible mechanism for obtaining detailed information on quality measures, further their dissemination, implementation, and use in order to inform health care decisions. All 2,198 NQMC indicators were searched in full. The HHS Measure Inventory compiles indicators from the following contributory agencies: Administration for Community Living (ACL), Agency for Healthcare Research & Quality (AHRQ), Centers for Disease Control and Prevention (CDC), Centers for Medicare & Medicaid Services (CMS), Health Resources and Services Administration (HRSA), Indian Health Service (IHS), National Institutes of Health (NIH), Office of the Assistant Secretary for Health (OASH), Office of the National Coordinator for Health Information Technology (ONC), and Substance Abuse and Mental Health Services Administration (SAMHSA). All 2,179 HHS Measure Inventory indicators were searched in full.

Search Outcomes

Based on abstract review and upon de-duplication, 100 published articles were selected for review in full and potential inclusion in the systematic review; also, after initial screening and review, 31 organization websites were selected for detailed review and potential inclusion in the review. Following detailed review, 10 articles and 18 organization websites were included in the systematic review yielding 28 and 65 obstetric quality of care indicators, respectively, for a total of 93 unique indicators.

Among the 18 organizations included in the final review, 15 organizations develop new quality of obstetrical care indicators, three assess and endorse existing measures (National Quality Forum, the Joint Commission, and the Leapfrog Group), and one both develops new measures and utilizes existing measures (ACNM Benchmarking Project). Of note, one nursing organization (AWHONN) and one quality collaborative (Physician Consortium for Performance

Improvement, comprised of ACOG, AMA, and NCQA) were in the process of testing both original and existing measures at the time of this review and, therefore, they were not included.

CHAPTER 3: Results

In total, 93 clinical indicators of the quality of obstetric care during childbirth were identified in the published (N=28; Table 3) and gray literature (N=65; Table 4). A complete listing of indicators identified in the published literature, including definitions and detail regarding indicator characteristics, is presented in Table 3; the same information is presented for the indicators identified in the unpublished literature in Table 4. When numerators and denominators for measure calculation were provided or could be easily extracted, these are included; when such specific information is not available, the authors' definitions are shown.

Of the 93 indicators, 53 are process indicators, 33 are outcome indicators, and seven are composite measures (Table 2). Apart from the seven composite measures, all indicators are individual measures. Forty-eight indicators are amenable to use with administrative data only, while the remaining 45 require medical chart review. When classified into clinical categories, 19 relate to the induction or augmentation of labor, or elective delivery, six relate to vaginal birth, five relate to vaginal birth after cesarean (VBAC), 16 relate to perineum care, 19 relate to cesarean delivery (four specific indicators for primary and two specific indicators for repeat cesarean), 16 relate to maternal morbidity and mortality, and five are miscellaneous including procedure- and hospitalization-specific indicators (see Tables 3 and 4). Among the published literature, 12 are process indicators, 11 are outcome, and five are composite. Five measures are amenable to administrative data only, while 23 require chart review. In the unpublished

literature, 41 are process indicators, 22 are outcome indicators, and 2 are composite measures. Forty-three of these indicators are amenable to use with administrative data only, while 22 indicators require chart review.

Table 2. Key characteristics of identified obstetric quality of care indicators (n=93)

Characteristic	**N (%)**
Indicator type	
Process indicator	53 (57.0%)
Outcome indicator	33 (35.5%)
Composite indicator	7 (7.5%)
*Clinical category**	
Induction/augmentation/elective delivery	19 (20.4%)
Vaginal delivery	6 (6.5%)
VBAC**	5 (5.4%)
Perineum care	16 (17.2%)
Cesarean delivery	19 (20.4%)
Maternal morbidity/mortality	16 (17.2%)
Miscellaneous	5 (5.4%)
Data source	
Administrative data only	48 (51.6%)
Medical chart review required	45 (48.4%)

Notes: *Seven indicators are composite measures; **VBAC, vaginal delivery after cesarean.

Labor Induction, Augmentation, and Elective Delivery

The indicators identified for induction and augmentation of labor covered multiple aspects of this care process, from overall incidence to timing with respect to gestational age and the care processes followed during the actual induction or augmentation. Australian Council on Healthcare Standards (ACHS), American College of Nurse Midwives (ACNM), and authors Chalmers and Porter all look at the incidence of induction, yet vary slightly in their measurements. ACNM looks at overall incidence regardless of maternal characteristics, whereas ACHS limits their tracking to a selected primipara population (age 20-34 years, singleton, term

fetus in cephalic presentation). Chalmers and Porter (2001) propose an indicator that measures in conjunction the percentage of women with induced labor or undergoing elective cesarean. Using this measure, they can identify the women who present in spontaneous labor and use this as the standardized population for calculating their proposed Bologna Score (see *Composite Measures* for further details).

Recent attention to the risks of early elective deliveries (vaginal or cesarean delivery without clear medical indication prior to 39 completed weeks gestation) is evident in the number of entities that have utilized or endorsed measures regarding the timing of induction and elective delivery. An indicator developed by the Hospital Corporation of America (HCA) was endorsed for use by NQF, the Joint Commission, the Leapfrog Group, and Center for Medicare and Medicaid, and is under consideration for endorsement by Physician Consortium for Performance Improvement (PCPI). The indicator measures all elective vaginal or cesarean deliveries between 37 0/7 and 38 6/7 weeks gestation. The New York State Perinatal Quality Collaborative (NYSPQC) has developed several indicators related to elective delivery. One indicator tracks the percent of scheduled inductions of labor between 36 0/7 and 38 6/7 weeks gestation without a documented maternal or fetal reason, while another tracks the same for all scheduled deliveries within the given gestational age. Another NYSPQC indicator measures the percent of early inductions of labor with documentation of a Bishop score, a scoring system used to assess the favorability of the cervix for labor. NYSPQC also measures the optimality of gestational age dating for scheduled deliveries between 36 0/7 and 38 6/7 weeks. One indicator tracks the percentage of scheduled deliveries that have any documentation of gestational age in the chart, while another tracks the percentage that document gestational age according to optimal criteria (see Table 4 for optimal criteria). All NYSPQC measures require chart review.

Table 3. Indicators identified in the published literature (N = 28)

Author (year)	Indicator	Definition
Labor, Induction, Augmentation, and Elective Delivery (n=4)		
Chalmers and Porter (2001)	Indicator A √ Δ	Percentage of women with induced labor or undergoing elective cesarean section
	Indicator B √ Δ	Percentage of women attended by a skilled attendant in labor
Main, et al. (2004)	NTSV inductions at <41 wks gestation √ ‡	Induction of labor after 37 but before 41 completed weeks gestation in the NTSV population
	NTSV labor admissions >/= 3cm dilation √ ‡	NTSV women admitted for labor at less than or equal to 3 cm of cervical dilation
Vaginal Birth (n =1)		
Haikin and Mankuta (2012)	Optimal range of vacuum cup placement during delivery √ Δ	Midline lateral and midline anterior-posterior deviation from ideal placement in centimeters (not to exceed 2 cm and 3 cm, respectively)
Perineal Care (n =4)		
Main, et al. (2004)	NTSV 3rd/4th degree perineal laceration rate ◊ ‡	Rate of 3rd and 4th degree perineal lacerations in NTSV population
	NTSV episiotomy rate √ ‡	Rate of NTSV women receiving an episiotomy during vaginal delivery
Soong, et al. (1999)	Episiotomy rate, midwife only √ Δ	Proportion of non-instrumental vaginal deliveries assisted by midwives in which episiotomy was performed
	Intact lower genital tract, midwife only ◊ Δ	Proportion of non-instrumental vaginal deliveries assisted by midwives without episiotomy or perineal laceration
Cesarean Section (n =1)		
Main, et al. (2004)	Nulliparous, term, singleton, vertex (NTSV) cesarean birth rate √ ‡	Rate of cesarean birth among nulliparous women with a term singleton fetus in vertex presentation
Maternal Morbidity and Mortality (n = 12)		
Graham, et al. (2000)	Primary postpartum hemorrhage ◊ Δ	Genital tract bleeding within 24 hours of delivery w/ gestation of fetus >/= 24 wks and at least one qualifying additional feature
	Eclampsia ◊ Δ	Generalized fits in a patient without a previous history of epilepsy
	Obstructed labor ◊ Δ	Clinical signs of shock, temperature >/= 37.5˚C, odorous vaginal discharge, with at least one qualifying additional feature
	Uterine rupture ◊ Δ	Rupture of uterus during labor with confirmation at laparotomy
	Chorioamnionitis ◊ Δ	Evidence of ruptured membranes, temperature >/= 37.5˚C or odorous vaginal discharge
Luitjes, et al. (2013)	Preeclampsia (2 measures) √ Δ	Systolic blood pressure >/= 170 mmHg and/or diastolic blood pressure >/= 110 mmHg in a patient with gestational hypertension or preeclampsia needs medical treatment
		Target values for the systolic blood pressure are 140-160 and 90-102 mmHg for the diastolic blood pressure in patients with preeclampsia
	Severe Preeclampsia and Eclampsia (2 measures) √ Δ	Treatment of patients with severe preeclampsia needs to be a clinical one*
		Patients with severe preeclampsia need to be

		adequately stabilized before intervention (transport to tertiary care centers and/or delivery). Treatment consists of magnesium sulfate and/or antihypertensive drugs depending on the blood pressure.
Martijn, et al. (2012)	Anemia ◊ Δ	No definition for anemia
	Complicated instrumental birth or cesarean birth ◊ Δ	Uterine infections, wound infections cited as examples; no systematic definition provided.
	Prolonged hospitalization ◊ Δ	No definition for prolonged hospitalization.
Miscellaneous (n =1)		
Martijn, et al. (2012)	Clinical Management ◊ Δ	Incidents due to incorrect prescription, dosage, or administration of medication during process of care
Composite Measures (n=5)		
Anastakis and Antsaklis (2007)	Maternity Unit Performance Index (MUPI) † Δ	Index by which a maternity unit's performance can be compared over time and to other units based on singleton primipara population.
Chalmers and Porter (2001)	Bologna score † Δ	A composite measure of normal labor management within a given population based on 5 elements: presence of a companion at birth, use of a partogram, absence of augmentation or emergency cesarean section, use of a non-supine position for birth, skin-to-skin contact of mother and baby upon delivery.
Cragin and Kennedy (2006)	Optimality Index-US (OI-US) † Δ	A measurement of perinatal health optimality, defined as "the maximal perinatal outcome with minimal intervention placed against the context of the woman's social, medical, and obstetrical history". A higher average OI-US reflects a more optimal balance of interventions and outcomes, given the women's health status.
Haney, et al. (1999)	Optional vaginal delivery rate † Δ	Successful vaginal birth that could have been q cesarean section if a less aggressive approach were taken
	[Provider] delivery score † Δ	Score gives credit for each vaginal delivery, additional credit for achieving vaginal delivery in difficult circumstances, and deducts credit for potentially avoidable cesarean sections

Note: * The author of this paper (Luitjes) was contacted to clarify this definition; no response was received at the time this research project was completed.

Key

† Composite Measure
√ Process Measure
◊ Outcome Measure
‡ Administrative Data Only
Δ Medical Record Review Required

Table 4. Indicators identified in the unpublished literature (N = 65)

Organization	Indicator	Definition
Labor, Induction, Augmentation, and Elective Delivery (n = 15)		
Australian Council on Healthcare Standards	Percentage of selected primipara who undergo induction of labor √ ‡	Numerator = number of selected primipara who undergo induction of labor Denominator = number of selected primipara who give birth Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
American College of Nurse Midwives	Total induction √ ‡	Initiation of labor using synthetic oxytocin, prostaglandins, mechanical means, and/or another method when spontaneous labor has not yet begun. This measure excludes augmentation of labor that is performed after spontaneous labor has begun but is not yet progressing.
	Percent of inductions <41 Weeks √ ‡	Initiation of labor prior to 41 0/7 completed weeks gestation using synthetic oxytocin, prostaglandins, mechanical means, and/or another method when spontaneous labor has not yet begun.
Hospital Corporation of America	Elective delivery prior to 39 completed weeks gestation √ Δ	Numerator = patients with elective deliveries Denominator = delivering patients 37-38 completed weeks of gestation
Institute for Clinical Systems Improvement	Percentage of patients who are assessed for risk status on entry to labor and delivery √ Δ	Numerator = number of patients with evidence of assessment for risk status on entry to labor and delivery to include 20-minute fetal heart rate (FHR) assessment, patient assessment, prenatal risk review, risk in labor assessment. Denominator = number of patients who present in labor Risk assessment should be performed on all patients in active labor and is the responsibility of all members of the health care team
	Percentage of patients who have an IV fluid bolus administered √ Δ	Numerator = number of patients who have an intravenous (IV) fluid bolus administered Denominator = number of patients who present in labor
	Percentage of patients whose oxytocin is discontinued √ Δ	Numerator = number of patients whose oxytocin is discontinued Denominator = number of patients who present in labor
	Percentage of patients whose position is changed to the left or right side to decrease compression of vena cava √ Δ	Numerator = number of patients whose position is changed to the left or right side to decrease compression of vena cava Denominator = number of patients who present in labor
	Percentage of patients with protracted labor who are administered oxytocin √ Δ	Numerator = number of patients who are given oxytocin Denominator = number of delivering women who are full term, without concomitant medical problems, having contractions, singleton fetus, cephalic presentation, no evidence of fetal distress, expected to have a normal spontaneous vaginal delivery, and are in protracted labor
Joint Commission	Percentage of patients with elective vaginal deliveries or elective cesarean sections at greater than or equal to 37 and less than 39 weeks of gestation completed √ Δ	Numerator = patients with elective deliveries Denominator = delivering patients 37-38 completed weeks of gestation Excludes patients with conditions possibly justifying elective delivery prior to 39 weeks gestation, length of stay > 120 days, or enrolled in clinical trials.
New York State Perinatal Quality	Percent of scheduled inductions of labor at 36 0/7	2 alternate calculations are presented (e.g. Numerator = number of scheduled inductions of labor at

Collaborative	to 38 6/7 weeks gestation without documentation of listed maternal or fetal reason ◊ Δ	36 0/7 to 38 6/7 weeks gestation without documentation of listed maternal or fetal reason Denominator = All scheduled deliveries of infants between 36 0/7 to 38 6/7 weeks gestation)
	Percent of all deliveries induced at 36 0/7 to 38 6/7 weeks gestation without documentation of a Bishop Score √ Δ	Numerator = number of all deliveries induced at 36 0/7 to 38 6/7 weeks gestation without documentation of a Bishop Score Denominator = all deliveries induced at 36 0/7 and 38 6/7 weeks gestation
	Percent of all scheduled deliveries at 36 0/7 to 38 6/7 weeks gestation without documentation of listed maternal or fetal reason ◊ Δ	Numerator = number of all scheduled deliveries at 36 0/7 to 38 6/7 weeks gestation without documentation of listed maternal or fetal reason Denominator = all scheduled deliveries of infants between 36 0/7 and 38 6/7 weeks gestation
	Percent of scheduled deliveries at 36 0/7 to 38 6/7 weeks gestation that have documentation in the medical record of gestational age using any criteria √ Δ	Numerator = number of scheduled deliveries at 36 0/7 to 38 6/7 weeks gestation where gestational age was documented in the chart using any criteria Denominator = total number of scheduled deliveries at 36 0/7 to 38 6/7 weeks
	Percent of scheduled deliveries at 36 0/7 to 38 6/7 weeks gestation with documentation that meets optimal criteria of gestational age assessment √ Δ	Numerator = number of scheduled deliveries in women at 36 0/7 to 38 6/7 weeks gestation for which there is documentation of data that confirmed or established due date AND for which one of the following methods that are considered to be optimal was checked: 1) first or second trimester ultrasound < 20 weeks; 2) fetal heart tones documented for 30 weeks by Doppler ultrasonography; or 3) 36 weeks since positive serum/urine human chorionic gonadotropin pregnancy test result Denominator = total number of scheduled deliveries at 36 0/7 to 38 6/7 weeks gestation
Vaginal Birth (n = 5)		
Australian Council on Healthcare Standards	Percentage of selected primipara who have a spontaneous vaginal birth √ ‡	Numerator = total number of selected primipara who have a spontaneous vaginal birth Denominator = total number of selected primipara who give birth Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
	Percentage of selected primipara who undergo an instrumental vaginal birth √ ‡	Numerator = number of selected primipara who undergo an instrumental vaginal birth Denominator = total number of selected primipara who give birth Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
	Percentage of women who give birth vaginally who receive a blood transfusion during the same admission ◊ ‡	Numerator = total number of women who give birth vaginally who receive a blood transfusion during the same admission Denominator = total number of women who give birth vaginally
American College of Nurse Midwives	Total vaginal birth √ ‡	All vaginal births including those that are classified as VBAC and those requiring assistance from vacuum or

		forceps
	Spontaneous vaginal birth √ ‡	All spontaneous vaginal births including those that are classified as VBAC; does not include vaginal births requiring assistance from vacuum or forceps
Vaginal Birth After Cesarean (n = 5)		
Australian Council on Healthcare Standards; Agency for Healthcare Research and Quality	Percentage of women delivering vaginally after a primary caesarean section. √ ‡	Numerator = number of women delivering vaginally following a previous primary cesarean section Denominator = number of women delivering who have had a previous primary cesarean section Includes only women with no intervening pregnancies greater than 20 weeks gestation
American College of Nurse Midwives	VBAC success √ ‡	Any vaginal birth (spontaneous or assisted) after a previous cesarean section
Agency for Healthcare Research and Quality	IQI #21 Vaginal birth after cesarean (VBAC) rate all √ ‡	Numerator = number of vaginal births Denominator = number of deliveries with a previous Cesarean delivery
	IQI #22 Vaginal birth after cesarean (VBAC) rate uncomplicated √ ‡	Numerator = number of vaginal births in women without abnormal presentation, preterm, fetal death, or multiple gestation Denominator = all deliveries with previous cesarean delivery in women without abnormal presentation, preterm, fetal death, or multiple gestation
Royal College of Obstetricians and Gynaecologists	Vaginal birth after cesarean rate √ ‡	Numerator = Number of vaginal deliveries Denominator = Number of women giving birth after a previous cesarean deliveries
Perineal Care (n = 12)		
Australian Council on Healthcare Standards	Percentage of selected primipara with an intact perineum or unsutured perineal tear ◊ ‡	Numerator = total number of selected primipara with an intact perineum or unsutured perineal tear Denominator = total number of selected primipara delivering vaginally Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
	Percentage of selected primipara undergoing episiotomy and NO perineal tear while giving birth vaginally ◊ ‡	Numerator = total number of selected primipara undergoing episiotomy and NO perineal tear while giving birth vaginally Denominator = total number of selected primipara delivering vaginally Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
	Percentage of selected primipara sustaining a perineal tear and NO episiotomy ◊ ‡	Numerator = total number of selected primipara sustaining a perineal tear and NO episiotomy Denominator = total number of selected primipara delivering vaginally Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
	Percentage of selected primipara undergoing episiotomy AND sustaining a perineal tear ◊ ‡	Numerator = total number of selected primipara undergoing episiotomy AND sustaining a perineal tear while giving birth vaginally Denominator = total number of selected primipara delivering vaginally Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation

	Percentage of selected primipara undergoing surgical repair of the perineum for third degree tear ◊ ‡	Numerator = total number of selected primipara undergoing surgical repair of the perineum for third degree tear Denominator = total number of selected primipara delivering vaginally Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
	Percentage of selected primipara undergoing surgical repair of the perineum for fourth degree tear ◊ ‡	Numerator = total number of selected primipara undergoing surgical repair of the perineum for fourth degree tear Denominator = total number of selected primipara delivering vaginally Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
American College of Nurse Midwives	Intact perineum ◊ ‡	Intact birth canal or any laceration not requiring repair
	Episiotomy ◊ ‡	No definition provided
Agency for Healthcare Research and Quality	PSI #18 Obstetric trauma Rate- Vaginal delivery with instrument ◊ ‡	Numerator = discharges among cases meeting the inclusion and exclusion rules for the denominator with ICD-9-CM codes for 3rd and 4th degree obstetric trauma in any diagnosis field Denominator = all vaginal delivery discharges with any procedure code for instrument-assisted delivery
	PSI #19 Obstetric Trauma Rate- Vaginal Delivery Without Instrument ◊ ‡	Numerator = discharges among cases meeting the inclusion and exclusion rules for the denominator with ICD-9-CM codes for 3rd and 4th degree obstetric trauma in any diagnosis field Denominator = all vaginal delivery discharge patients
Christiana Healthcare System	Incidence of episiotomy √ ‡	Numerator = number of episiotomy procedures performed on women undergoing a vaginal delivery (excluding those with shoulder dystocia) Denominator = all vaginal deliveries (excluding those with shoulder dystocia)
Royal College of Obstetricians and Gynaecologists	Percentage of women with episiotomy or tear sutured within 1 hour ◊ Δ	Numerator = Number of women with episiotomy or tear sutured within 1 hour Denominator = Number of women with episiotomy or tear requiring suturing
Cesarean Section (n = 18)		
Australian Council on Healthcare Standards	Percentage of selected primipara undergoing caesarean section √ ‡	Numerator = total number of selected primipara undergoing cesarean section Denominator = total number of selected primipara who give birth Selected primipara = woman 20-34 years giving birth for the 1st time at 37-41 weeks, singleton pregnancy, cephalic presentation
	Percentage of high risk women undergoing cesarean section who receive appropriate pharmacological thromboprophylaxis √ ‡	Numerator = total number of high risk women undergoing cesarean section who receive appropriate pharmacological thromboprophylaxis Denominator = total number of high risk women undergoing cesarean section Women at high risk = patients with ≥3 of: age> 35 years, prepregnancy weight > 80 kg, para 4 or more, gross varicose veins, current infection, preeclampsia, immobility prior to surgery (>4 days), emergency caesarean section in labor, major current illness (heart or lung disease, cancer, inflammatory bowel, nephritic syndrome, recent surgery in

		pregnancy) OR one of the following: extended major pelvic or abdominal surgery (caesarean hysterectomy), family or personal history of deep vein thrombosis; pulmonary embolism or thrombophilia (including antiphospholipid syndrome); paralysis of lower limbs. Appropriate pharmacologic thromboprophylaxis = prophylaxis that is concordant with the recommendations in available guidelines
	Percentage of women having a general anesthetic for cesarean delivery √ ‡	Numerator = total number of women having a general anesthetic for a cesarean section Denominator = total number of women having a cesarean section
	Percentage of women who receive an appropriate prophylactic antibiotic at the time of caesarean section √ ‡	Numerator = total number of women who receive an appropriate prophylactic antibiotic at the time of cesarean section Denominator = total number of women undergoing cesarean section A**ppropriate prophylactic regimen** = correct medication choice, route of administration and dosing schedule, correct duration and correct timing; for elective and emergency caesarean section, antibiotic protocols should be in line with available guidelines.
	Percentage of women who undergo a caesarean section who receive a blood transfusion during the same admission ◊ ‡	Numerator = total number of women who undergo cesarean section who receive a blood transfusion during the same admission Denominator = total number of women who undergo cesarean section
American College of Nurse Midwives	Total Cesarean √ ‡	Number of cesarean deliveries in a specified time period
	Primary Cesarean √ ‡	First cesarean section for a patient
Agency for Healthcare Research and Quality	IQI #21 Cesarean delivery rate √ ‡	Numerator = number of cesarean deliveries Denominator = all deliveries
	IQI #33 Primary cesarean delivery rate √ ‡	Numerator = number of primary cesarean deliveries Denominator = all deliveries
California Maternal Quality Care Collaborative	Cesarean rate for low-risk first birth women ◊ ‡	Numerator = number of nulliparous low risk patients delivered by cesarean Denominator = number of nulliparous low risk patients Low risk= woman with a term singleton newborn in vertex position
Hospital Corporation of America	Appropriate DVT prophylaxis in women undergoing cesarean delivery √ Δ	Numerator = number of women undergoing cesarean delivery who receive either fractionated or unfractionated heparin or heparinoid, or pneumatic compression devices prior to surgery Denominator = all women undergoing cesarean delivery
Healthy People 2020	MICH 7.1 Cesarean births among low risk women with no prior cesarean birth √ ‡	Numerator = number of births delivered by cesarean section to low-risk females (full-tem, singleton, vertex presentation) Denominator = number of live births to low-risk females (full-tem, singleton, vertex presentation)
	MICH 7.2 Cesarean births among low-risk women with a prior cesarean birth √ ‡	Numerator = number of births delivered by cesarean section to low-risk females with a prior cesarean birth Denominator = number of live births to low-risk females with a prior cesarean birth
Massachusetts General/Partners Healthcare System	Prophylactic Antibiotic Received Within One Hour Prior to Surgical Incision or at	Numerator = percentage of women who receive recommended antibiotics within one hour before the start of cesarean section

	the Time of Delivery – Cesarean section √ Δ	Denominator = all patients undergoing cesarean section without evidence of prior infection or already receiving prophylactic antibiotics for other reasons
New York State Perinatal Quality Collaborative	Percentage of scheduled cesarean sections at 36 0/7 - 38 6/7 weeks gestation without documentation of listed maternal or fetal reason ◊ Δ	4 calculation variations are presented (e.g. Numerator = Number of scheduled cesarean sections at 36 0/7 - 38 6/7 weeks gestation without documentation of listed maternal or fetal reason Denominator = All scheduled deliveries of infants between 36 0/7 to 38 6/7 weeks)
Royal College of Obstetricians and Gynaecologists	Percentage of primiparous women having cesarean √ ‡	Numerator = Number of women undergoing cesarean delivery Denominator = Number of women giving birth for the first time
	Percentage of cesarean sections for fetal distress or maternal emergency in which the decision to delivery interval is 30 minutes √ Δ	Numerator = Number of cesarean sections in which the decision to delivery interval is 30 minutes Denominator = Number of cesareans for fetal distress or maternal emergency
World Health Organization	Cesarean sections as a proportion of all births √ ‡	Numerator = number of cesarean sections in emergency obstetrical care facilities in specified period Denominator = expected number of births in area in same period
Maternal Morbidity and Mortality (n = 4)		
Healthy People 2020	MICH 6 Pregnant females suffering complications during hospitalized labor and delivery ◊ ‡	Numerator = number of hospital discharges for females with any listed diagnosis of maternal complications* Denominator = number of hospital discharges for females who delivered one or more infants
Royal College of Obstetricians and Gynaecologists	Percentage of women with a postpartum hemorrhage of 2500 ml or more ◊ Δ	Numerator = Number of women with an estimated blood loss of 2,500 ml or more Denominator = Number of women giving birth
World Health Organization	Direct obstetric case fatality rate in emergency obstetrical care (EmOC) facilities ◊ ‡	Numerator = number of maternal deaths due to direct obstetric causes in EmOC facilities in specified period Denominator = number of women treated for direct obstetric complications in EmOC facilities in the same period
	Proportion of maternal deaths due to indirect causes in emergency obstetrical care (EmOC) facilities ◊ ‡	Numerator = number of maternal deaths due to indirect causes in EmOC facilities in specified time period Denominator = all maternal deaths (from direct and indirect causes) in EmOC facilities in same period
Miscellaneous (n = 4)		
American College of Nurse Midwives	Epidural √ ‡	Numerator = Number of women using an epidural, including intrathecal, for labor pain relief but excluding epidural initiated exclusively for cesarean sections and/or assisted vaginal delivery Denominator = Number of women undergoing non-instrumental vaginal birth
	Length of stay (maternal) √ ‡	Time in hours from birth to discharge
Royal College of Obstetricians and Gynaecologists	Percentage of singleton breech pregnancies where external cephalic version was attempted √ Δ	Numerator = Number of external cephalic versions attempted Denominator = Number of breech pregnancies

	Percentage of women who are attended by the anesthetist within 30 or 60 minutes of requesting epidural anesthesia ◊ Δ	Numerator = Number of women attended to by an anesthetist within 30 or 60 minutes Denominator = Number of women requesting epidural anesthesia
Composite measures (n = 2)		
Institute for Healthcare Improvement	Elective induction bundle compliance † Δ	Numerator = number of patients given oxytocin for induction with all four components of bundle in place Denominator = number of patients given oxytocin for elective induction Bundle components: gestational age greater than 39 weeks, recognition and management of tachysystole, pelvic exam, and reassuring fetal status
	Augmentation bundle compliance † Δ	Numerator = number of patients given oxytocin for augmentation with all four components of bundle documented Denominator = number of patients where oxytocin was used for augmentation Bundle components: documentation of estimated fetal weight, recognition and management of tachysystole, pelvic exam, and reassuring fetal status

Note: * See reference for list of included ICD-9 codes: Healthy People. (2013). 2020 Topics and Objectives: Maternal, Infant, and Child Health. Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=26.

Key

√ Process Measure
◊ Outcome Measure
† Composite Measure
‡ Administrative Data Only
Δ Medical Record Review Required

ACNM and Main, et al. (2004) also measure the timing of labor induction, but measure the rate of inductions that take place before 41 completed weeks of gestation. Additionally, Main, et al. (2004) propose measuring the rate of labor admissions at greater than or equal to three centimeters cervical dilation for the selected primipara population (NTSV; nulliparous, term pregnancy, singleton fetus, vertex presentation). The Institute for Healthcare Improvement (IHI) has developed two composite measures to assess the prevalence of safe clinical practices during elective labor induction and augmentation. The elective induction bundle compliance indicator measures the proportion of elective inductions initiated with oxytocin in which all four elements of the bundle are in place; the bundle components require a gestational age greater than or equal to 39 weeks, recognition and management of tachysystole, pelvic exam/pelvic assessment, and reassuring fetal status/normal fetal status (using NICHD 3-Tier System). Bundle compliance for patients given oxytocin for augmentation of labor requires documentation of estimated fetal weight, recognition and management of tachysystole, pelvic assessment, and reassuring fetal status/normal fetal status. Apart from the ACHS and ACNM measures, all other measures for labor induction, augmentation, and elective delivery require chart review.

Vaginal Birth and Vaginal Birth After Cesarean (VBAC)

Two entities (ACHS and ACNM) utilize measures of vaginal birth rates. The American College of Nurse Midwives measures both total vaginal birth (all vaginal deliveries, including instrumental) and spontaneous vaginal birth (which excludes cases of instrument-assisted vaginal delivery). The Australian Council on Healthcare Standards measures instrumental vaginal birth and spontaneous vaginal birth separately, and also measures the proportion of women receiving a blood transfusion during their admission for vaginal delivery. Haikin and Mankuta (2012)

propose an indicator to track the optimal range of vacuum cup placement on the neonatal head during vacuum-assisted vaginal delivery. This indicator would require nurses to measure the position of the imprint of the vacuum cup on the neonatal head and record in the chart for data collection.

Measurements identified for vaginal birth after cesarean (VBAC) varied minimally. ACNM and RCOG all measure the overall VBAC rate, or the proportion of vaginal births in women with a previous cesarean delivery. ACHS limits the calculation of the VBAC rate to women with only one prior cesarean birth. AHRQ distinguishes between the overall VBAC rate and the uncomplicated VBAC rate that excludes cases of abnormal presentation, preterm delivery, fetal death, and multiple gestation. All vaginal birth and VBAC measures can be utilized with administrative data only (see Introduction for definition of *administrative data*).

Perineal Management and Outcome

Among indicators that were classified into clinical categories, measures relating to perineal management and outcomes occurred with the third greatest frequency. Incidence of episiotomy was the most common measure, utilized by entities such as ACHS, ACNM, the Leapfrog Group, and the National Quality Forum (NQF), and is under consideration for endorsement by PCPI. While the most entities simply measure a crude episiotomy rate, measures developed by ACHS provide a slightly more detailed tracking of episiotomy outcomes by measuring the proportion of selected primipara (age 20-34, singleton, term fetus in cephalic presentation) undergoing episiotomy and sustaining no vaginal tear versus those undergoing episiotomy and also sustaining a vaginal laceration. Main, et al. (2004) also limit their measurement of episiotomy incidence to those occurring in selected, low risk, primipara

population (term, singleton fetus in vertex position). Soong, et al. (1999) proposed two measures to track rates of episiotomy and intact lower genital tract for midwives only; these indicators exclude instrumental deliveries as these are out of the scope of practice of midwives.

The second most common perineal indicators were measures of obstetric trauma or 3rd and 4th degree perineal laceration rates. ACHS, AHRQ, and Main, et al. have all developed such indicators, but differ in how they propose to measure them. ACHS and Main, et al. use the same selected primiparous population to standardize for comparison. However, Main, et al. (2004) propose a single measure that includes both 3rd and 4th degree lacerations, whereas ACHS tracks 3rd and 4th degree lacerations separately. ACHS also includes an additional measure that tracks the incidence of any perineal laceration in the absence of episiotomy for the selected primipara population. AHRQ uses a measure that includes both 3rd and 4th degree lacerations, but tracks the incidence separately for instrumental versus non-instrumental vaginal deliveries. Both ACHS and ACNM measure positive perineal outcomes by tracking rates of intact perineum (ACHS and ACNM) or unsutured perineal tear (ACHS only) following vaginal delivery. The Royal College of Obstetricians and Gynaecologists (RCOG) looks at the timeliness of perineal repair by measuring the percentage of women with an episiotomy or tear sutured within one hour. Aside from the single RCOG measurement that requires chart review, all perineal measurements can be used with administrative data only.

Cesarean Delivery

The most basic cesarean measures identified were the annual number of cesarean deliveries and the cesarean delivery rate (i.e. proportion of cesareans of all live births in a given time period). These measures are utilized by organizations such as AHRQ, ACNM, and the

World Health Organization (WHO) in conjunction with other UN agencies and the Averting Maternal Death and Disability (AMDD) program at Columbia University. The Agency for Healthcare Research and Quality and ACNM have also used or proposed the use of the primary cesarean delivery rate or the number of women having their first cesarean delivery out of all live births. Some organizations and authors further refined this indicator to measure the primary cesarean section rate for a specified population, most commonly for low-risk women (i.e. nulliparous women with term, singleton, vertex position fetus). The Australian Council on Healthcare Standards, AHRQ, California Maternal Quality Care Collaborative (CMQCC), Healthy People 2020, National Quality Forum (NQF), the Joint Commission, the Leapfrog Group, and RCOG all utilize this measure, and it is under consideration for endorsement by PCPI. In addition, Healthy People 2020 utilizes the rate of repeat cesarean delivery (i.e. the proportion of women with a previous cesarean delivery having a subsequent cesarean delivery).

The Australian Council on Healthcare Standards, Hospital Corporation of America (HCA), and NQF propose measuring the proportion of women who receive appropriate thromboprophylaxis prior to a cesarean section. Australian Council on Healthcare Standards, Massachusetts General/Partners Healthcare System, and NQF support assessing the proportion of women receiving appropriate antibiotic prophylaxis with a cesarean. Australian Council on Healthcare Standards includes the proportion of women having general anesthesia for cesarean delivery, as well as the proportion receiving a blood transfusion during their admission for cesarean delivery in their set of quality of care measures. RCOG-supported indicators include the proportion of cesarean sections indicated for fetal distress or maternal emergency in which the decision-to-delivery interval is 30 minutes. In contrast, NYSPQC measures the percent of scheduled cesarean sections between 36 and 39 completed weeks of gestation without

documentation of maternal or fetal indication. Apart from the four indicators that require chart review (thrombo- and antibiotic prophylaxis, timing of emergency cesarean delivery, scheduled cesarean without documented reason), all other 15 cesarean delivery indicators can be assessed using administrative data alone.

Maternal Morbidity and Mortality

Healthy People 2020 measures the incidence of pregnant women suffering complications during hospitalized labor and delivery using discharge diagnosis or procedure coding. Indicators were also identified that measured rates of specific morbidity outcomes. The Royal College of Obstetricians and Gynaecologists measures the percentage of women with a postpartum hemorrhage of 2,500 ml or more. Graham, et al. (2000) propose a set of audit indicators to track morbidity outcomes, including rates of primary postpartum hemorrhage (within 24 hours of delivery), eclampsia, obstructed labor, uterine rupture, and chorioamnionitis. Martijn, et al. (2012) have also proposed several outcome measures to track maternal morbidity, including percentages of maternal anemia, complicated instrumental or cesarean birth, and prolonged maternal hospitalization. Luitjes, et al. (2013) have developed a set of 14 clinical indicators to measure the quality of care for women with hypertensive disorders of pregnancy. Four indicators were selected as being amenable to use during hospitalization during labor and delivery. For preeclamptic patients, an indicator tracks the percentage of women with significantly elevated blood pressure who are medically treated, while another tracks the percentage of women who achieve a blood pressure level within the desired range. For women with severe preeclampsia, one indicator tracks the percentage of women in which the treatment is medical, while another tracks the percentage of women that are adequately stabilized before delivery or transport to a

higher level facility. In addition, two EmOC indicators measure obstetric case fatality rates for direct obstetric causes versus indirect causes. All the above indicators of maternal morbidity and mortality can be utilized with administrative data, however composite maternal morbidity indicators exist that will be discussed below.

Miscellaneous Measures

Several notable indicators were identified that did not fall into the above named clinical categories. Chalmers and Porter (ref) have developed an indicator that requires chart review to measure the presence of any skilled healthcare provider during labor and birth, and it is designed for use primarily in developing countries. Additionally, RCOG measures the of percentage of births by location, percentage of singleton breech pregnancies where external cephalic version was attempted, as well as the percentage of women that are attended to by an anesthetist within 30 or 60 minutes of requesting epidural anesthesia. American College of Nurse Midwives tracks overall rates of epidural anesthesia use and maternal length of stay from the time of delivery to discharge. Finally, Martijn, et al. (2012) propose an indicator that tracks the number of incidents due to incorrect prescription, dosage, or administration of medication during the process of care for labor and delivery hospitalizations. Among the miscellaneous measures, two are amenable to use with administrative data only and three require medical chart review.

Composite Measures

Anastakis and Antsaklis (2007) propose the Maternity Unit Performance Index (MUPI), a composite measure that allows a maternity unit to track its performance over time and compare it to that of other units. A numeric contributor index (+1, +0.5, -1, -0.5) assigns positive and

negative values to various clinical process and outcomes (such as vaginal delivery, cesarean delivery, perineal lacerations, and blood transfusions) based on their contribution toward achieving vaginal birth and optimal outcomes. Negative scores reflect cesarean delivery or suboptimal outcomes. The index is then used to develop a numeric MUPI value for each individual laboring woman from a selected population (primipara with term, singleton fetus). The mean annual MUPI is then calculated and used for tracking and comparison of unit performance over time. This indicator requires medical chart review.

Chalmers and Porter (2001) propose the Bologna score as a measure of how normal labor is managed in a given setting among women who present in spontaneous labor and whose labor is assisted by a skilled attendant. The measure consists of five components of normal labor (presence of a birth companion, use of a partogram, absence of labor augmentation, use of a non-supine position for birth, and skin-to-skin contact of mother and baby). Using chart review, each component is given either a 1 or 0 if it is present or absent, respectively, for a maximum score of five indicating effective management of normal labor. Calculation of the Bologna score requires medical chart review.

Cragin and Kennedy (2006) propose the Optimality Index-US (OI-US) which seeks to measure perinatal health optimality defined as "the maximal perinatal outcome with minimal intervention placed against the woman's social, medical, and obstetrical history". Using another proposed measure, the Perinatal Background Index (PBI), the authors suggest that a woman's general health status upon entering pregnancy can be estimated and expressed as a percentage, with a higher percentage signifying better health status. This can allows for the comparison of outcomes among women relative to their health status upon entering pregnancy. The OI-US consists of 40 care processes and outcomes that are given either a 1 or 0 based if the process or

outcome is optimal or not, respectively. This indicator is not used for risk assessment of individual laboring patients, but for a group of women; higher OI-US scores signify a more optimal balance between the interventions performed and the outcomes observed. Calculation of the OI-US requires medical chart review.

Haney et al. (1999) propose two measures, the optional vaginal delivery rate and the provider delivery score, that seek to promote more aggressive approaches to achieving vaginal delivery as opposed to performing potentially avoidable cesarean sections. Using chart review, vaginal deliveries are categorized as "optional vaginal delivery" if a cesarean section could have been an appropriate alternative in the given clinical setting. In this way, the measure rewards clinicians for avoiding unnecessary cesarean sections. Also proposed is a provider-specific delivery score whereby practitioners receive credit for each vaginal delivery and additional credit for achieving vaginal delivery in difficult circumstances, while credit is deducted for potentially avoidable cesareans. Both measures require medical chart review.

CHAPTER 4: Discussion, Implications, and Recommendations

Statement of Principle Findings

No nationally- or internationally-accepted set of clinical indicators exists to routinely measure the quality of obstetric care during childbirth. This primary aim of this research project was to identify current measures proposed in the published and unpublished literature for this purpose, and to examine which clinical aspects of care the indicators measure. The review identified 93 clinical indicators that have been proposed to measure the quality of care during hospitalization for childbirth. As a comprehensive set, the identified indicators cover a range of care processes and outcomes including labor induction and augmentation, elective delivery,

vaginal birth, vaginal birth after cesarean, perineum care, cesarean section, and maternal morbidity and mortality, and several composite measures incorporate multiple patient and obstetric care aspects. Based on the number of indicators identified, cesarean section and labor induction, augmentation, or elective delivery are the two most common clinical categories for measurement tracking, followed by maternal morbidity and mortality and perineum care. This order reflects recent trends in obstetric practices -- rising cesarean delivery and labor induction rates and an increased focus on reducing the number of early elective deliveries and poor maternal outcomes.

The indicators identified varied by type (process vs. outcome vs. composite) and data source needed for assessment (administrative vs. medical records), with notable differences between those arising from the published versus unpublished (or "gray") literature. For both literature sources, the majority of indicators are individual type assessments with a numerator and denominator (82% published and 97% unpublished). Comparatively, the published literature had more composite measures than the gray literature (5 versus 2, respectively), however composite measures were relatively uncommon overall. Indicators in the unpublished literature were more likely to be process measures (63%), whereas the published literature was relatively evenly divided between process and outcome measures (43% and 39%, respectively). Indicators identified in the published literature were overwhelmingly more likely to require medical record review compared to those in the unpublished literature (82% versus 34%).

Process measures tend to be more useful for quality improvement as they can identify specific areas of care upon which improvement efforts can focus (Rice Simpson, 2006). They measure *how* obstetrics is practiced and are useful for tracking the quality of clinical practice and adherence to evidence-based care. Outcome measures focus on the end result of the care being

provided, regardless of the provider or processes of care, and "do not give an insight into the nature and location of the deficiencies or strengths to which the outcome might be attributed" (Donabedian, 1966). However outcome indicators are typically characterized by greater reliability than process indicators, and are often used to measure the health outcomes that individuals and societies value. However, alone, neither process nor outcome measures provide a complete picture of the quality of obstetric care, and any quality improvement effort or assessment of quality of care will be more informative if it utilizes a combination of both process and outcome indicators.

The indicators identified in this review were overwhelmingly individual as opposed to composite indicators (92% and 8%, respectively). Not only are individual indicators easier to calculate and interpret, but also measuring a single care process or outcome allows one to easily tease out where to focus improvement efforts (NQMC, 2013; Donebedian, 1966). Conversely, composite measures allow for a more comprehensive assessment of quality of care given that they take multiple clinical factors into account, including patient and provider, process and outcome measures. Composite measures typically involve more complex calculations, often a scoring system that requires clinical detail from medical chart review (all composite measures identified in this study required chart review). The fact that few composite measures were present in the literature overall, and even fewer when the unpublished literature is considered alone (only two were identified), provides more evidence that individual indicators may be more amenable to actual use in routine practice and for regular monitoring at the patient, facility and hospital levels.

Importantly, the majority of indicators identified in the unpublished literature were usable with administrative data alone, specific to the level of measurement (i.e.- national, state, facility,

provider). Administrative data consists of routinely collected hospital discharge data, as well as claims and encounter data from both public (e.g. Medicaid and the Veteran's Health Administration) and private insurers (data available through external vendors such as MedStat and Mercer) (Riley, 2009). Administrative data includes patient demographics, as well as diagnostic and procedure codes. Individuals without extensive medical training can easily collect administrative data, as it does not involve medical chart review. Additionally, compiling and analyzing administrative data is often a relatively expedient process as the data is already routinely collected and stored in a database for use. For these reasons, indicators that need only administrative data seem more to be more feasible for actual use. Administrative data do however have significant limitations. Diagnostic codes and demographics alone are often unable to provide sufficient clinical detail regarding care processes, and coding errors and variations can significantly influence data quality (Rice Simpson, 2006).

The need for medical chart review is more common among the indicators proposed in the published literature. Chart review is beneficial as a data source, especially for process indicators, as it has the ability to provide ample clinical detail, including the timing of procedures. Yet chart review requires more time for data abstraction, and often requires that data abstractors have a basic understanding of clinical care processes, evidence-based practice, and medical terminology (Donabedian, 1966; Rice Simpson, 2006). There is some evidence, however, that individuals with limited medical training but who are highly trained as clinical data abstractors have comparable validity completing medical chart review when compared to physicians (Donabedian, 1966).

The collection of indicators identified was split relatively evenly between U.S. and international sources (51% and 49%, respectively), however three fifths (60%) of U.S. indicators

were found in the unpublished literature, while 71% of international indicators were found in the published literature. Regarding indicator characteristics, U.S. indicators were more often composite measures than international indicators (11% versus 4%, respectively), more often process measures (68% versus 46%, respectively), and less likely to require chart review (43% versus 54%, respectively). This may reflect the fact that U.S. indicators were more likely to be from the unpublished literature, and indicators in the unpublished literature were more likely to be process indicators requiring only administrative data for calculation.

Strengths and Weaknesses of the Study

The design of this systematic review was strengthened by the inclusion of clinical indicators from the unpublished literature. This allowed insight into the indicators that are currently in use by obstetric quality assurance and accreditation organizations (e.g. The Joint Commission), as well as key international organizations. Inclusion criteria allowed the identification of indicators that can be easily integrated into clinical practice due to the accessibility of data sources, as well as those that are most conducive to quality improvement initiatives (i.e. both process and outcome indicators). Several studies considered for inclusion were excluded from the final review as they proposed composite indicators that could not be calculated without the inclusion of neonatal outcomes (Gregory et al., 2009; Mann et al., 2006; Roberts et al., 2008), and although one study proposed a variation on the measurement of cesarean delivery (the age-adjusted cesarean delivery rate), it was excluded as it was not proposed as a quality measure (Main et al., 2006). Inclusion and exclusion criteria also limited the scope of indicators identified, in effect failing to capture elements such as patient satisfaction and input or structural measures that influence the processes and outcomes of care.

Unanswered Questions and Future Research

As part of the research project, evaluation of the indicators against some set of quality criteria was considered. Both the Institute of Medicine (IOM) quality aims and the National Quality Forum's (NQF) measure evaluation criteria were considered as frameworks, however evaluation against IOM aims was felt to be unduly influenced by author subjectivity, while use of the NQF measure criteria would have biased the evaluation of indicators in favor of those already endorsed by NQF. Going forward, it would be important for the indicators identified in this research project to be evaluated for quality, validity, and reliability as a set to determine the most effective measures for quality improvement.

Notably, none of the indicators identified were designed to address potential racial or ethnic disparities in clinical processes and outcomes. As presented previously, one of the most significant trends within the rising U.S. maternal morbidity and mortality rates is the stark contrast between outcomes among non-Hispanic White women and women of other racial and ethnic backgrounds, with women who belong to racial and ethnic minorities experiencing a disproportionate burden of disease, disability, and death as a result of childbirth. Further research is needed to understand the nature and etiology of these disparities, as well as a review of clinical indicators that could be used to equilibrate risk based on race and ethnicity while improving the quality of obstetric care for all women.

In addition, it would be beneficial for this research project to be replicated for other aspects of obstetric care. When evaluating the quality and safety of obstetric care during childbirth, it is important to consider what is often referred to as the "3 delays," or three potential obstacles during the process of a woman receiving timely medical care during labor and delivery. Opportunities for a delay in care occur first when the woman makes the initial decision to seek

care, again when the woman has to make the journey to the care facility, and lastly during the time between the woman's arrival at the facility and when she is treated. While these delays can be greatly problematic in developing countries, they have been largely mitigated in most developed countries for several reasons. Women in developed countries are typically not as tied to domestic responsibilities, and gender norms allow women to make decisions to freely leave the home and seek medical care for themselves. Furthermore, reliable transportation and passable roadways are more likely to be present in developed regions, whereas many developing countries experience long rainy seasons that can make unpaved roads impassable for extended periods of time. While a laboring woman in a developed country may be met with highly trained staff upon arrival at the facility, women in developing regions often arrive to find a shortage of adequately trained providers and may experience grave delays in receiving life-saving treatment. Although these delays are less often a problem in developed countries, women living in rural or impoverished areas of developed countries may experience similar obstacles to those in developing regions.

The focus of this research project was to identify indicators that have been proposed to measure the quality of the care received once a woman is at the healthcare facility for delivery. As the "three delays" greatly influence a woman's ability to access care (and the health status she presents in upon arrival), it would be beneficial to conduct research to identify quality indicators that can be used to evaluate the process of care-seeking for women in labor. Furthermore, recreating this research project for antenatal and postpartum care (through 6 weeks post-delivery) would identify additional quality indicators that could be used to more comprehensively evaluate the continuum of obstetric care.

Implications and Recommendations for Clinicians and Policymakers

This research project has shown not only that a wealth of indicators have been proposed to measure the quality of obstetric care during childbirth, but also that this vast array of indicators may make it challenging for those developing quality improvement initiatives to identify a cohesive set that is easy to use and captures multiple elements of quality care. As previously stated, quality improvement efforts including a both process and outcome indicators are more informative. Studies need to recognize the limitations based on the data source chosen (e.g. administrative data characterized by limited clinical detail, and chart review requiring more time and effort, as well as medically-trained data extractors). In light of recent calls to action to improve the quality of care during childbirth in the U.S., the indicators identified in this review can serve as a basis for developing a national standardized set of measures by which the practice and outcomes of obstetric care can be routinely measured and tracked over time. Implementation of obstetric quality measures on a national scale can identify gaps in care and serve to foster the development of evidence-based guidelines to improve the practice of obstetrics in specific clinical realms or for specific high-risk conditions.

Although the Joint Commission has included two new measures that will be required reporting for accreditation (i.e. early elective deliveries and cesarean section rate), these capture only a small part of what is needed to assess the quality of obstetric care. Furthermore, the required indicators lack specified target ranges for and hospitals have little incentive to go beyond simply reporting these rates to actually improving them. A possible incentive would be to tie care provider reimbursement to specific measurement targets for both the processes of care utilized and the resulting outcomes. This would likely be met with backlash from the medical community, and would place an increased burden on providers who serve a high-risk patient

population or racial/ethnic minority women. An alternative avenue is to require patient care facilities and practice groups to publicly report on an agreed upon set of measures, and allow patient demand to influence practices as patients can make a choice of which facilities or practices to patronize based on the reported statistics. Although Healthy People 2020 has set national targets for maternal morbidity and mortality, these have little influence on the day-to-day practice of obstetrics. A large-scale national obstetric quality improvement effort will require regulation, incentivizing, and measure tracking at multiple levels, from the national level down to the level of individual care providers. Improving the practice of obstetrics as well as maternal outcomes during childbirth must be made a national priority in the United States, and the comprehensive review of indicators presented in this research project is a step toward providing the means to do so.

REFERENCES

Agency for Healthcare Research and Quality (AHRQ). (2011). Quality Indicator Development. Retrieved from http://www.qualityindicators.ahrq.gov/Modules/Default.aspx.

Agency for Healthcare Research and Quality (AHRQ). (2013). National Quality Measures Clearinghouse. Retrieved from http://www.qualitymeasures.ahrq.gov/index.aspx.

American Academy of Family Physicians (AAFP). (2000). Elective induction doubles cesarean delivery rate. *American Family Physician, 61*(4), 1173.

Anastasakis, E.; Antsaklis, A. (2008). Maternity unit performance index. A novel approach for evaluation of the changing obstetric practice in a single maternity unit. *Archives of Gynecology and Obstetrics, 277*(2), 121-126.

Bailit, J. (2007). Measuring the quality of inpatient obstetric care. *Obstetrical and Gynecological Survey, 62*(3), 207-213.

Berg, C. J.; Harper, M. A.; Atkinson, S. M.; Bell, E. A.; Brown, H. L.; Hage, M. L.; Mitra, A. G.; Moise, K. J.; Callaghan, W. M. (2005). Preventability of pregnancy-related deaths: Results of a state-wide review. *Obstetrics and Gynecology, 106*(6), 1228-1234.

Berkowitz, G. S.; Fiarman, G. S.; Mojica, M. A.; Bauman, J.; de Regt, R. H. (1989). Effect of physician characteristics on the cesarean birth rate. *American Journal of Obstetrics and Gynecology, 161*(1), 146-149.

Bingham, D.; Strauss, N.; Coeytaux, F. (2011). Maternal mortality in the United States: A human rights failure. *Contraception, 83*(2011), 189-193.

Bryant, A.S.; Worjoloh, A.; Caughey, A.B., Washington, A.E. (2010). Racial/ethnic disparities in obstetric outcomes and care: Prevalence and determinants. *American Journal of Obstetrics and Gynecology, 202*(2010), 335-343.

Callaghan, W. M.; Creanga, A. A.; Kuklina, E. V. (2012). Severe maternal morbidity among delivery and postpartum hospitalizations in the United States. *Obstetrics and Gynecology, 0*(0), 1-7.

California Maternal Quality Care Collaborative (CMQCC). (2008). Maternity Quality Measures. Retrieved from http://www.cmqcc.org/maternity_quality_measures.

Centers for Disease Control and Prevention (CDC). (2013). Pregnancy mortality surveillance system. Retrieved from http://www.cdc.gov/reproductivehealth/MaternalInfantHealth/PMSS.html.

Centers for Disease Control and Prevention (CDC). (2013). Reproductive health: State perinatal quality collaboratives. Retrieved from http://www.cdc.gov/reproductivehealth/MaternalInfantHealth/PQC-States.html.

Centers for Medicare and Medicaid Services (CMS). (2013). Adult Health Care Quality Measures. Retrieved from http://www.medicaid.gov/Medicaid-CHIP-Program-Information/By-Topics/Quality-of-Care/Adult-Health-Care-Quality-Measures.html.

Chalmers, B.; Porter, R. (2001). Assessing effective care in normal labor: The Bologna score. *Birth, 28*(2), 79-83.

Cragin, L.; Kennedy, H. P. (2006). Linking obstetric and midwifery practice with optimal outcomes. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 35*(6), 779-785.

Creanga, A. A.; Berg, C. J.; Syverson, C.; Seed, K.; Bruce, F. C.; Callaghan, W. M. (2012). Race, ethnicity, and nativity differentials in pregnancy-related mortality in the United States: 1993-2006. *Obstetrics and Gynecology, 120*(2), 261-268.

Donabedian, A. (1966). Evaluating the quality of medical care. *The Millbank Memorial Fund Quarterly, 44*(3), 166-203.

EURO-PERISTAT Project with SCPE and EUROCAT. (2013). European perinatal health report: The health and care of pregnant women and babies in Europe 2010. Retrieved from http://europeristat.com/images/European%20Perinatal%20Health%20Report_2010.pdf.

Glantz, J. C. (2005). Elective induction vs. spontaneous labor associations and outcomes. *Journal of Reproductive Medicine, 50*(4), 235-240.

Graham, W.; Wagaarachchi, P; Penney, G.; McCaw-Binns, A.; Antwi, K. Y.; Hall, M. H. (2000). Criteria for clinical audit of the quality of hospital-based obstetric care in developing countries. *Bulletin of the World Health Organization, 78*(5), 614-620.

Gregory, K.D.; Fridman, M.; Shah, S.; Korst, L. M. (2009). Global measures of quality- and patient safety-related childbirth outcomes: should we monitor adverse or ideal rates? *American Journal of Obstetrics and Gynecology, 200*(6), 681-687.

Gould, J. B.; Danielsen, B.; Korst, L. M.; Phibbs, R.; Chance, K.; Main, E.; Wirtschafter, D. D.; Stevenson, D. K. (2004). Cesarean delivery rates and neonatal morbidity in a low-risk population. *Obstetrics and Gynecology, 104*(1), 11-19.

Goyert, G. L.; Bottoms, S. F.; Treadwell, M. C.; Nehra, P. C. (1989). The physician factor in cesarean birth rates. *New England Journal of Medicine, 320*(11), 706-709.

Haikin, E. H.; Mankuta, D. (2012). Vacuum cup placement during delivery--a suggested obstetric quality assessment measure. *Journal of Maternal, Fetal, and Neonatal Medicine, 25*(10), 2135-2137.

Haney, E. I.; Reiter, J. A.; MacGregor, S. N.; Silver, R. K. (1999). Optional vaginal delivery rate. An informative indicator of intrapartum care. *Journal of Reproductive Medicine, 44*(10), 842-848.

Healthy People. (2013). 2020 Topics and Objectives: Maternal, Infant, and Child Health.

Retrieved from http://www.healthypeople.gov/2020/topicsobjectives2020/objectiveslist.aspx?topicId=26.

Institute for Healthcare Improvement (IHI). (2013). The IHI Improvement Map. Retrieved from http://www.ihi.org/offerings/Initiatives/Improvemaphospitals/Pages/default.aspx.

Institute of Medicine (IOM). (2001). Crossing the Quality Chasm: A New Health System for the 21st Century (Executive Summary). Retrieved from http://iom.edu/Reports/2001/Crossing-the-Quality-Chasm-A-New-Health-System-for-the-21st-Century.aspx.

Institute of Medicine (IOM). (2013). Announcement: Crossing the Quality Chasm: The IOM Health Care Quality Initiative, IOM Definition of Quality. Retrieved from http://www.iom.edu/Global/News%20Announcements/Crossing-the-Quality-Chasm-The-IOM-Health-Care-Quality-Initiative.aspx.

Korfine, L. (2011). Elective inductions: Current research and resources [report]. *Citizens for Midwifery*. Retrieved from http://cfmidwifery.org/pdf/Elective%20induction%20--September%202011.pdf.

Lawrence, H.C., et al. (2012). Quality patient care in labor and delivery: A call to action. *American Journal of Obstetrics and Gynecology, 207*(3), 147-148.

Luitjes, S. H.; Wouters, M. G.; Franx, A.; Bolte, A. C.; de Groot, C. J.; vanTulder, M. W.; Hermens, R. P. (2013). Guideline-based development of quality indicators for hypertensive diseases in pregnancy. *Hypertension in Pregnancy, 32*(1), 20-31.

Luthy, D. A.; Malmgren, J. A.; Zingheim, R. W.; Leininger, C. J. (2003). Physician contribution to a cesarean delivery risk model. *American Journal of Obstetrics and Gynecology, 188*(6), 1579-1587.

Main, E. K.; Bloomfield, L.; Hunt, G.; Sutter Health, First Pregnancy and Delivery Clinical Initiative Committee. (2004). Development of a large-scale obstetric quality-improvement program that focused on the nulliparous patient at term. *American Journal of Obstetrics and Gynecology, 190*(6), 1747-1756.

Main, E. K.; Moore, D.; Farrell, B.; Schimmel, L. D.; Altman, R. J.; Abrahams, C.; Campbell Bliss, M.; Polivy, L.; Sterling, J. (2006). Is there a useful cesarean birth measure? Assessment of the nulliparous term singleton vertex cesarean birth rate as a tool for obstetric quality improvement. *American Journal of Obstetrics and Gynecology, 194*(2006), 1644-1652.

Main, E. K.; Bingham, D. (2008). Quality improvement in maternity care: Promising approaches from the medical and public health perspective. *Current Opinion in Obstetrics and Gynecology, 20*(2008), 574-580.

Main, E. K. (2009). New perinatal quality measures from the National Quality Forum, the Joint Commission and the Leapfrog Group. *Current Opinion in Obstetrics and Gynecology, 21*(2009), 532-540.

Mann, S., et al. (2006). Assessing quality in obstetric care: Development of standardized measures. *Journal on Quality and Patient Safety, 32*(9), 497-505.

Martijn, L.; Jacobs, A.; Harmsen, M.; Maassen, I.; Wensing, M. (2012). Patient safety in midwifery care for low-risk women: instrument development. *Journal of Midwifery and Women's Health, 57*(4), 386-395.

National Quality Forum (NQF). (2013). Measures, Clinical Condition/Topic Area: Perinatal and Reproductive Health. Retrieved from http://www.qualityforum.org/Qps/QpsTool.aspx.

National Quality Measures Clearinghouse (NQMC). (2012). Australian Council on Healthcare

Standards: Obstetrics. Retrieved from http://www.qualitymeasures.ahrq.gov/browse/by-organization-indiv.aspx?orgid=1984&term=obstetrics.

National Quality Measures Clearinghouse (NQMC). (2013). Glossary. Retrieved from http://www.qualitymeasures.ahrq.gov/about/glossary.aspx.

Rice Simpson, K. (2006). Measuring perinatal patient safety: Review of current methods. *Journal of Obstetric, Gynecologic, and Neonatal Nursing, 35*(3), 432-442.

Riley, G. F. (2009). Administrative and claims records as sources of health care cost data. *Medical Care, 47*(7), S51-S55.

Russo, A. C.; Andrews, R. M.; Barrett, M. (2008). Racial and ethnic disparities in hospital patient safety events, 2005. *HCUP Statistical Brief #53*. Agency for Healthcare Research and Quality.

Roberts, C. L.; Cameron, C. A.; Bell, J. C.; Algert, C. S.; Morris, J. M. (2008). Measuring maternal morbidity in routinely collected health data: development and validation of a maternal morbidity outcome indicator. *Medical Care, 46*(8), 786-794.

Siston, A. M.; Rasmussen, S. A.; Honein, M. A.; Fry, A. M.; Seib, K.; Callaghan, W. M.; Louie, J.; Doyle, T. J.; Crockett, M.; Lynfield, R.; Moore, Z.; Wiedeman, C.; Anand, M.; Tabony, L.; Nielsen, C. F.; Waller, K.; Page, S.; Thompson, J. M.; Avery, C.; Springs, C. B.; Jones, T.; Williams, J. L.; Newsome, K.; Finelli, L.; Jamieson, D. J. (2010). Pandemic 2009 influenzea A (H1N1) virus illness among pregnant women in the United States. *Journal of the American Medical Association, 303*(15), 1517-1525.

Soong, B.; Grimes, K.; Baade, P. (1999). The development of clinical indicators--the impact on midwifery practice in Queensland in the future. *Australian College of Midwives Incorporated Journal, 12*(2), 26-31.

The Joint Commission. (2011). Core Measure Sets: Perinatal Care. Retrieved from http://www.jointcommission.org/core_measure_sets.aspx.

The Joint Commission. (2010). Preventing Maternal Death. *Sentinel Event Alert, 44*(Jan 26, 2010). Retrieved from http://www.jointcommission.org/assets/1/18/SEA_44.PDF.

The Joint Commission. (2013). Specifications Manual for Joint Commission National Quality Measures (v2013B): Perinatal Care (PC). Retrieved from https://manual.jointcommission.org/releases/TJC2013B/PerinatalCare.html.

The Leapfrog Group. (2012). The Leapfrog Hospital Survey Reference Book: Normal Deliveries Measures References, pp 113-122. Retrieved from https://leapfroghospitalsurvey.org/wp-content/uploads/2012/03/2012SurveyReference.pdf.

Tucker, M. J.; Berg, C. J.; Callaghan, W. M.; Hsia, J. (2007). The Black-White disparity in pregnancy-related mortality from 5 conditions: Differences in prevalence and case-fatality rates. *American Journal of Public Health, 97*(2), 247-251.

United Nations (UN), World Health Organization (WHO). (2012). Indicators for Monitoring the Millennium Development Goals, Goal 5: Improve maternal health. Retrieved from http://mdgs.un.org/unsd/mi/wiki/MainPage.ashx.

Watts, L. A.; de Bocanegra, H. T.; Darney, P. D.; Hulett, D.; Howell, M.; Mikanda, J.; Zerne, R.; Policar, M. S. (2012). In a California program, quality and utilization reports on reproductive health spurred providers to change. *Health Affairs, 31*(4), 852-862.

World Health Organization (WHO). (2012). Trends in maternal mortality: 1990-2010, WHO, UNICEF, UNFPA, and The World Bank estimates. Retrieved from http://whqlibdoc.who.int/publications/2012/9789241503631_eng.pdf.

Young, B. C.; Hacker, M. R.; Dodge, L. E.; Golen, T. H. (2012). Timing of antibiotic

administration and infectious morbidity following cesarean delivery: Incorporating policy change into workflow. *Archives of Obstetrics and Gynecology, 285*(2012), 1219-1224.

Zibrat, Frank. (2013). Performance measurement. *Joint Commission Online*. Retrieved from http://www.jointcommission.org/issues/article.aspx?Article=%2fNm2cIJcBIUvzQTGxhp3pW2kJ7ntpLWaW1Dimh7G9l4%3d.

APPENDIX

Table A1. List of organization websites searched for potential inclusion in review (n = 66)

Category	Organization
Perinatal Quality Collaboratives (n = 42)	Alabama Perinatal Excellence Collaborative American Medical Association Physician Consortium for Performance Improvement National Institute of Child Health and Human Development: Maternal-Fetal Medicine Units Network National Perinatal Information Center – Quality Analytic Services California Maternal Quality Care Collaborative California Perinatal Quality Care Collaborative Childbirth Connection Colorado Perinatal Care Council Delaware Perinatal Cooperative Florida Perinatal Quality Collaborative Hawaii Collaborative Health Initiative Indiana Perinatal Quality Improvement Collaborative Kansas Perinatal Quality Collaborative Louisiana Birth Outcomes Initiative March of Dimes Maryland Hospital Quality Indicator Project Maryland Patient Safety Center: Perinatal Collaborative Massachusetts Perinatal Quality Collaborative Maternal Quality Collaborative of North Carolina Michigan Health and Hospital Association, Keystone Center for Patient Safety and Quality, Obstetrics National Perinatal Information Center Neonatal Quality Improvement Collaborative of Massachusetts New Jersey Hospital Association Perinatal Collaborative New York State Perinatal Quality Collaborative Northern Connecticut Neonatal-Perinatal Collaborative Northern New England Perinatal Quality Improvement Network Office of Perinatal Quality Improvement (University of Oklahoma) Ohio Perinatal Quality Collaborative Oregon State Obstetric and Pediatric Research Collaboration Pennsylvania Perinatal Partnership Perinatal Quality Collaborative of Illinois Perinatal Quality Collaborative of North Carolina Premier Perinatal Safety Initiative South Carolina Birth Outcomes Initiative Tennessee Initiative for Perinatal Quality Care United Hospital Fund/Greater New York Hospital Association Perinatal Safety Collaborative Vermont Oxford Network NIC/Q Neonatal Quality Improvement Collaborative Virginia Regional Perinatal Councils Washington Obstetrics Clinical Outcomes Assessment Program Washington State Perinatal Quality Collaborative West Virginia Perinatal Partnership Wisconsin Neonatal Perinatal Quality Collaborative
Quality Assurance or Quality Promotion Organizations (n = 13)	Agency for Healthcare Research and Quality American Health Quality Association Australian Council on Healthcare Standards Canadian Institute for Health Information Healthy People 2020 Hospital Corporation of America Institute for Clinical Systems Improvement

	Institute for Healthcare Improvement Institute of Medicine National Committee for Quality Assurance National Quality Forum The Leapfrog Group The Joint Commission
Professional Organizations & International Bodies (n = 9)	American College of Nurse Midwives American Congress of Obstetrics and Gynecology American Medical Association Association of Women's Health, Obstetric, and Neonatal Nurses International Confederation of Midwives Midwives Alliance of North America Royal College of Obstetricians and Gynaecologists United Nations World Health Organization
Healthcare Systems (n = 2)	Christiana Healthcare System Massachusetts General Hospital/Partners Healthcare System

Table A2. Description of organizations included in final review (n = 18)

Organization	**Description**
Agency for Healthcare Research and Quality (AHRQ)	Governmental agency housed under the U.S. Department of Health and Human Services (HHS) with the aim of promoting safety, quality, and efficiency of healthcare. The National Quality Measure Clearinghouse (NQMC) is an initiative of AHRQ consisting of a database for information on specific evidence-based health care quality measures and measure sets. The NQMC mission is to provide an accessible mechanism for obtaining detailed information on quality measures, and to further their dissemination, implementation, and use in order to inform health care decisions. The HHS Measure Inventory is a separate repository of measures currently being used by the agencies of the U.S. Department of Health and Human Services for quality measurement, improvement, and reporting. *Source:* Agency for Healthcare Research and Quality (AHRQ). (2013). About Us. Retrieved from http://www.ahrq.gov/about/index.html, and U.S. Department of Health and Human Services (HHS) Measure Inventory. Retrieved from http://www.qualitymeasures.ahrq.gov/hhs/index.aspx; National Quality Measure Clearinghouse (NQMC) (2013) Retrieved from http://qualitymeasures.ahrq.gov.
American College of Nurse Midwives (ACNM)	U.S.-based professional organization for Certified Nurse Midwives, Certified Midwives, and affiliated persons. *Source:* American College of Nurse Midwives (ACNM). (2010). About ACNM. Retrieved from http://www.midwife.org/About-ACNM.
Australian Council on Healthcare Standards (ACHS)	An independent, not-for-profit organization that serves as Australia's leading healthcare assessment and accreditation provider. *Source:* Australian Council on Healthcare Standards (ACHS). (2012). About Us. Retrieved from http://www.achs.org.au/about-us.
Canadian Institute for Health Information (CIHI)	Independent, not-for-profit corporation that aims to contribute to the improvement of the health of Canadians and the health care system by disseminating quality health information. CIHI has developed information standards that allow every jurisdiction to understand, compare and use the data effectively. Source: Canadian Institute for Health Information 2013. Vision and Mandate. Retrieved from http://www.cihi.ca/CIHI-ext-portal/internet/EN/SubTheme/about+cihi/vision+and+mandate/cihi010703
California Maternal Quality Care Collaborative (CQMCC)	Perinatal quality collaborative based in the U.S. state of California with a focus on quality of maternal health care. *Source:* California Maternal Quality Care Collaborative (CQMCC). (2007). About Us. Retrieved from http://cmqcc.org/about.
Christiana Care Health System (CCHS)	A private, non-for-profit regional healthcare system located in Wilmington, Delaware that serves as one of the largest healthcare providers and teaching hospitals in the U.S. *Source:* Christiana Care Health System (CCHS). (2013). About Us. Retrieved from http://www.christianacare.org/about.
Healthy People 2020	A U.S. government initiative that aims to identify healthcare improvement priorities, define measurable objectives, and engage various sectors to improve healthcare practices, outcomes, and disparities. *Source:* Healthy People 2030. About Healthy People (2013). Retrieved from

	http://www.healthypeople.gov/2020/about/default.aspx
Hospital Corporation of America (HCA)	The United States' first hospital company that now serves as the nation's leading provider of healthcare services with a focus on quality improvement and cost-effective healthcare. *Source:* Healthy People 2020. (2012). About Healthy People. Retrieved from http://www.healthypeople.gov/2020/about/default.aspx.
Institute for Healthcare Improvement (IHI)	An independent, not-for-profit organization based out of Cambridge, Massachusetts with a focus on improving healthcare worldwide. *Source:* Institute for Healthcare Improvement (IHI). (2013). About IHI. Retrieved from http://www.ihi.org/about/pages/default.aspx.
Institute for Clinical Systems Improvement (ICSI)	An independent, non-profit health care improvement organization that unites clinicians, health plans, employers, policymakers and consumers to bring innovation and urgency to improve health, optimize the patient experience and make health care more affordable. ICSI is comprised of 50+ medical groups representing 9,000 physicians, and is sponsored by five Minnesota and Wisconsin non-profit health plans. ICSI supports process and quality improvement within health care groups. Source: The Institute for Clinical Systems Improvement (ICSI). (2013). About ICSI. Retrieved from https://www.icsi.org/about_icsi/
Massachusetts General Hospital/Partners Healthcare System	Partners Healthcare is an integrated healthcare system founded by Massachusetts General Hospital that seeks to provide a continuum of coordinated patient care with a focus on quality improvement and cost-effectiveness. *Source:* Massachusetts General Hospital. (2013). Partners HealthCare. Retrieved from http://www.massgeneral.org/partners.aspx.
National Quality Forum (NQF)	A U.S.-based non-profit, nonpartisan, public service organization that focuses on the improvement of healthcare by establishing priorities, identifying quality measures, and promoting achievement of national quality goals. *Source:* National Quality Forum (NQF). (2013). Who We Are. Retrieved from http://www.qualityforum.org/who_we_are.aspx.
New York State Perinatal Quality Collaborative (NYSPQC)	A perinatal quality collaborative initiated by the New York State Department of Health. *Source:* University at Albany. (2011). New York State Perinatal Quality Collaborative. Retrieved from http://www.albany.edu/sph/cphce/mch_nyspqc.shtml.
Royal College of Obstetricians and Gynecologists (RCOG)	United Kingdom-based professional organization for obstetricians and gynecologists and affiliated persons. *Source:* Royal College of Obstetricians and Gynecologists (RCOG). (2013). What We Do. Retrieved from http://www.rcog.org.uk/what-we-do.
The Joint Commission (JC)	A U.S.-based independent, not-for-profit organization that serves as the primary accreditor of U.S. healthcare facilities and is a major proponent of quality improvement. *Source:* The Joint Commission (JC). (2013). About Us. Retrieved from http://www.jointcommission.org/about_us/about_the_joint_commission_main.aspx.
The Leapfrog Group (LG)	A U.S.-based employer group that promotes quality improvement in healthcare through public reporting of quality measures.

	Source: The Leapfrog Group (LG). (2013). About Leapfrog. Retrieved from http://www.leapfroggroup.org/about_leapfrog.
United Nations (UN)	The UN is an intergovernmental organization that aims to promote and facilitate social progress, better living standards and human rights. The UN was founded in 1945 after World War II to replace the League of Nations, and currently has 193 member states. *Source:* United Nations (UN). (2013). Retrieved from http://www.un.org/en/aboutun/index.shtml
World Health Organization (WHO)	The WHO is the directing and coordinating authority for health within the United Nations system and works to shape the global health research agenda, set standards, disseminate evidence, and provide technical support to countries seeking to improve health trends. *Source:* World Health Organization (WHO). (2013). About WHO. Retrieved from http://www.who.int/about/en/.