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**Cost-effectiveness Analysis of Elective Repeat Cesarean Delivery and Trial of Labor**

**By**

**Elisa L Patterson**

BS, Recreational Therapy, University of Colorado, Boulder, '74

BSN, Nursing, University of Colorado Health Science Center, '78

MS, Nurse Midwifery, University of Colorado Health Science Center, '93

DISSERTATION

Submitted in Partial Fulfillment of the

Requirements for the Degree of

**Doctor of Philosophy in Nursing**

University of New Mexico

Albuquerque, New Mexico

December, 2014

### **Dedication**

I dedicate this work first, to the women who deserve a choice in the mode of delivery of their babies. Next, I dedicate this to my mother, Louverta Brunkow a powerful leader among nurses and an amazing woman. She encouraged me to be well educated, knowledgeable, and to pursue my dreams. She has inspired me throughout my career to empower women in whatever their endeavor might be.

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## **ABSTRACT**

Every year, one-third of the 4 million child-bearing women in the United States have a cesarean delivery. Of these, 91% have a repeat cesarean delivery with the birth of subsequent children. Cesarean deliveries account for more than half of childbirth-related hospitalization expenses totaling approximately \$8 billion every year. A repeat cesarean delivery has a 40% greater hospital cost than a vaginal delivery. Yet, the cost of the delivery for the health-care payer is rarely addressed in the published peer-reviewed literature.

The purpose of this research was to determine the cost-effectiveness of elective repeat cesarean deliveries (ERCD) compared with trials of labor (TOL) in low-risk women who had a cesarean delivery with their first pregnancy and are now in their second pregnancy. The study compared the cost-effectiveness of ERCD versus TOL from the perspective of the health-care payer (defined as private insurance, self-pay, Medicaid, and Medicare). Cost-effectiveness was calculated on the difference of costs to the health-care payer for a delivery-related hospital stay and the possible complications

incurred by the mother and baby divided by the difference of length of stay in the hospital for mother and baby for the two interventions, ERCD and TOL. Sources of data for the study were the Agency for Healthcare Research and Quality's (AHRQ's) Healthcare Cost and Utilization Project (HCUPnet) for the year 2010, and the peer-reviewed literature. The study's findings reveal that a TOL is more cost-effective than an ERCD, with a possibility of cutting the health-care payers' costs overall by \$225 million per year. Limitations of the study pertain to HCUP data, cost-effectiveness analysis assumptions, physician idiosyncratic coding practices, and the effectiveness measure (LOS). The findings have implications for practice, research, and policy. In particular, the findings could be of interest to health-care providers counseling women about their choice for mode of delivery, policymakers interested in creating new systems that reduce health-care costs and increase patient engagement, and for researchers studying health-care payment reform.



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## **Chapter 1**

### **Introduction**

One of the most important decisions in maternity care is determining the optimum mode of delivery for a woman in her second pregnancy when her first resulted in a cesarean delivery. Health-care providers customarily frame this choice to women as balanced decision-making that considers the clinical risks and benefits between an elective repeat cesarean delivery (ERCD) and a trial of labor (TOL). The principal focus of this decision is on quantifying the likelihood of uterine rupture and the probability of a vaginal delivery. A second pregnancy after a cesarean delivery presents a unique opportunity for a woman to be offered a choice between a planned vaginal or planned cesarean birth. The American College of Obstetricians and Gynecologists (ACOG, 2004) addressed this choice in a practice bulletin regarding vaginal birth after cesarean (VBAC) by endorsing the concept of including the woman's preferences and values in the clinical decision-making. ACOG concluded that the decision between ERCD and an attempt at a TOL should ultimately be made through a collaborative exchange between the physician and the patient after thorough counseling on risks and benefits and consideration of the woman's preferences and values.

Within the context of delivery after cesarean, Kamal and Kupperman (2010) conducted a review of the literature on methods of communicating risks and benefits, provider and patient preferences, and obstetrical decision-making. Their review concluded that gaps in research on these topics remain, which, if filled, could contribute to development of a framework with important information for a woman when forming her preferences for either ERCD or TOL.



First, it is necessary to identify the types of data that are essential for a woman when formulating her preference for an ERCD versus TOL. Emmett, Shaw, Montgomery, and Murphy (2006) interviewed 21 women in England about their views on decision-making for their childbirth. These women had all recently given birth via cesarean delivery. The researchers concluded that women whose previous pregnancy had resulted in a cesarean delivery wanted more information on clinical risks and benefits, and economic information such as costs, when using shared decision-making about mode of delivery. Emmett et al. (2007) piloted a computer-based decision aid that incorporated economic considerations, including direct costs of hospitalization, and reported that many of the 21 participants found the decision aid helpful and had less decisional conflict when economic information was included.

In the peer-reviewed medical literature, economic considerations have generally been approached through various types of economic analyses: cost-minimization analysis assumes equal outcomes; cost-effectiveness analysis measures cost per unit of effectiveness with the effectiveness measure in clinical units; cost-utility analysis is usually measured in quality adjusted life years; and cost-benefit analysis is measured by outcomes in dollars (Rascati, 2009).

Much of the current published literature related to cesarean deliveries focuses on safety, demographics, geographic differences, and clinical management issues (Cunningham et al., 2010; Guise et al., 2010). Little has been published on the overall economic consequences of ERCD. Peer-reviewed articles describe a few studies on the economic consequences of repeat cesarean deliveries compared to TOL from the

perspectives of the health-care payer or the woman and her family (Chung et al., 2001; DiMaio, Edwards, Euliano, Treloar, & Cruz, 2002; Grobman et al., 2000).

Clark et al. (2000), Chung et al. (2001), and Macario, El-Sayed, and Druzin (2004) used a hypothetical population to perform their cost-effectiveness analyses of TOL compared with ERCD. All three of the research teams concluded that a TOL, when a vaginal delivery without complications was successfully achieved, was more cost-effective than an ERCD. They also reported that if the TOL resulted in a cesarean section, the direct cost of hospitalization would be greater by thousands of dollars than with an ERCD or TOL because of a longer hospital stay and documented complications.

DiMaio et al. (2002) and Grobman et al. (2000) performed cost-effectiveness analyses comparing ERCD and TOL. DiMaio et al. (2002) reviewed 204 medical records in a retrospective cost-effectiveness analysis. They included the medical records of all women who delivered at their hospital in Florida in 1999 and had a history of one previous cesarean delivery prior to admission. They found a TOL to be more cost-effective than an ERCD; their primary outcome variable was the mean cost of hospital care in their own hospital. Grobman et al. (2000) used a decision tree to analyze the reproductive life of a hypothetical cohort of 100,000 women with a history of cesarean deliveries, they included in their analyses the cost of a second delivery, whether ERCD or TOL. Their robust analysis showed an increase in maternal mortality, morbidity, and cost with ERCD. This led them to conclude that a TOL resulting in a vaginal delivery was more cost effective by thousands of dollars than an ERCD. Their outcome variable was the overall cost of maternal and neonatal morbidity and mortality in their health-care system.

The perspective, an economic term that describes whose costs are relevant based on the purpose of the study, varied in these studies. Chung et al. (2000) and Macario et al. (2004) considered the broad allocation of resources affected by the decision made in the second pregnancy in the context of planned vaginal or cesarean delivery. This is referred to as the *societal perspective*, which includes a comprehensive view of the costs (direct and indirect) experienced by all those affected by the studied intervention. Clark et al. (2000) and DiMaio et al. (2004) performed their cost-effectiveness analysis from a health-care system's perspective. Grobman et al. (2000) used the perspective of a health-care provider using data from a specific hospital in Florida.

Definitions of terms are useful in economic analyses. The health-care payer is an organization or entity that purchases or pays for services given to a group or individual (Tampor & Mohr, 2014). For the purpose of this study, the term *health-care payer* encompasses private insurance (of all types), Medicaid, Medicare, and self-payment by an individual (Health Care Utilization Project, 2010). A health-care system is the organization that provides health related services, and then bills the health-care payer for those services. The health-care payer's perspective is broader than that of one health-care system, which means it could be more generalizable. To date, there is no evidence of work reported by other researchers regarding cost-effectiveness for ERCD and TOL in a second pregnancy and the possible complications of each to the mother and baby from the perspective of the health-care payer.

The major goal of the Patient Protection and Affordable Care Act (2010) (here after referred to as the ACA) is to ensure that everyone receives as high quality health care as possible at an affordable cost (Catalyst for Payment Reform, 2013). Many

provisions of the ACA (2010; Kaiser Family Foundation, n.d.) affect health-care payers. A major challenge for health-care payers is improve population and patient outcomes while maintaining or lowering costs. In an effort to manage their costs, health-care payers often require consumers to assume a greater share of their health-care costs. To accomplish this, payers recognize that consumers need more information on the cost of health care. With knowledge about health-care costs, the ability of payers and consumers to make effective decisions is enhanced. This cost transparency for health-care payers and consumers could help payers contain costs, inform consumers' health-care decisions as they take on a greater financial responsibility, and reduce price variations (Catalyst of Payment Reform, 2013).

Cesarean deliveries are the most common surgical procedure in the United States, totaling 1.5 million childbearing women in 2010 (Guise et al., 2010). Guise et al. (2010) used an evidence-based approach to perform a systematic review of 3,134 citations and reviewed 963 papers. Of those, 203 met the inclusion criteria, finding prior cesarean delivery as the most common indication for a cesarean, accounting for more than one-third of cesarean deliveries a year. In 2007, Guise et al. (2010) also noted that 8.7% of childbirth-related hospital admissions among women with previous cesarean deliveries were attributed to VBAC. A major finding of their report, using an evidence-based approach, showed TOL to be a reasonable choice for women. Guise et al., however, noted the lack of data on cost-effectiveness, specifically what it costs the health-care payer for a woman's choice between an ERCD and TOL. This study may fill that gap by providing a cost-effectiveness analysis of the different choices for modes of delivery after

cesarean from the perspective of the health-care payer. The major outcome variables are length of hospital stays for the mother and baby.

### **Statement of the problem**

Every year, one-third of the 4 million childbearing women in the United States have a cesarean delivery (Guise et al., 2010). Of these, 91% have a repeat cesarean delivery with the birth of subsequent children (Menacker, Declercq, & Macdorman, 2006). Annual U.S. cesarean delivery rates increased from 4.5% in 1965 (when they were first recorded) to a high of 32.9% in 2009 (National Center for Health Statistics, 2011). Many repeat cesarean deliveries are elective, meaning that women who previously underwent a cesarean delivery for medical reasons opt for the procedure when given a choice between a cesarean and a vaginal delivery for a subsequent birth. From 1997 to 2007, ERCD increased by 19%, from 72% in 1997 to 91% in 2007 (U.S. Department of Health and Human Services [USDHHS], 2012).

One of the goals of *Healthy People 2010* (USDHHS, 2012) was to decrease the United States' cesarean delivery rate to 15%. As 2010 has come and gone, the rate, 32%, is still more than twice that goal (Guise et al., 2010). *Healthy People 2020* (USDHHS, 2011) has a revised goal for reducing the cesarean delivery rate than *Healthy People 2010*. It aims to decrease the overall rate by 10% (from 32.9% to 22.9%). This includes primary cesarean and repeat cesarean rates (USDHHS, 2011).

Clinical researchers have offered several possible explanations for the growth rates of cesarean deliveries. These include the increase in multiple births due to fertility treatments (Reynolds, Schieve, Martin, Jeng, & Macaluso, 2003), maternal request (particularly because of the rising age of parturition) (Lee & D'Alton, 2008), providers'

fears of litigation (Brown, 2007; Minkoff, 2012), maternal fear of urinary incontinence (Wax, Cartin, Pinette, & Blackstone, 2004), and increasing physician reimbursement rates for cesarean deliveries (Grant, 2009).

Cesarean deliveries account for more than half of all U.S. childbirth-related hospitalization expenses totaling approximately \$8 billion annually (Guise et al., 2010). Although the Agency for Healthcare Research and Quality (AHRQ, 2009) reported that a repeat cesarean delivery has a 40% greater hospital cost than a vaginal delivery, the cost of the delivery for the health-care payer is rarely addressed in the published peer-reviewed literature. Moreover, few researchers have analyzed the cost-effectiveness of cesarean deliveries compared to vaginal deliveries for a second pregnancy from the perspective of the health-care payer, despite the growing proportion of childbirth-related hospitalizations and significant cost to the health-care delivery systems.

When reviewing recent published literature related to cesarean deliveries, emphasis is on safety, demographics, geographical differences, and clinical management issues, but few published studies analyze the economic consequences of ERCD (Cunningham et al., 2010). Peer-reviewed articles and government reports refer to a few studies on such deliveries compared to a TOL from the perspective of the health-care system (Clark et al., 2000; DiMaio et al., 2003), health-care provider (Grobman et al., 2000), or the woman and her family (Chung et al., 2001; Macario et al., 2004).

Health economists have used cost-effectiveness analyses to compare costs of two or more interventions and their expected gains for a specific population (Gold, Siegel, Russell, & Weinstein, 1996; Rascati, 2009). In the present study, a systematic review of the nursing, medical, public health, and economics literature was conducted from 2000 to

2010, to identify published cost-effectiveness studies as they relate to ERCD versus TOL. Most of the literature on cost-effectiveness analysis in this area compares ERCD with the choice of a TOL (DiMaio et al., 2002; Grobman et al., 2000; Macario et al., 2004). Only a couple of studies (Clark et al., 2002; Chung et al., 2000) have reported evidence regarding the cost per unit of clinical effect for the target population of concern here—those women electing repeat cesarean deliveries compared to women electing to attempt a vaginal birth after a previous cesarean delivery.

Chung et al. (2001) performed a cost-effectiveness analysis using a hypothetical computerized model of a 30-year-old woman's choices for her mode of second delivery after having a cesarean with the first pregnancy. The objective was to determine which mode of delivery, ERCD or TOL, was most cost-effective. The model employed by Chung et al. used data from peer-reviewed studies, actual hospital costs from 1999, and utilities (a preference measure) to quantify health-related quality of life. Their incremental cost-effectiveness model compared the additional cost that one intervention incurred over the other, with health-related quality of life as their outcome measure. Chung et al. concluded that if the probability of successful vaginal delivery was between 0.74 and 0.76, a TOL that resulted in an uncomplicated vaginal delivery was more cost-effective than either an ERCD or a rescue cesarean delivery (RCD). Hospital costs were from one state, Florida, limiting national generalizability.

Given the scarcity of empirical studies that compare the cost-effectiveness of ERCD with TOL, a cost-effectiveness analysis from the perspective of the health-care payer is both relevant and necessary. This study uses the methodology of the Chung et al.

(2001) study as a guide, combined with current (2010), nationally representative cost data and event probabilities.

Moreover, this method has several cost implications. For example, the average length of stay for childbirth-related hospitalizations is 2.8–3.5 days (Guise et al., 2010). Each additional day of care needed for a complication adds to the overall cost of hospitalization. Furthermore, knowing that total charges are over 40% higher for a repeat cesarean delivery than for a TOL, a cost-effectiveness analysis from the viewpoint of the health-care payer could offer information to help women and providers in determining the optimum mode of delivery for women in their second pregnancy when their first resulted in a cesarean delivery (AHRQ, 2009).

If this economic analysis determines that an uncomplicated TOL is more cost-effective than an ERCD, then health-care payers could suggest a new formulation for maternity payment, such as a bundled rate (all care paid in one payment) for maternity care instead of paying fee-for-service to providers and hospitals separately. Having evidence of cost-effectiveness might inform and even change the decision faced by women and their providers (ERCD vs. TOL), which may lead to better outcomes for mothers and babies and lower costs overall to health-care systems. The potential findings of cost-effectiveness for one strategy over the other resulting from this study would again provide only one piece of evidence as this decision is multifaceted, entailing mother's preferences, provider liability, and provider reimbursement.

### **Statement of Purpose**

The purpose of this research was to determine whether an ERCD is cost-effective when compared to a TOL at term (in a second pregnancy) from the perspective of the



health-care payer. Decisional analysis was used to model the decision made by a woman in her second pregnancy after her first pregnancy resulted in a cesarean birth and to determine the cost-effectiveness of the decision.

### **Research Objectives**

This study's research objectives were:

1. Establish the probabilities of complications incurred by mother and baby for ERCD and TOL in a second pregnancy.
2. From the perspective of the payer, determine the costs associated with ERCD and TOL by the mother and the baby in a second pregnancy.

From the perspective of the payer, determine the outcomes (length of stay) associated with ERCD and TOL by the mother and the baby in a second pregnancy.

3. Determine and calculate an incremental cost-effectiveness ratio for ERCD and TOL for mother and baby in the second pregnancy.

Note: Lists of definitions and abbreviations are in Appendices A and B, respectively.

## **Chapter 2**

### **Literature Review**

This chapter provides a review of the literature in three major areas: (a) the clinical question of choice of mode of delivery, the controversy over choices between costs of TOL and ERCD with a second pregnancy, from health-care payer's perspective, and point of service payment reform; (b) the framework of economic evaluations in medicine; and (c) previous economic studies performed around VBAC or TOL compared to ERCD in a second pregnancy.

### **Pregnancy and Maternity Care**

Pregnancy and birth of a child are unique experiences for each woman. Women and their families maintain different views and preferences about childbearing based on their values, knowledge, belief systems, culture, and social backgrounds (Mortimer et al., 1990). The goal of maternity care is to promote evidence-based, safe, effective, timely, efficient, and equitable care promoting optimal health outcomes for the mother and baby (Cunningham et al., 2010; Varney, Kriebs & Gegor, 2004). Maternity care represents an opportunity to promote and improve health through teaching health promotion and disease prevention, including nutrition counseling and weight management. The majority of women seeking prenatal care have private insurance (51%) an additional 42% are covered by Medicaid programs (Sakala & Corry, 2008). Many other women without health insurance begin receiving health insurance benefits (private insurance or Medicaid) in the early portion of their pregnancy by applying for maternity coverage.

Maternity care practices impact outcomes for mothers and babies while attempting to minimize the risk of harm. Effective maternity care is meant to minimize

overuse, underuse, and misuse of care practices and services (Institute of Medicine, 2001). It is also important that maternity care be timely, which means that care is delivered when it is needed. Timely maternity care is determined by maternal-fetal physiology, not by external time pressures without clear medical indications. Efficient care produces the best possible health outcomes using the most appropriate and conservative application of resources and technology (Institute of Medicine, 2001). Equitable care means all women and their babies have access to and receive high-quality and high-value care. Variations in maternity care should only be based on the health needs and values of each woman and her baby, not on other nonmedical factors (Institute of Medicine, 2001).

Sakala and Corry (2008) list the essential features of prenatal care as being evidence-based and supportive for decision-making, and choices, for example, genetic testing and delivery setting. These concepts together entail providing information about risks and benefits, harms, and areas of uncertainty in the care being offered. An interactive process that takes place between a woman and her care provider is built into maternity care at every level (Mortimer et al., 1990; Varney, Kriebs, & Geger, 2004). During this interactive process, the provider offers information, taking into consideration the woman's values and preferences, including the desired level of involvement from her family, in language that is appropriate and understandable, and gives her time to process the information. Making an informed choice about maternity care means that women have access to the full range of safe and effective care options, and take into account care givers' opinions, care setting, and their family's choices and preferences. A woman ideally has the essential choice about options, including the mode of her delivery.

### **Mode of Delivery for First Pregnancy**

At term (39 weeks gestation or greater) with a first pregnancy, a woman has many choices to face. She has most likely chosen her delivery setting and care provider. In 2010, almost 4 million women gave birth (Martin, Hamilton, Ventura, Osterman & Mathews et al., 2012). The first-birth rate was 25.9/1000 women, which was down 3% from 2009 (Martin et al., 2012). The majority of women chose to deliver with a physician (86.3%) or a certified nurse midwife (CNM, 7.6%) in a hospital (Martin et al., 2012).

Although most women still elect to have a vaginal delivery, recently decisions made by patients and their providers have shifted toward cesarean delivery by maternal request. In 2006, approximately 2.5% of all births in United States were cesarean deliveries by maternal request (Lee & D'Alton, 2008). This decision (by maternal request) is typically made knowing there are no medical indications for this procedure. Most often cesarean delivery by maternal request happens with a first pregnancy. Lee and D'Alton (2008) listed as advantages of cesarean by maternal request (a) avoiding an emergent or unplanned cesarean, which carries a much higher risk for morbidity, (b) convenience of planning the day of delivery, (c) lower risk of hemorrhage than with an emergent cesarean delivery, and (d) lower in neonatal neurologic injury compared to an emergent cesarean delivery.

The disadvantages of cesarean by maternal request are (a) a pregnancy after a prior cesarean have a higher incidence of abnormal placental implantation, such as placenta previa or accreta, (b) higher possibility of uterine rupture in pregnancy after prior cesarean, and (c) future pregnancies need to be limited to one or two planned cesareans. Although neonatal respiratory morbidity is higher with cesareans and the woman's future

pregnancy might have abnormal placental implantation, most obstetricians are following ACOG Committee Opinion No.394 (2007b), which addresses decision-making that allows women to have primary elective cesarean deliveries, and honors the woman's request.

A woman has a low risk of pregnancy complications if she has completed 38 weeks of pregnancy, has one fetus whose head is down, and has not had any obstetric or medical complications in the pregnancy (Kamath, Todd, Glazner, Lezotte, & Lynch, 2009; Tita et al., 2010). One-third of the normal low-risk first pregnancies result in cesarean deliveries (Zhang et al., 2010). Indications for nulliparous women to have a cesarean delivery are failure to progress (47.1%), nonreassuring fetal heart rate or fetal distress (27.3%), fetal malpresentation (7.5%), hypertension (1.6%), and fetal macrosomia (1.2%) (Zhang et al, 2010).

Zhang et al. (2010) grouped indications for cesareans as clinically indicated (74.9%), done for mixed reasons (11%), and truly elective (2.5%). Kennare, Tucker, Heard, and Chan (2007) included additional indications for cesarean deliveries as antepartum bleeding (2.75%), intrauterine growth retardation (1.3%), and other (10.8%), encompassing herpes and HIV. Zhang et al. also showed a two-fold increase in a woman's labor resulting in a cesarean if she was induced. Kennare et al. suggested two approaches to decrease the overall cesarean rate: a) was to cut down the number of the primary cesarean deliveries, which account for 40% of first births, and b) decrease the number of women induced with an unfavorable cervix.

## **Clinical Decision-Making**

For most of the 20th century, providers thought that once a woman had a cesarean delivery, all her future pregnancies would end the same way (Guise et al., 2010). In 1980, the National Institutes of Health (n.d.) held a Consensus Development Conference:

Vaginal Delivery after Cesarean to study two questions: (a) Does a previous cesarean delivery necessitate a repeat cesarean delivery? and (b) In what situations might a vaginal birth after cesarean be a clinically feasible option? The consensus conference participants concluded that VBAC was a viable option. This conclusion contributed to an increase in the number of VBACs from 18 per 100 live births in 1980 to about 30 per 100 live births in 1996 (National Center for Health Statistics, 2007). As the rate of VBACs increased, researchers noted a rise in the risk of uterine rupture (Grobman et al., 2008). Starting in the mid-1990s, the cesarean delivery rate overall increased and as of 2012 is at an all-time high of 32.9%. At the same time, the rates of VBACs started to drop and as of 2010 were at 9% (Cunningham et al., 2010).

The increase of cesarean deliveries and the decrease of VBACs are thought to have occurred for both clinical and nonclinical reasons (Cunningham et al., 2010). One clinical reason is the increased number of uterine ruptures with VBACs (Grobman et al., 2008). The nonclinical reasons include providers' interpretation of the American College of Obstetricians and Gynecologists (ACOG, 2010) guideline requiring an obstetrician to be "immediately" available during a TOL because of a known high risk of complications if a TOL is unsuccessful and a perceived increase in uterine rupture rate. Because of medical-legal concerns, many obstetricians and hospitals have impeded full choice for

VBAC, citing that they could not provide “immediate” availability of anesthesia and obstetricians (Bucklin, 2003).

In 2010, the NIH (n.d.) convened the Consensus Development Conference: Vaginal Birth after Cesarean, which was a summit of leaders in women’s health interested in reaching a consensus on VBAC. Using an evidence-based approach, including a meta-analysis of the medical literature (Guise et al., 2010), the attendees deemed “a TOL a reasonable option for many pregnant women with one prior low transverse uterine incision” (Cunningham et al., 2010, p. 2). This evidence-based consensus statement was aimed at enhancing obstetrical stakeholders’ understanding of the clinical risks and benefits of VBACs, their interactions with nonclinical factors, and their potential impact on informed decision-making.

Informed decision-making was one of the non-clinical factors that participants at both the 1980 and 2010 summits discussed. Bekker et al. (1999) defined informed decision-making as a process in which “a reasoned choice is made by a reasonable individual using relevant information about the advantages and disadvantages of all possible courses of action, in accord with the individual’s beliefs” (p. 1). The term *informed decision-making* emerged partly with the rise in advocacy organizations placing pressure on the health-care administrators in health-care systems to help consumers assess the appropriateness of recommended cancer screening tests such as mammograms, pap smears, prostate screening, clinical breast exams and colorectal screening (Rimer, Briss, Zeller, Chan, & Woolf, 2004). Consumer groups and researchers have given much attention to using informed decision-making with breast cancer treatments (Bekker et al., 1999; Rimer et al., 2004). The essential components of

informed decision-making are (a) understanding the screening test (or procedure) and its risks, benefits and alternatives; (b) understanding personal values and preferences; (c) considering pros and cons of a test (or procedure); (d) discussing decisional preferences and seeking additional information; and (e) deciding on a plan of action (Bekker et al., 1999; Rimer et al., 2004).

Reviewing the risks and benefits of a TOL and repeat cesarean delivery with the mother may have a significant impact on her ability to make an informed choice.

Chervenak and McCullough (2011) contended that the key component of informed decision-making is a “reliable account of benefits and harms relevant to the care of patients and of how those goods and harms should be reasonably balanced against each other” (p. 28). Additionally, Chervenak and McCullough suggested that recognizing the woman’s knowledge level (taking into account how the general public understands the baseline risk of childbirth) and considering the impact of the provider’s delivery of information are practices that should be incorporated into informed decision-making.

Murray, Charles, and Gafni (2006) conceptualized informed consent as a process in which information is transferred in a reciprocal manner, with both the patient and provider using their expertise. The health-care provider is the expert in options of treatment, and the patient is the expert in her own circumstances and preferences of treatment outcomes. As values are shared, the treatment deliberation becomes a joint decision, taking into consideration various treatment options, provider priorities, and patient preferences. Entwistle and Watt (2006) cited evidence showing that when patients had a sense of involvement with decision-making, it had positive implications for their health status.



In their development of shared decision-making approaches, Charles, Gafni, and Whelan (1997), acknowledged that one method of informed consent is not best for every encounter. How do providers switch from the paternalistic model of informed consent they learned while in their professional education training for medical, nursing, or physician assistant to a shared decision-making process, while still respecting both the patient's preferences and their own beneficence? Leclercq, Kulers, Scheltinga, Spauwen, and van der Wilt (2010) claimed that with an increase in the complexity of surgical operations and the pressure of patients wanting to know more about their options, the use of computer-based information as part of shared decision-making could meet the needs of both providers and patients. They contended that although retraining health-care providers is costly in time and money, using computer-based educational materials does not necessarily undermine the clinician/patient relationship, but instead can enhance it.

Informed decision-making is closely related to shared decision-making. The latter connotes a process where the provider and patient share in the decision-making process usually in face-to-face encounters (Rimer et al., 2004). In maternity care, shift from informed decision-making to sharing the decision with the woman moves the conversation and decision from the "paternalistic" manner of telling a patient what treatment to have to involving the patient in making decisions about her health care (Makoul & Clayman, 2006). Godolphin (2009) noted that patient-centered care is a key element in improving quality and safety in health care. He contends that many errors can be avoided by having more active patient involvement. Shared decision-making, as a best practice in patient-centered care, was recommended in the Institute of Medicine's (2001) landmark report *Crossing the Quality Chasm: A New Health System for the 21st Century*.

The report concluded that, “the best care results from the conscientious, explicit, and judicious use of current best evidence and knowledge of patient values by well-trained, experienced clinicians” (p. 76). Towle, Godolphin, Grams & LaMarre (2006) contended that putting this new paradigm into practice is an ethical imperative. It modifies the present system from “paternalism” with the provider, who is the expert in medicine, holding the monopoly of power, to a shared decision with the patient, who is an expert in his/her own life, values and circumstance.

Changing the dynamics of the relationship between provider and patient will entail educating both groups, especially by letting patients know their preferences and values matter as much as the evidence-based options provided by clinicians (Declercq, Sakala, Corry, & Applebaum, 2006). Shared decision-making is used in many health-care decisions with reasonable paths to choose, from the option of doing nothing (when appropriate) to choosing different therapies leading to possibly differing outcomes. Examples of conditions for which shared decision-making has been used include breast cancer, prostate cancer, lipid-lowering medications for prevention of cardiac disease, and genetic and cancer screening (Barry & Edgman-Levitan, 2012).

Many guidelines written for providers in obstetrics by ACOG have changed in the past 10 years. The present recommendation for shared decision-making from the 2010 NIH consensus report and ACOG is to allow a woman a choice with adequate counseling on risks and benefits for a TOL or ERCD. Eden et al. (2010) evaluated screening tools with the goal of establishing a method of prediction for successful VBAC versus a failed attempt; however, they did not find an adequate method. Grobman et al. (2011), also looking for a way to predict who will be successful, concluded in their analysis that

VBACs are decreasing because fewer women and their providers are seeking a TOL. Their goal was “to provide insight into whether changes in the choice of undergoing a TOL or the abandoning of a TOL are related to the changes in a population’s characteristics or to the approach to patient care” (p.41).

The 2010 NIH consensus report strongly recommended a greater use of shared decision-making as a necessary change in the approach to VBAC, which could affect the rate of VBACs. Preference-sensitive shared decision-making strives to balance the best available evidence-based knowledge about treatment options, including risks and benefits offered by the provider, with the patient’s values and preferences. Together, the patient and the clinician deliberate about options and come to a consensus that considers advantages and disadvantages (including no treatment). This consensus is a joint decision, taking into consideration advantages and disadvantages and concluding with a plan both patient and provider is willing and able to implement (Makoul & Clayman, 2006).

Contextual conditions are important to include in shared decision-making (Towle, Godolphin, Grams, & LaMarre, 2006). For instance: Are patients able to make their own decisions (were they recently medicated for pain)? Do they have the education level or ability to understand the conversation? Is the conversation in their native language? Towle et al. (2006) counseled and trained family physicians to implement shared decision-making and found it was difficult for physicians to change how they offer information and consider patient’s preferences, though they agreed with the overall concept.

For many reasons, it has been difficult to engage providers in implementing shared decision-making (Elwyn et al., 2010). Lagaré et al. (2008) found that health professionals self-selected patients for whom they deemed shared decision-making was feasible and functional. This practice did not allow for patient involvement in decision-making. Elwyn et al. contended that the use of high quality decision aids is a best practice to encourage patient and provider engagement in shared decision-making.

Using shared decision-making with a woman during her maternity care is an opportunity for a health-care provider to be the expert in medicine and partner of the patient, who is the expert on her values, life history, and preferences. However, shared decision-making is not widely utilized, happening in about 10% of medical encounters (Godolphin, 2009). Towle et al. (2006) formulated an educational plan for physicians to use shared decision-making in their practices. Though many physicians agreed with the key characteristics of implementing this practice, few followed their training, citing that it took too much time (Towle, et al., 2006). Patients do not expect shared decision-making. Some do not understand the medical terminology used, and others contend that being assertive in a medical encounter might affect their relationship with their provider (Stacy et al., 2011). Others rely on the physician as the expert, and their own opinions and preferences do not matter to them.

To enhance the effectiveness of shared decision-making, researchers, patients, and clinicians have called for changes in the provider-patient relationship. A conversation rooted in a relationship between informed patients and benevolent providers moves the process away from paternalism (Godolphin, 2009). Laws and professional guidelines increasingly encompass consenting processes, which are gradually raising the use of

shared decision-making. Furthermore, medical education is now expanding training in communication skills, including shared decision-making. Decision aids are being developed to aid patients and providers with a range of information considering the patient's values and the provider's evidence with the ultimate goal being improved health outcomes (Leclercq et al., 2010; Stacy et al., 2011).

### **Shared Decision-Making Regarding ERCD and TOL**

Six issues surface when reviewing the literature on shared decision-making and ERCD and TOL. The first four have bioethical considerations that include (a) respect for a woman's autonomy, which governs her right to choose or refuse recommended treatments for herself and her fetus; (b) the provider's beneficence, meaning that the provider has the obligation to promote the health and well-being of the woman and fetus; (c) conflicts between respect for autonomy and beneficence; and (d) social justice, the same manner of shared decision-making being offered to all women, so that the great majority have a choice and are not being put at clinical risk (Sharma, Chervenak, McCullough, & Minkoff, 2004). The other two issues pertain to access to care and other controversies surrounding access to ERCD versus TOL.

**Respect for a woman's autonomy.** Autonomy is defined as self-governance or "self-rule that is free from a controlling interference by others and limitations that prevent meaningful choice" (Beauchamp & Childress, 2013, p. 101). With regard to maternity care, autonomy means that a woman has the freedom to make an informed decision about the mode of delivery of her baby. Her decision will be influenced by her understanding of the spectrum of risks and benefits of a TOL and ERCD, whether she has been given the evidence to support these risks and benefits, and whether the delivery setting affords her

those choices. In paternalistic informed consent (e.g., “I think this is best for you”), the provider gives her the information he or she thinks the woman needs and essentially tells her how she will deliver (Sharma et al., 2004). With shared decision-making, the health-care providers’ present information in a manner that gives the evidence of the risks and benefits, describes the possible complications, answers questions, and supports the woman in her decision, even if the clinician does not agree (Sharma et al., 2004).

Research on perceived consent (how patients perceive the process through which they are consented to a procedure) is limited, but the concept is important to understand in relation to shared decision-making. The major study on perceived consent found that 26% of women surveyed (national sample of 200 patients by phone and 1,373 by online questionnaire) who had a previous cesarean birth, felt pressured by the provider to have another cesarean (Declercq, Sakala, Corry, & Applebaum, 2006). In addition, whereas 81% felt all complications should be disclosed during the discussion, 10% of these women did not feel that had happened in their case. When asked who should make decisions about the mode of delivery, 73% stated that the woman, after consulting with the provider, should make the decision, barring no medical complication that would make the situation emergent. A very small portion (3%) felt the provider should make the decision after talking to the woman. In general, all respondents felt that providers should not be the sole decision-maker.

Bernstein, Matalon-Grazi, & Rosenn (2012) also looked at patients’ perceptions of informed consent for ERCD and TOL. This group performed a prospective study of 155 women presenting to their hospital with a second pregnancy who were candidates for a TOL. Upon admission for their ERCD or TOL, the women filled out a questionnaire

about their perceptions of informed consent. The results from this questionnaire demonstrated a lack of knowledge about the risks and benefits of the chosen procedure for women electing for both ERCD or for TOL. This study also revealed that patients chose the procedure they perceived to be their provider's preference.

Beauchamp and Childress (2013) contended that respect for autonomy obligates the provider to disclose information and to probe for and ensure understanding with the purpose of fostering proper decision-making. To respect an autonomous agent is to recognize that person's right to hold views, to make choices, and to form a plan of care based on his or her values and beliefs (Beauchamp & Childress, 2013; Power & Faden, 2006).

**Provider's beneficence.** Beneficence is defined as an act of kindness or doing good, and a charitable gift (Beauchamp & Childress, 2013). Nonmaleficence is the obligation to do no harm. Bioethicists and health policy scholars often conceptualize these two words as manifestations of the same principle (ACOG, 2007a). This underlying principle demands that while offering information on a choice of procedures (ERCD or TOL), the provider should respect the woman's autonomy while taking into consideration the well-being of both the mother and baby (Sharma et al., 2004). Broad principles of ethics require that beneficence and nonmaleficence be used together, especially when the situation is complicated by the patient's psychological makeup, physical condition, race, education level, and spiritual well-being (Beauchamp & Childress, 2013). An example of a situation where provider beneficence is particularly important is when a woman has had a long labor, is exhausted and not progressing, and needs to make a decision about a cesarean section.

**Conflicts between autonomy and beneficence or nonmaleficence.** The Hippocratic Oath, which all physicians take, is centered on beneficence and nonmaleficence, “to help, or at least do no harm” (Beauchamp & Childress, 2013, p. 214). Traditionally, physicians have depended on their own judgments about their patient’s desires for information about treatments and treatment choices. However, in the world of modern medicine, patients increasingly need to receive information and make independent judgments. Respect for autonomy comes into conflict with beneficence when a patient disagrees with the recommendations a health-care provider considers to be in the patient’s best interest. Examples would be a patient not wanting a treatment due to cultural and religious beliefs or family members having differing opinions as to the treatment plan (Beauchamp & Childress, 2013). In obstetrics, for example, a woman might switch providers after being counseled about risks and benefits for ERCD versus TOL if she realizes her values and beliefs are not being supported.

**Social justice.** Social justice is defined by Rawls (1971) in terms of equality and liberty. Rawls claimed each member in society has an equal claim on the goods of society. Beauchamp & Childress (2013) aligned their definition of justice to distributive justice, which declares that vital social resources, including healthcare, be dispersed according to need. This implies that individuals should receive equal treatment unless medical evidence establishes relevant treatments that differ due to circumstances or situations. Powers and Faden (2006) agreed that social justice for health policy concentrates on inequalities in health and access to healthcare. In clinical practice, social justice requires balancing clinicians’ obligation to render the care a patient is entitled to with the allocation of limited resources. On a societal level, this becomes complicated by



decisions regarding the allocation of scarce resources, such as some Medicaid programs not reimbursing for organ transplants (Cappel, Phillips, & Phillips, 2011). On an individual level, social justice might be compromised when a woman requesting an attempt for a VBAC is not offered this choice because anesthesia for an emergency cesarean delivery is not available (ACOG, 2007b), or when clinicians fail to offer shared decision-making for a TOL because they are uncomfortable providing the procedure.

**Denial of access.** Clinicians often attribute the limitations to a woman's access to a TOL following a previous cesarean delivery to guidelines in the ACOG Practice Bulletin (ACOG, 2010), which state that *immediate* availability of a physician and anesthesia is necessary to offer a TOL. This immediate response is necessary because an existing uterine scar could cause the placenta to detach, causing maternal hemorrhage, which could lead to hypoxia (decrease in oxygen) of the fetus. Hypoxia can cause fetal brain injury or death if the baby is not delivered immediately. The national incidence of uterine rupture for TOL is 4.7/1000 and for ERCD is 0.3/1000 (Guise et al., 2010). The risk of uterine rupture occurring is thought to be the primary reason a TOL is not offered in some communities (Cahill et al., 2006). ACOG's "immediately available" clause has created a group, or separate class, of patients that are not offered a vaginal birth after cesarean because a physician or hospital is unable to provide an immediate (within 30 minutes) response for a rescue cesarean delivery. Roberts, Deutchman, Fryer, King, and Miyoshi (2007) compared hospitals that continued providing VBACs with those that stopped allowing them after the ACOG Practice Bulletin (2010) was published. They determined that three out of every 10 hospitals (68 of 229 or 29.7%) that previously allowed VBACs had discontinued the practice by 2005.

**Controversy over choices.** Approximately 40% of the 1.3 million cesarean deliveries performed each year are scheduled elective repeat procedures (Lydon-Rochelle, Cahill & Spong, 2010). Counseling for the choice between ERCD and TOL varies (Declercq et al., 2006). For a woman, making this choice can feel like being engaged in a controversy about what choices she has. This controversy centers on safety, but the risks and benefits are not quantified in one place, making it difficult to find information easily. Some delivery settings address the issue of safety by not offering a TOL due to lack of necessary staff and availability in their facility for an emergency delivery. Moreover, physicians may have reservations about proposing a TOL out of fear of litigation, which might give women the feeling that all of their options are not being offered to them (Brown, 2007; Minkoff, 2012).

### **ERCD, VBAC, and TOL**

ACOG (2010) provides an overview of how to evaluate data presented in the literature regarding the incidence of ERCD, VBAC, and complications from these procedures. Risks for either VBAC or ERCD are listed as maternal hemorrhage (listed as blood transfusion; respectively, 0.7-1.7%, 1-1.4%), infection (listed as endometritis; respectively, 2.9%, 1.5-2.1%), operative injury (0.4%, 0.42-.6%), thromboembolism (not listed), hysterectomy (0.2-0.5%, 0-0.4%), and maternal death (0.02%, 0.02-0.04%). Another risk ACOG included was maternal morbidity, which is greater when TOL fails and a rescue repeat cesarean becomes necessary. Therefore, it is safer for a woman with a high probability of achieving a VBAC to attempt a TOL (ACOG, 2010). Included also are tables to help assess this probability. Suggestions about counseling the woman from

the beginning of maternity care in her second pregnancy are included with the ultimate goal of the woman and her physician making the decision.

Lydon-Rochelle et al. (2010) reviewed information about short-term maternal outcomes from 18 observational studies, which reported differences between outcomes of VBAC and ERCD. The authors reported factors that might influence these outcome differences and then compared successful VBACs and unsuccessful VBACs, identifying knowledge gaps to assist in the management of dilemmas in childbirth after a cesarean. Their event rates were similar to the ACOG (2010) practice bulletin which lists risks for TOL and ERCD respectively, as follows: hysterectomy (0.1-0.3%, 0.1-0.5%), thromboembolic event (0-0.6%, 0.1-0.5%), endometritis (1.0-8.2%, 1.2-8.8%), uterine rupture (0.3-0.9%, 0.0-0.2%), and maternal death (0.001-0.01%, 0.005-0.04%). Lydon-Rochelle et al. suggested that the frequency of these short-term maternal outcomes was comparable to other common medical procedures, thereby dispelling the major perception among clinicians, health-care payers, and women that an attempt for a VBAC was very risky. Lydon-Rochelle's team identified a lack of a randomized, controlled, multicenter trial comparing TOL and ERCD to evaluate adverse outcomes for mother and baby. They suggested that such a study be done.

Landon et al. (2004) performed a prospective four-year observational study from 19 medical centers across the United States. With a large cohort (N = 33,699), they compared VBAC and ERCD and outcomes for mother and baby. This study group's goal was to provide information that was relevant for counseling a woman about her choices in childbirth after a cesarean. They found symptomatic uterine rupture to occur in women with TOL (0.7%). Hypoxic-ischemic encephalopathy occurred only in infants

whose mothers had a TOL with the majority happening following a uterine rupture (Landon et al., 2004).

Using the same goal, to provide the clinician information for counseling a woman for childbirth after a cesarean, Cheng et al. (2011) built on the systematic evidence-based review performed by Guise et al. (2010) and added information clinicians and patients might need to make a choice between ERCD and TOL. They found that, in the United States, among the women who had a TOL, 74% had a VBAC. This group also predicted the probability of success for TOL, taking into account favorable and unfavorable factors, which included indication for prior cesarean as favorable and increase in maternal age, body mass index, preexisting maternal medical disease, and short interdelivery interval as unfavorable. Cheng et al. (2011) reported higher risk of maternal mortality in ERCD, 13.4 per 100,000 (95% CI 4.3-41.6 per 100,000 ERCD) compared to 3.8 per 100,000 in VBAC (95% CI 0.9-15.5 per 100,000 VBAC). Uterine rupture had an overall incidence for both ERCD and TOL of 0.30% (95% CI 0.23%-0.40%); with 96% of the ruptures occurring in the TOL group (Cheng et al., 2011). No statistically significant differences were found in rates of hysterectomy, hemorrhage, infection or surgical injury between ERCD and TOL.

Cahill et al. (2006) conducted a retrospective cohort study with 17 sites including 13,238 women who had prior cesarean deliveries to determine the safety of VBAC compared to ERCD for their next birth. The primary outcomes identified for VBAC and ERCD groups were as follows: uterine rupture for VBAC and ERCD respectively (1.94%, 1.07%), bladder injury (0.51%, 0.44%), fever (11.21%, 12.11%), and need for transfusion (0.87%, 1.08%). This study population considered women with prior vaginal

deliveries and a prior cesarean as well as women without prior cesarean deliveries and vaginal deliveries. They concluded that a woman with prior vaginal and cesarean deliveries was the best candidate for a successful VBAC.

In a study of 1,408 deliveries performed at their facility, Loebel, Zelop, Egan, and Wax (2004) included the same groups as above, VBAC and ERCD, but also included the unsuccessful TOL women that had a rescue repeat cesarean. The outcome measures they tracked were comparable for ERCD and VBAC: transfusion (0.9%, 0.6%), infection (1.9%, 2.3%), uterine rupture (none in either group), and operative injury (0%, 0.4%), respectively. Their population was from a large community hospital affiliated with a university with no maternal deaths in the study time frame. A failed TOL reported risks of adverse outcomes as transfusions (2.8%), infections (5.1%), uterine rupture (2.2%), and operative injury (2.2%). The study concluded that outcomes were much worse for a mother with a failed TOL.

From a prospective registry including 19 sites from 1999 to 2002, Mercer et al. (2008) selected 13,532 women with one or more prior low transverse cesarean deliveries (most common type of cesarean surgery) who wanted to attempt a VBAC in their current pregnancy. Their goal was to estimate success rates and risks for a VBAC after one or more previous cesareans. Among the women meeting their criteria, they found success of VBAC increased after each VBAC and the risk of uterine rupture decreased with each successful VBAC. The risk of maternal outcomes measured were similar in both groups, including uterine rupture (first VBAC 0.87% and second 0.45%), hysterectomy (first VBAC 0.23% and second 0.17%), surgical complications (first VBAC 0.45% and second 0.17%), thromboembolism (first VBAC 0.09% and second 0%), endometritis (first

VBAC 3.68% and second 1.17%), and maternal death (first VBAC 0.02%, and second 0%). Regarding VBAC attempts, they concluded that 73% of women attempting VBAC will succeed and 0.7% will have a uterine rupture.

Cahill et al. (2006), Cheng et al. (2011), Landon et al. (2004), Loebel et al. (2004), and Lydon-Rochelle et al. (2010) determined the safety of VBAC when compared with ERCD from their various research methods considering possible complications. Mercer (2008) concluded his research dispelled the common perception that a successful VBAC has as many complications as an ERCD. With the safety of a TOL resulting in a successful VBAC seemingly established, where does a woman go to have her TOL?

**Access to TOL.** In 2010, ACOG (2010) reviewed its previous statement that a provider needs to be “immediately” available while a woman is attempting a TOL. They upheld the statement that a facility that is providing care to a woman with a TOL must have emergency surgery available. If this service is not available, ACOG (2010) suggests the woman and her physician meet with the facility’s staff prior to her labor to discuss hospital resources. If the facility is concordant with the ACOG recommendation, she should proceed. If not, other options should be discussed to meet these recommendations.

As previously mentioned, in 2007, Roberts et al. (2007) found three out of every 10 hospitals (68 of 229 or 29.7%) that at one time allowed vaginal births after cesarean had discontinued this practice. Furthermore, Cheng et al. (2011) reported one-half of all hospitals in the United States have the capability for TOL and “immediate” availability of emergency care. Therefore, offering women that are good candidates a choice between a TOL and ERCD is not always possible.

**Fear of liability.** The last controversy to consider is the physician's fear of liability. Health-care payers, women, and providers perceive that this fear is a major driver of the increase in the cesarean delivery rate (Minkoff, 2012). Minkoff contends that concerns about "defensive medicine" and cesarean deliveries are reflected in physicians' reports in a survey that they have practiced defensive medicine in the past year.

Physicians also noted they are aware that this practice of defensive medicine, that is, ordering more tests and doing more procedures than might be necessary, can increase health-care costs. Baicker et al. (2007) reported that this increase in spending did not affect patient mortality. Studdert et al. (2005) surveyed six high-liability medical specialties in Pennsylvania (N = 824) to assess how often physicians changed their clinical decision-making because of the threat of malpractice liability. On the questionnaire, obstetricians acknowledged that their defensive behaviors were mostly with high-risk patients (7%) and performing cesarean sections (6%).

Based on the realities of litigation, most obstetricians have been sued once, the first time being in their residency (Minkoff, 2012). VBAC is the seventh most common reason for a medical lawsuit, one ahead of operative vaginal delivery. Other reasons listed in obstetrical litigation involve, in some manner, allegations about the failure to perform a cesarean in a more timely fashion. Minkoff (2012) ends his review with doubt that meaningful tort reform would help this practice of defensive medicine and asks his fellow professionals to follow their professional obligation to serve the patient's interests first.

## Cost

In 2007 the Institutes for Healthcare Improvement (IHI) formulated a plan to improve the U.S. health-care system. This plan has proposed “a simultaneous pursuit of three aims (triple-aim): improving the experience of care, improving the health of populations, and reducing the per capita cost of health care” (Berwick, Nolan, & Whittington, 2008, p. 759). An example of using these aims simultaneously would be using shared decision-making to improve the experience of care, which could decrease the cost to the health-care system by decreasing the number of ERCDs while improving the outcomes for mothers and babies. Berwick et al. (2008) said that the first step to approach controlling cost is to put in place a system to measure and make transparent the per capita cost for a defined population.

IHI (2009) included roles for integration of these components in the triple-aim concept. As this is a systems approach, they defined *macro* and *micro* integrators. A *macro* integrator is defined as an entity that can be a single organization that has the ability to gather resources from numerous organizations to arrange an effective system to support a defined population (IHI, 2009). Such a system could take the form of the establishment of standards for using shared decision-making and making the cost of procedures transparent to women. The *micro* integrator is defined as a single person or team that improves the experience of care for a stated population. An example would be the maternity care team.

In an economic analysis, cost is defined as the input measure to which the consequences or output are compared (Drummond, Sculpher, Torrance, O’Brien, & Stoddart, 2005). Rascati (2009) refers to costs as “resources used in the production of



goods and services” (p. 237). The perspective of an economic analysis specifies which costs to use from a certain point of view.

Hospital costs can be calculated as an estimate of resources used, as opposed to charges, which are the bill a hospital sends to a health-care payer or patient for a case or hospitalization. Charges do not necessarily reflect the actual cost of a hospitalization. The AHRQ’s Healthcare Cost and Utilization Project (HCUP, 2012) converts total charges for a case or hospitalization to costs using a cost-to-charge ratio, which is based on hospital accounting reports from the Centers for Medicare and Medicaid Services (HCUP, 2012). Hospital costs are most often less than charges and represent the true cost used in the hospital’s production of the goods and service. Charges typically represent upcharges, or embedded profits, for services provided. Also, facilities can be reimbursed a different amount than cost-to-charge ratios due to a contracted arrangement for a certain amount between the facility and health-care payer.

An economic analysis has two types of costs: variable and fixed. Direct and indirect costs are considered variable costs because these costs might change due to the intervention being considered. Rascati (2009) defines direct medical costs as those used to directly provide a treatment. Indirect medical costs include a patient’s loss of productivity due to an illness or medical intervention. Fixed costs, those costs that are held at a constant level, which not part of the level of production and the time frame of the analysis, are typically omitted in a cost-effectiveness analysis (Gold et al., 1996).

To estimate the cost of VBAC, ERCD and TOL, Grobman et al. (2000) used only direct medical costs found in the published medical literature. When a value (direct cost) was unavailable, the cost-to-charge ratio was calculated or expert opinion was sought. In

the standard fashion, costs calculated and reported prior to 1999 were adjusted to 1999 dollars using the medical care component of the consumer price index, and future costs were discounted at a rate of 3%. Direct medical costs were derived retrospectively from reimbursement and medical records claims data. Direct medical costs reported were VBAC \$3,578, ERCD \$5,511, and failed TOL \$6,889 (Grobman et al, 2000).

Macario et al. (2004) used an alternative approach to estimating costs, which attempted to use more accurate cost data. With this approach, called bottom-up or micro-costing, it can be difficult to separate all the fixed costs from the variable components. For instance, different labor and delivery units might have different variable costs depending on how their staff is paid: hourly or salary. When compared to other similar calculations done by another hospital in the same city, estimates were deemed consistent. Costs for an ERCD were about \$7,700, for a failed TOL about \$9,800 and for an uncomplicated vaginal delivery about \$6,000. With any complication to mother or baby, the total cost increased by about \$6,000.

Another approach to considering cost is to use the societal perspective. Costs from this perspective encompass “all costs and health effects regardless of who incurs the costs and who obtains the effects” (Gold et al., p. 408). Using the societal perspective, Chung et al. (2000) established baseline cost for uncomplicated VBAC as \$4,950, ERCD as \$7,244, and failed TOL as \$8,414. They also formulated incremental costs for complications to be added to baseline costs.

Using actual hospital costs obtained from their hospital’s clinical resource department, DiMaio et al. (2002) included direct and indirect medical costs, and fixed costs. Their hospital’s procedural coding system adds labor, supply, and equipment for

each revenue code. Incremental costs for complications were calculated based on mean number of added hospital days. Reported costs without complications were ERCD \$4,155+/-661 and VBAC \$3,675+/-936.

Using actual costs, Clark et al. (2000) derived estimated cost from diagnosis-related group (DRG) data. These data were from 1996, covering 22 hospitals in the western United States, totaling 26,000 births. DRG costs were VBAC \$1,480 plus anesthesia cost \$674, ERCD \$2,510 plus anesthesia \$532, and failed TOL \$2,735 plus anesthesia \$940.

Not only do the calculated costs vary in these studies, so do the methods of calculating what their costs entailed. Clark et al. (2000), using 1996 cost data, quoted the cost of ERCD at \$2,510. Grobman et al. (2000) and Chung et al. (2000) used cost data for cesarean as \$5,511 and \$7,244, respectively. DiMaio et al. (2002) cited ERCD costs at \$4,155. Macario et al. (2004) estimated costs for ERCD at \$7,700. HCUPnet (2010), using cost-to-charge ratio, quoted \$4,749 as the cost for repeat cesarean delivery. Also, because the costs are all estimates, some from a specific hospital and some from larger data sets, and the perspectives vary, these numbers are hard to compare. Nonetheless, each study found a TOL resulting in a successful VBAC as the most cost-effective.

### **Payment Reform**

In 2009, United States health-care spending represented 17.6 % of the United States Gross Domestic Product (GDP, Grubmuller, 2009). By 2017, the share of the GDP devoted to healthcare is predicted to reach 19.5 % (Grubmuller, 2009). Government economists predict that between 2007 and 2017, U.S. health-care spending will nearly double (Grubmuller, 2009). These numbers reflect a looming financial crisis. Fixing the

U.S. health-care system will require a multifaceted approach. One possible reform that might affect a change in this growing industry is how we pay for care (Miller, 2009).

Under the current fee-for-service payment system, physicians, hospitals, and other health-care providers are paid primarily based on how many services they deliver. They are paid for volume (Miller, 2012). However, the literature on payment reform is inconclusive on whether physicians may or may not be influenced by the amount of payment for their services, traditionally fee-for-service (Miller, 2012; Schneider, Hussey, & Schnyer, 2011). Additionally, each physician, laboratory, hospital, and other health-care provider involved in the patient's care is paid separately. This can result in paying for duplicate services and tests for the same patient. In this fee-for-service system there is no incentive to providers to coordinate care (Miller, 2012). Low, if any, payment is given for preventive care or care coordination services. Because of these problems, significant changes are needed in the way providers are paid for health care to aid in reducing costs (Miller, 2012).

Fixing how care is paid for with alternate payment plans entails many issues. For example, one strategy of payment reform is not to debate why a procedure, such as a cesarean delivery, is performed. But debating why *low-risk* cesarean deliveries are performed might affect change (Druzin & Sayed, 2006). Additionally, reviewing the current medical literature on present patterns of reimbursement and possible provider incentive programs could aid in the system reforms necessary for a change (Schneider et al., 2011).

Purchasers and insurers have suggested changes in payment plans for health-care services, and reforms for maternity care payments have been developed as alternate

payment models away from fee-for-service. There is some evidence to support the use of one of these alternate payment plans: bundled payments (Catalyst for Payment Reform, 2012).

In the obstetrical community, in conversations with patients discussing the risks and benefits of ERCD or between colleagues discussing their own beliefs, considerable controversy exists. Druzin and El-Sayed (2006) addressed one of the major aspects of this controversy: maternal request for elective cesarean deliveries. In Brazil, the country with the highest cesarean rate in the world (close to 60%), socioeconomic class determines whether or not a woman receives a cesarean section by maternal request. Women in the higher classes ask and receive elective cesarean deliveries, whereas the lower class women are not given this option. Grant (2009) arrived at the striking conclusion that some U.S. physicians perform ERCD because they receive higher reimbursement for that procedure than for a TOL after cesarean.

Keeler and Brodie (1993) found a sizable difference in cost (including hospital cost and physician reimbursement) between an ERCD and a VBAC. They suggested that for a vaginal delivery, payment reform should start with a split in savings between “the mothers for their labor pains, physicians for their time and effort, and hospitals for their backup capacity that allows them to persist with difficult vaginal deliveries” (Keeler & Brodie 1993, p. 393). They also recounted that physician reimbursement rates for uncomplicated cesarean deliveries and vaginal deliveries equalized in 1993, after physicians were surveyed by Blue Cross Blue Shield on their costs (fees) for each procedure. Blue Cross changed its reimbursement practices and a few other commercial insurers followed suit. Consequently, in certain parts of the U.S., uncomplicated cesarean

deliveries and vaginal deliveries were then reimbursed the same amount (Keeler & Brodie, 1993).

Gruber, Kim, and Mayzlin (1999) compared cesarean delivery rates between Medicare and Medicaid recipients and private insurers, assessing causality for differing cesarean delivery rates and reimbursement rates. They found a positive relationship between cesarean delivery rates and fee differentials. This fee differential was large enough to explain why Medicaid recipients had more cesarean deliveries than privately insured women did. On the other hand, Keeler and Fok (1996) studied physician fee changes instituted in California with the goal of decreasing cesarean rates, concluding that equalizing physician fees (payment was the same for elective repeat cesarean deliveries and vaginal births after cesarean) had little effect on cesarean rates.

Keeler and Brodie (1993) determined that economic incentives rarely affect physicians' medical decision-making. They examined other factors that might influence physicians' behavior and reduce cesarean delivery rates, and cited competition with midwives and birth centers (where there is only a 7% cesarean rate) as a possible factor.

Payment reform efforts from purchasers and insurers currently focus on approaches that include incentives to improve quality and reduce the use of costly services (Schneider et al., 2011). In 2010, the Affordable Care Act (ACA, 2010) incorporated some such payment reform measures. Cost containment efforts under the ACA are centered on reversing incentives built into fee-for-service payments to increase services by shifting some of the financial risk to providers. The goal of this strategy is to prompt consideration of the cost for the provider's decision, provide incentives for efficiency, and align payment incentives with quality goals. In turn, providers might

increase and maintain appropriate and necessary care, create care responsive to patients' needs, and promote safer care. Schneider et al. (2011) suggested that new payment schedules are not enough to comprehensively reduce costs. They proposed new payment reform models, which include the following:

- Global payments – These consist of a single monthly payment per member per month for all services delivered for this patient from a mix of providers. Payments may be adjusted depending on measured provider performance and patient's risk.
- Accountable Care Organization (ACO) shared programs – This refers to groups of providers (ACOs) that voluntarily assume responsibility for delivery and services of care for a population of patients. Shared savings come when this group meets quality and cost performance measures.
- Medical homes – A group or single physician may receive additional payments if medical home criteria are met. Payment may be determined through a quality and cost performance mechanism.
- Bundled payments – A single bundled payment is made for services provided during an “episode” of care related to a medical condition or procedure. Payment might be to multiple providers in multiple settings.
- Hospital physician gainsharing – This is payment that allows a hospital to pay physicians. It represents shared savings resulting from the physician and hospital providing collaborative services that improve quality and efficiency.

- Payments for coordination – Payment made to providers that supply care coordination services to integrate care between providers.
- Hospital P4P (Pay for Performance) – Payments to the hospitals based on whether they meet or miss performance benchmarks.
- Payment adjustments for readmissions – Hospital payments are adjusted based on potentially avoidable readmissions.
- Payment adjustments for potential hospital acquired conditions – Hospitals are penalized for high rates of hospital-acquired conditions or are not reimbursed.
- Physician P4P – Payments to physicians are based on whether they make or miss performance benchmarks.
- Payments for shared decision-making – Payment are made for establishing shared decision-making services (Schneider et al., 2011).

Two of these payment reform models are especially relevant to maternity care: bundling payments and shared decision-making. Payments for maternity care are most often bundled but are separated into outpatient services and inpatient care. Shared decision-making can be offered but is not presently standard in payment models.



**Bundled Payments.** Conceptually, bundled payments decrease health care spending while improving quality of care by generating financial incentives for providers to exclude unnecessary services that are clinically ineffective or duplicative (Schoen, Guterman, Zessa, & Abrams, 2013). This could also possibly encourage coordination of care by holding multiple providers and hospitals accountable, through shared payments, for cost of bundled care. Bundled payments could potentially work well for maternity care (Hussey, Ridgely, & Rosenthal, 2011; Schoen et al., 2013). Although there is little empirical evidence at present to support the use of bundled payments, there is an experimental payment model being tested for bundling care that is managed and implemented by Health Care Incentives Improvement Institute, a nonprofit organization that also manages Bridges for Excellence (an organization that measures and provides incentives to providers for quality work; Hussey et al., 2011). This model is called PROMETHEUS, which is an acronym for Provider Payment Reform for Outcomes, Margins, Evidence, Transparency, Hassle Reduction, Excellence, Understandability, and Sustainability. The goal of the Health Care Incentives Improvement Institute is to determine whether this model works in real-world conditions.

Key tools in the PROMETHEUS model are the use of evidence-informed case rates, provider quality score cards, and potentially avoidable (incidents) scorecards. As a comprehensive episode of care is established, the PROMETHEUS payment model centers payment around all services related to that single illness. Costs for treatments are calculated into the evidence-informed case rate. This case rate can be adjusted for complexity of the patient's individual condition. This bundled care includes, for example, services such as hospital, laboratory, pharmacy, and radiologic testing services. The

comprehensive quality scorecard encompasses metrics that track and evaluate care across the entire span of treatment including provider performance measures in meeting clinical practice guidelines for positive patient outcomes, avoidance of preventable complications, and patient satisfaction. The PROMETHEUS payment model rewards providers with an incentive program for improving care and reducing avoidable complications.

Many pilot programs under the PROMETHEUS model have been developed using the episodes of care for heart attacks, hip and knee replacements, diabetes, asthma, congestive heart failure and hypertension. Taken together, these conditions represent a potential impact on 30% of the adult insured population (PROMETHEUS Payment, 2009).

Hussey et al. (2011) discovered conceptual challenges when implementing this model, including defining bundles, defining payment methods, implementing quality measurement, determining accountability, engaging providers, and establishing delivery designs. In spite of these challenges, all three pilot sites testing this payment model have begun to at least implement quality measurements and have found them to improve care and add care coordination to their teams.

Catalyst for Payment Reform (CPR), a nonprofit organization working for coordinated action among the largest purchasers of healthcare (CPR, 2010), contends the present bundle payment system for maternity service needs to be reformed. Currently, outpatient health-care providers for maternity care have a bundled payment system that encompasses the health-care provider's delivery fees. The hospital then uses the fee-for-service payment mechanism for hospitalization for the birth portion of pregnancy. The

hospital is then paid a case rate with the ability to add additional payments for complications. This fee-for-service system is based on the type of birth a woman has knowing a cesarean delivery is reimbursed at a 40% higher rate than a vaginal delivery (Cunningham et al., 2010). CPR suggests a blended facility payment for delivery, creating a single rate whether the birth is vaginal or cesarean. This rate would assume an overall cesarean rate of 32% (or could be calculated for a lower rate) and would combine cesarean costs and vaginal delivery costs. Their example was from 2005 data; with a vaginal delivery cost of \$7,773 and a cesarean delivery cost of \$10,958, the blended rate would be \$8,792. This would remove the financial incentives for cesarean deliveries for both the hospital and provider without the involvement of the health-care payer.

CPR (2010) reported that the Minnesota Department of Human Services has tried this method with Medicaid payments in 2010. The blended rate was set based on the assumption that there would be 5% fewer cesarean than vaginal deliveries. Minnesota projected an estimated facility savings at \$2.25 million annually (based on 26,195 Medicaid-paid births).

CPR (2010) also recommended advancing efforts to combine bundled maternity care payments to encompass comprehensive payments for the women and their newborns. Three approaches were recommended, each with different incentives:

- Bundle professional (obstetrician or midwife) fee and hospital birth payment for labor and delivery into one payment (Main et al., 2011). This would encourage hospitals and providers to coordinate efforts to reduce cesarean rates and improve quality of maternity care. It would also give the hospital a financial lever to use with the providers, helping reduce

unnecessary interventions. The system gets the payment then pays the professional.

- Bundle the hospital delivery payment for both mother and baby into one payment (Main et al., 2011). This bundle would add the baby's immediate cost of care to the mother's expenses. Any neonatal intensive care unit expense for a term infant would be included in this bundle. Additional payments would be made for outliers such as prematurity or known congenital anomalies.
- Establish a comprehensive bundled payment for maternity care episode. One single payment, risk adjusted, would be made for pregnancy, laboratory tests, ultrasounds, and actual delivery including anesthesia. The provider would be paid per pregnancy at the same rate regardless of resources used. One consistent single payment is meant to lead to lower cesarean rates, lower complication rates, and higher profit margins.

Replacing current maternity care payment systems with systems that promote affordability, advance clinical quality, foster prevention, coordinate care and safety, and promote better patient outcomes would have positive implications for mothers and babies. CPR (2011) contends these reforms should be balanced with realistic goals for implementation and should consider a timeline that takes into account the need to change a complex system reflecting geography, delivery system organizations, type of payee, and patient characteristics. Payment reform mechanisms must ensure that the patients receive the right care by the right provider at the right time, incorporating the values and preferences of the patient (Berwick et al., 2008).

Challenges in implementation of bundled payment involve two competing systems function at the same instance, fee-for-service and bundle payments. Future challenges are cited as:

- Aligning physician practices with a shift from volume of service to value and quality outcomes (Delisle. 2013).
- Sharing financial risk management between health-care payers and providers (Snoop, Huckfeldt, Escarce, Grabowski, & Newhouse, 2011).
- Coordinating integrated delivery-of-care systems between acute and post-acute settings.
- Managing financially bundled payments claims processes (Weeks, Rauh, Wadsworth, & Weinstein, 2013).
- Coordinating information to ensure effective communication that facilitates care coordination, exchange of information among providers, and increases access to and transparency of data (Delisle, 2013).
- Standardizing clinical processes by use of evidence-based practice to ensure a reduction in cost and improvement in consistencies of outcomes (Weeks et al., 2013).

Changes in reimbursement such as bundled payments will cause a systematic transformation in delivery, healthcare, health-care provider operations, and consumer perspectives (Delisle, 2013). Implementation challenges in this paradigm shift from volume to value will be a complex system. This method of payment reform is meant to provide value and appropriate levels of use and not punish efficiencies (Weeks et al., 2013).

**Shared Decision-Making.** The ACA (2010) established the Centers for Medicare and Medicaid Innovation and authorized one billion dollars to test payment reform models and delivery of care innovations. One of the delivery of care innovations is shared decision-making and the use of decision aids. The Informed Medical Decisions Foundation and Childbirth Connection, two not-for-profit organizations, have formed a collaborative effort to integrate shared decision-making into maternity care by developing decision aids for women with low literacy skills (Informed Medical Decision Foundation, 2011). Patients and providers at ten sites across the country will test these aids at ten sites across the country. Decisional aids in the form of videos, websites or pamphlets can add value to a preference-sensitive decision, even though these are thought to be nonessential elements for informing patients.

Stacy et al. (2011) reported that decisional aids increase knowledge, lower decisional conflict, and reduce the number of people who choose major elective invasive surgery. As an extensive Cochrane review, Stacy et al. (2011) noted no adverse effects on health outcomes or patient satisfaction when using shared decision-making and decisional aids. They also indicated that cost of implementation has been only slightly studied, which was thought to be a barrier for some sites to implement this practice.

Implementation and evaluation of these practices will provide important data for improving cost containment and quality. Hussey et al. (2011) warned changing to this new system will take time and considerable effort. How payers and providers share the risk of episodes of care seem to be the center of the debate (Hussey et al., 2011).

In sum, knowing the cost-effectiveness of ERCD and TOL could add useful information to this policy debate about maternity care payment reform. In establishing the blended facility rate for deliveries, knowing which mode of delivery is more cost-effective could assist in the use of rate-setting to attempt to adjust cesarean rates. Health-care providers can consider shared decision-making as a mechanism to increase TOL rates. They might have an incentive to do so if health-care payers implement a bundled payment system or similar reforms. Health-care payers, in turn, could support shared decision-making knowing its potential to decrease decisional conflict. For maternity care, shared decision-making could promote the decision to avoid elective surgery by 25% (Stacey et al., 2011).

### **Framework for Economic Analysis in Medicine**

This section of the literature review presents a framework for performing economic evaluations or analyses in medicine. Economic evaluations are essentially concerned with choices, utilization of scarce resources, and costs and consequences of human activities (Drummond, et al., 2005; Siegal, 2005). Consequently, two basic characteristics underlie an economic analysis (Drummond et al., 2005). First, economic evaluations assess the costs (resources used) and consequences of each competing therapy. Second, economic evaluations are concerned with the choices made between alternate therapies, taking into account the scarcity of resources used by those therapies. Therefore, the basic purpose of an economic evaluation is to identify and make explicit one set of criteria, which may be useful in choosing among different uses of scarce resources.

Drummond et al. (2005) specify that the basic responsibility of any economic evaluation is to identify, measure, value, and compare costs and consequences of the alternatives being considered. As a characterization of all economic evaluations, two components must be included: (a) a comparison of two or more alternatives and (b) an examination of both costs (inputs) and consequences (outputs) of the alternatives.

To conduct an economic evaluation, three essential components are required (Gray et al., 2011). The first is the perspective from which to evaluate the various costs and benefits. The second is a formulation of costs to be included in the evaluation (direct, indirect, and intangible). The third required component is a formulation of the economic methodology for the given activity or health question under consideration. These methodologies include cost-minimization, cost-effectiveness, cost-benefit, and cost-utility analysis.

**Perspective in Economic Analyses.** The perspective is the viewpoint from which the study or analysis is conducted. It may assume the viewpoint of a single provider or facility, health-care payer, health-care system, or society at large (Gold et al., 1996). It is important to state explicitly the perspective of an economic evaluation, since the perspective determines whose costs are relevant to the purpose of the study (Rascati, 2009).

Conventional economic theory suggests the societal perspective is the most comprehensive approach (Gold et al., 1996; Rascati, 2009). Societal costs include cost to the insurance company, cost to the patient, other sector costs, and indirect costs because of loss of productivity of the patient and associated caregivers. It is difficult to estimate all these costs accurately. However, in many cases the research question of



interest more simply concerns differences in direct medical costs between two alternatives. The most common perspectives used in pharmacoeconomics studies are those of the institution, the provider or the payer because these may be more practical in answering the query in hand than using the societal perspective (Rascati, 2009).

**Costs in Economic Analyses.** Direct costs in a medical intervention include the value of all goods, and services that are used in the intervention. Direct costs consist of all types of resources used in the direct production or provision of the medical intervention, usually measured in monetary terms, and can have both medical and nonmedical components. Direct medical costs are the most relevant costs to measure because they include costs of tests, drugs, supplies, health-care personnel and medical facilities (Rascati, 2009). Examples of direct nonmedical costs are family expenses for transportation and lodging for family during the treatment.

Direct costs are those costs needed to direct and operate a program. They can be divided into variable costs (supplies, hospital costs) and fixed or overhead costs (such as rent, heat or capital costs). Direct costs are usually calculated by adding direct medical and nonmedical costs for the intervention in question and the alternative therapy.

Indirect costs, also referred to as productivity costs, are the costs associated with loss of or inability to work (temporary or permanent) or engage in leisure activities due to a complication from the intervention (Gold et al., 1996). Haddix, Teutsch, and Corso (2003) included opportunity costs in this concept. Opportunity costs are what a member of society gives up for now and in the future to have a certain intervention. Opportunity costs contain all monetary and nonmonetary costs of the treatment regardless of who bears the cost: the provider, institution, or consumer. If the consumer is unable to work

as the result of a treatment or test, society loses the benefit of that person's contribution in the work force, or that person's healthy time is forfeited. This cost value is most often only included in an economic analysis performed from the societal perspective (Haddix et al., 2003).

Intangible costs include the cost of pain and suffering, or anxiety and fatigue that happens due to the intervention or an illness. It is very difficult to place a monetary value or measurement on this type of cost. Rascati (2009) incorporated intangible costs using the willingness-to-pay technique in a cost-utility analysis. The willingness-to-pay method estimates the cost of an injury or disease by calculating what society would be willing to pay to avoid or reduce the likelihood of that injury or disease.

### **Methodology**

Economists generally refer to four methods of economic analyses: cost-minimization, cost-effectiveness, cost-benefit, and cost-utilization. Cost-minimization analysis is the simplest and costs the least to perform. It measures and compares the input costs and assumes the consequences or outcomes are the same. The goal is to find the least expensive method of achieving the specified outcome. A disadvantage of this method is that it has limited use because it is designed to compare two interventions or alternatives with the same outcomes, which rarely happens in the real world (Rascati, 2009).

Cost-effectiveness analysis is the most commonly used method of economic analysis. It measures costs in dollars and outcomes or effectiveness in natural health or clinical units. The goal is to identify the most cost-effective strategy from a set of alternate therapies or interventions that produce a common effect. An incremental cost-

effectiveness ratio (ICER), defined as the net cost between alternatives divided by the net effectiveness between alternatives, is a focus of cost-effectiveness analysis (Haddix et al., 2003). One disadvantage of this method is that its comparability between cost-effectiveness studies can be limited because each study may have a different outcome measure.

Haddix et al. (2003) touted the cost-benefit analysis as the “gold” standard for economic analysis. This is because cost and benefits are reported using common metrics (usually dollars), which allows for results to be compared for a wide range of public programs. A cost-benefit analysis compares the value of all resources consumed with the value of the outcomes from the intervention. This analysis compares society’s total willingness-to-pay for an outcome with the opportunity cost of the intervention or program.

Cost-benefit analysis has several advantages over a cost-effectiveness analysis. Cost-benefit analysis can be applied to single or multiple interventions or programs, whereas a cost-effectiveness analysis is applied only to multiple interventions or programs. Cost-benefit analysis can be used to compare programs with different outcomes, whereas a cost-effectiveness analysis isolates the least costly approach for a single outcome. A disadvantage of a cost-benefit analysis is that it calculates its outcomes in dollars only. However, some outcomes of great interest to health researchers, such as lives saved, can be difficult to assign an exact monetary value to (Haddix et al., 2003).

Cost-utility analysis, like other economic analysis, compares alternative program outcomes. The difference is that the outcome measure is stated as number of life years saved, with a quality-of-life adjustment, usually measured in QALYs. The question being

investigated in a cost-utility analysis establishes when this is an appropriate evaluation to use. The study question could include the following components: (a) quality of life is an important outcome, (b) the program being evaluated affects both morbidity and mortality, (c) the programs or interventions being compared have a wide range of different outcomes, and/or (d) the comparator intervention has already be evaluated using a cost-utility analysis (Haddix et al., 2003).

### **Framework for Conducting a Cost-Effectiveness Analysis**

A cost-effectiveness analysis can be used to describe and contrast the costs and outcomes for two or more health interventions. Usually an intervention (one or more) is compared to the standard of care or most-often-used intervention, using costs and outcomes for the same condition. The research question for a cost-effectiveness study is about an intervention and its impact on health-care costs and health outcomes. The cost-effectiveness analysis itself analyzes a series of decisions that formulates the study framework. In a cost-effectiveness analysis, the added costs and health outcomes associated with the interventions are used to calculate the incremental cost-effectiveness ratio in relation to the alternate course of events (Gold et al., 1996). This incremental cost-effectiveness ratio can provide an estimate of the additional cost per unit of effectiveness. When an intervention is both more effective and less costly to the alternative, it is said to dominate (Gold et al., 1996). In this case of dominance, there is no need to calculate a cost-effectiveness ratio because dominant strategies are always cost-effective.

Next, aspects of the target population are identified. Aspects of the population can have an impact on the cost-effectiveness calculations. Researchers often identify and

establish the population on the basis of previous research in the peer-reviewed literature. Depending on the analysis, the target population may be identified by age, gender, race, socioeconomic status, clinical history, geographic location, risk-related behaviors, physiological risk factors, or other descriptors. Cost-effectiveness analyses for specific subgroups within a target population may also be performed if indicated by the research question. This would be, for example, relevant when studying different care settings or subgroups in terms of race or age.

Boundaries, or scope of study, also need to be set. Defining the scope of a study can be understood as drawing a circle around it. In circumscribing a study, an attempt is made to include all significant events and health outcomes of said intervention that would be relevant for the stated population. The time horizon of a cost-effectiveness analysis, as part of the scope of a study, should extend far enough into the future to include all major health and economic outcomes (Rascati, 2009).

### **Decision Analysis**

A decision analysis is a systematic quantitative approach to decision-making under uncertainty (Goldie & Corso, 2003). Decision science aims to develop and apply systematic and logical structures to decision-making. Its representative feature is a focus on the outcomes of decisions, including descriptions of any uncertainty about those outcomes that exists when decisions are made. Decision analysis applies a prescriptive approach, which allows one to make effective decisions in a consistent manner. Decision analysis is most useful when multiple alternatives exist and the most efficient selection is unclear.

Another application of decision analysis is to provide policy-makers with a guide to health-care allocation issues (Gray, Clarke, Wolstenholme, & Wordsworth, 2011).

This application of decision modeling has evolved due to the limitations and barriers of other frameworks. An advantage of decision analysis is that the modeling process offers an opportunity to prospectively collect and analyze patient-specific data on resource use and outcomes and to quantify the effects of an intervention on those outcomes.

Application of decision analysis involves four steps: structuring the problem, estimating probabilities, valuing outcomes, and selecting the option with the highest expected value (Gray et al., 2011; Drummond et al., 2005; Haddix et al., 2003).

Structuring the problem includes stating the major issues, defining the perspective and developing a decision tree. The term *decision-tree* is used here because this list of options resembles a tree and its branches.

### **Structure of the Decision Model**

Models are used to structure a decision or problem. The schematic model serves as a guide in concrete, well-defined steps, which outline the event pathways stemming from the use of the intervention and linking the intervention to health outcomes. The model reflects the analyst's formulation of how the intervention is used and how it affects the course of the condition of interest, its treatments, and the health outcomes of the target population. This model includes all relevant effects of the intervention being considered: the events induced by the intervention, and intended and unintended effects. As the event pathway is built to represent health effects, health states, and events that have impacted health, it also reveals the cascade of cost implications caused by the intervention (Gold et al., 1996). The model as a decision tree is assembled from left to

right, starting with the initial decision node and moving to the right toward final outcomes (representing a temporal sequence of events) while estimating probabilities for each event (on the tree) that is subject to chance. Estimates of probabilities may come from the published literature, previous research, actual data, or expert opinion.

Valuing outcomes involves assigning a value to each outcome on the decision tree. The option with the highest expected value is selected after processes known as averaging-out and folding-back the decision tree. The calculation of expected value involves taking the individual products of values from outcomes and respective probabilities for outcomes and then summing these products. In cost-effectiveness and cost-utility analyses, the processes called averaging-out and folding-back are performed twice. These processes are used for the first time to determine the cost of the studied intervention and for the second time to determine the effectiveness of the intervention. The results of these calculations are combined into summary ratios. To test the robustness of the expected utility or expected value calculations, a sensitivity analysis is performed.

### **Review of Economic Evaluation of Cost-Effectiveness Comparing ERCD and TOL**

This section summarizes the published economic evaluations that have been performed comparing ERCD and TOL. It demonstrates the scarcity of this type of cost-effectiveness analysis and the gaps in the literature. The purpose of this review is not to tackle decision-making practices in obstetrics, such as indicated versus emergency cesarean deliveries due to medical complications or the reason the first cesarean delivery was performed. Rather, it is to review the cost-effectiveness of ERCD versus TOL. The literature reviewed focused on the population of women with uncomplicated term pregnancies with normal babies and one previous cesarean delivery.

In June, 2010 and repeated in August, 2012, a literature search was performed using PubMed, EconLit, Web of Science, and Google Scholar online citation indexing services. Similar findings were found from both searches. Search terms included variations of *elective cesarean section*, *cesarean delivery*, *cost-effective*, and *cost-effectiveness*. A total of 1,384 articles were found initially in both PubMed and Web of Science, using only *cesarean section*. With the addition of *cost-effective*, the search was narrowed to 24 articles. EconLit revealed 17 articles when the search terms *cost-effective* and *cesarean section* were entered. After applying the exclusion criteria (stated below), three articles from the medical literature were identified that addressed elective cesarean delivery and cost effectiveness using a cost-effectiveness analysis. Next, a search using reference lists from clinical bulletins from 2005 to 2012 addressing VBAC and ERCD revealed two more published cost-effectiveness analyses. The three articles previously identified by the search of citation indices were also listed in the reference lists for the clinical bulletins. A total of five articles were identified.

The search was limited to articles published in the U.S. between 2000 and 2012 involving term pregnancies with no known complications and with a history of one previous cesarean section. Articles written prior to 2000 or involving high-risk pregnancy conditions, including breech delivery, preterm delivery, low birth weight, multiple gestation, HIV, hepatitis C, gestational diabetes, or preeclampsia, were excluded. Articles written prior to 2000 were excluded because ACOG changed its provider guidelines for VBACs in 1999.



### **Synthesis of Studies on Cost-Effectiveness**

Randomized controlled trials comparing an ERCD and a TOL after cesarean section are not performed because of the ethical concerns inherent in this controversial subject, particularly if cutting health-care costs is the stated goal. Instead of randomized controlled trials, Clark et al. (2000), Chung et al. (2001) and Macario, El-Sayed and Druzin (2004) used hypothetical populations to perform their cost-effectiveness analyses of TOL versus ERCD. All three groups concluded that a TOL, when a vaginal delivery without complications was successfully achieved, was more cost-effective than an ERCD. They also found that if the TOL resulted in a cesarean delivery, the cost would be greater than with an ERCD or vaginal delivery by thousands of dollars because of a longer hospital stay and noted complications.

Grobman, Peaceman, and Socol (2000) used a decision tree to analyze the reproductive life of a hypothetical cohort of 100,000 women with a history of cesarean deliveries and the cost-effectiveness of a second delivery, whether ERCD versus TOL. Their analysis showed an increase in mortality, morbidity, and cost with ERCD. The perspective used was that of a single health-care system. Outcome measures used were maternal and neonatal morbidity and mortality, total cost to their health-care system, and cost per major neonatal complication avoided. They reported that prevention of one additional adverse neonatal outcome required 1,591 additional cesarean deliveries to be performed.

DiMaio et al. (2002) used a retrospective cohort analysis to review 204 medical records. By reviewing the records of all women who delivered at their hospital in 1999 and had a history of one previous cesarean delivery prior to admission, they found a TOL

to be more cost-effective than an ERCD. The outcome measure used for this study was mean cost of hospital care for mother-infant pairs. Interestingly, by using only their own institution's data they could account for all costs incurred, varied and fixed. Many studies are lacking in this area, because fixed cost varies between institutions. DiMaio et al. (2002) concluded that although a TOL that resulted in a cesarean delivery cost more in their institution, it was not by a significant amount. This group found that the mean cost of care was higher for the ERCD, considering mother alone and mother-infant pairs as separate groupings, than a TOL.

Chung et al. (2001) used a computer-generated hypothetical model of a 30-year-old woman pregnant with her second baby after having had a cesarean with her first. They used actual hospital cost and quality-adjusted-life years for the mother (QALY: a measure of disease burden, including both the quality and quantity of life lived) as their outcome measure. Costs associated with moderate morbidity of the infant or probability of infant morbidity heavily impacted their results. Chung et al. (2000) found, using ERCD as their base case, an incremental cost-effectiveness ratio would result of \$112,023 per QALY. This level exceeds the traditional willingness-to-pay for a QALY (\$50,000) and, hence, a TOL was calculated as the preferred method of delivery. That is, the reason that TOL was cost-effective was both that it was lower cost and that the ICER between TOL and ERCD was greater than the willingness to pay.

Also using QALYs as their outcome measure, Macario et al. (2004) used a computerized model for their population to perform a cost-effectiveness analysis comparing ERCD and VBAC. This group used a health utility measure scaling life from death (0) to perfect health (1). They also used the traditional threshold for a QALY at

\$50,000. From a societal perspective, they found that a VBAC has an opportunity cost associated with an obstetrician needing to miss part of his or her life in order to be immediately available for a woman attempting a VBAC. This study explicitly stated it was a cost-effectiveness analysis, but reported its results in cost-benefit ratios. The authors found that “if a priori chance of TOL after a cesarean success is at least 74%, then the cost/benefit profile favors a TOL” (Macario et al., 2004, p. 383).

Lastly, Clark et al. (2000) undertook a cost-effectiveness analysis comparing TOL and ERCD by using an algorithm of the clinical course of a hypothetical patient with a previous cesarean delivery. Costs were derived from DRGs for a large not-for-profit health-care system. The perspective was presumed to be that of a large health-care system. The effectiveness measure was perinatal morbidity. The study focused on total medical costs for a trial of labor and intended to add information, using a shared decision-making model, to the risks and benefits conversation for women deciding between each procedure. They found that an ERCD was associated with greater short-term perinatal morbidity than a vaginal birth. Their findings indicated ERCD was more cost-effective to the health-care system.

The proposed purpose of these five studies was similar. The population of interest was also similar: women in their second pregnancies who had had a first pregnancy resulting in a cesarean delivery. Three studies, Clark et al. (2000), Chung et al. (2001), and Macario et al. (2004), used hypothetical populations and concluded that if a TOL resulted in an uncomplicated vaginal delivery, TOL was more cost-effective. Grobman et al. (2000), using a hypothetical cohort and a decision tree for their cost-effectiveness analysis, found increases in mortality, morbidity, and cost with an ERCD compared to a

TOL. DiMaio et al. (2002) performed a retrospective chart review and found a TOL to be more cost-effective than an ERCD. Basically, although these studies used varying perspectives on costs and measures of effectiveness, the resulting conclusions were similar.

### **Summary**

This chapter reviewed literature related to pregnancy and maternity care, modes of delivery for the first pregnancy, options for the delivery of second pregnancy, and how providers and patients might choose among options for the second pregnancy when the first pregnancy resulted in a cesarean. This review was followed by an overview of the literature related to how the choice is made for ERCD or TOL using shared decision-making. It focused on bioethical aspects of shared decision-making: the mother's autonomy, the provider's beneficence, and differences among beneficence, autonomy, and social justice.

Next, the chapter discussed issues related to access to a TOL. As some women are now opting for a TOL, providers, researchers, and payers need to understand the controversies surrounding it. Results of past economic analyses of complication rates vary greatly from study to study. This variability enhances confusion about optimal delivery options for women and their babies. Major challenges in this area include lack of access to a TOL and providers' fear of liability.

This chapter also reviewed the major aspects of cost used in the published literature pertaining to cost-effectiveness analyses. It also discussed different methods to evaluate costs for economic analyses. Among the many challenges to drawing

comparisons across cost-effectiveness studies is that each study may use a different perspective for determining costs and different measure of effectiveness.

A review of payment reform as it relates to the health-care payer was also part of this chapter. It includes findings from the Catalyst for Payment Reform, which prescribed a few methods for payment system reform for maternity care. Other payment reform options, such as bundled payments and accountable care organizations, were also discussed.

A review of the literature on economic evaluation in medicine summarized the types of economic analyses considered in this study. This review was followed by a discussion of decision analysis and cost-effectiveness analysis. This chapter concluded with a review of cost-effectiveness analysis, comparing ERCD and TOL.

## **Chapter 3**

### **Methods**

This chapter addresses the research design and methods used in conducting the study objectives and are divided into nine sections: (a) Human Subjects Review, (b) Study variables, (c) Research Design, (d) Cost measures, (e) Effectiveness measures, (f) Model Inputs, (g) Calculation of Cost-Effectiveness, (h) Sensitivity Analysis, and (i) Summary.

#### **Human Subjects Review**

Although most academic departments require that researchers receive approval from the institutional review board, certain types of studies are exempt from such review. Studies that are exempt by the Human Research Review Committee (HRRC) at the University of New Mexico (UNM) Health Science Center (HSC) include research involving publicly available data. The estimates used in this study were publicly available from the peer-reviewed literature and from the Healthcare Cost and Utilization Project (HCUP) supported by Agency for Healthcare Research and Quality (AHRQ). Accordingly, the HRRC at UNM HSC confirmed that this study did not require HRRC approval.

#### **Study Variables**

##### **Independent Variable**

This study included one independent variable with two levels. The independent variable was the mode of delivery chosen by a woman in her second pregnancy, who had delivered by cesarean with her first birth. One level of the independent variable was an

elective repeat cesarean delivery (ERCD) after 39 weeks gestation. The second level of the independent variable was a trial of labor (TOL).

### **Dependent Variable**

This study had two types of dependent variables: cost and effectiveness. Direct medical costs, including normal delivery costs and medical complication costs related to delivery, were calculated for both the mother and baby. Possible maternal complications included hemorrhage, infection, thromboembolic event, operative injury, hysterectomy, uterine rupture/dehiscence, and maternal death. Possible baby complications included respiratory distresses, sepsis, hypoxic ischemic encephalopathy (HIE), and fetal death. Effectiveness was measured by length of hospital stay for both the mother and the baby, including a normal hospital stay related to the delivery and possible additional time spent for possible medical complications.

### **Research Design**

The overall purpose of this research was to determine the cost-effectiveness of ERCD compared with TOL in low-risk women who had a cesarean delivery with their first pregnancy and were in their second pregnancy. This analysis compares the cost-effectiveness of ERCD versus TOL from the perspective of the health-care payer by calculating incremental cost-effectiveness ratios for the alternatives ERCD versus TOL when applied to cost and effectiveness related to the mothers and babies.

### **Decision Analysis Model**

As a systematic, quantitative, and visual approach, a decision analysis can be used for addressing and evaluating issues related to medical decisions. The decision analysis model used in this study was an event pathway, built to represent health effects, health

states, and events that have impacted the health of a given population. The event pathway also reveals the cascade of cost implications caused by the intervention (Gold et al., 1996). The starting point in a decision analysis model is the decision between two alternatives. In this study, the decision considered was the choice the mother made between an ERCD and a TOL.

### **Model Specifications**

Developing a model for a decision analysis entails several components: creating a decision tree, selecting the data source, developing the model probabilities, identifying the outcomes (terminal nodes) of interest, and stating the model assumptions. The following sections discuss each of these key components for developing a model for decision analysis used in this study.

**Development of decision trees.** A simulated model was constructed using a decision tree created with TreeAge Pro Healthcare (2012). The decision tree includes two branches related to a woman's decision between an ERCD (performed at 39 weeks' gestation) and a TOL after previous cesarean delivery (See Figure 1). This original decision node represents the decision in question and is represented as a square in the decision tree. The TOL branch was then divided again into two scenarios, vaginal birth after cesarean (VBAC) or rescue cesarean delivery (RCD). The decision tree was then extended from left to right, starting with the decision nodes. The events that follow are clinical events and/or possible complications incurred as a result of the original decision, ERCD or TOL. These are chance events and are represented by chance nodes or circles in the decision tree. Events for each chance node are represented by lines (branches) that extend from a node. The likelihood of an event is represented by the event probability.



Events stemming from a chance node must be mutually exclusive, and probabilities of each chance node must sum to exactly one.

The final outcomes from these chance pathways in the decision tree end in a terminal nodes, represented by triangles in the decision tree. Each terminal node has values assigned to it for both cost and effectiveness. For the mother, possible events and complications resulting from an ERCD or a TOL were included as branches in the model and labeled as follows: no complications, thromboembolic event, infection, operative injury, hemorrhage, hysterectomy, uterine dehiscence/rupture, and maternal death. Because these risks are related to mode of delivery, the maternal events and complications and their probabilities were considered with each possible mode of delivery: ERCD, VBAC or RCD (Figure 1).

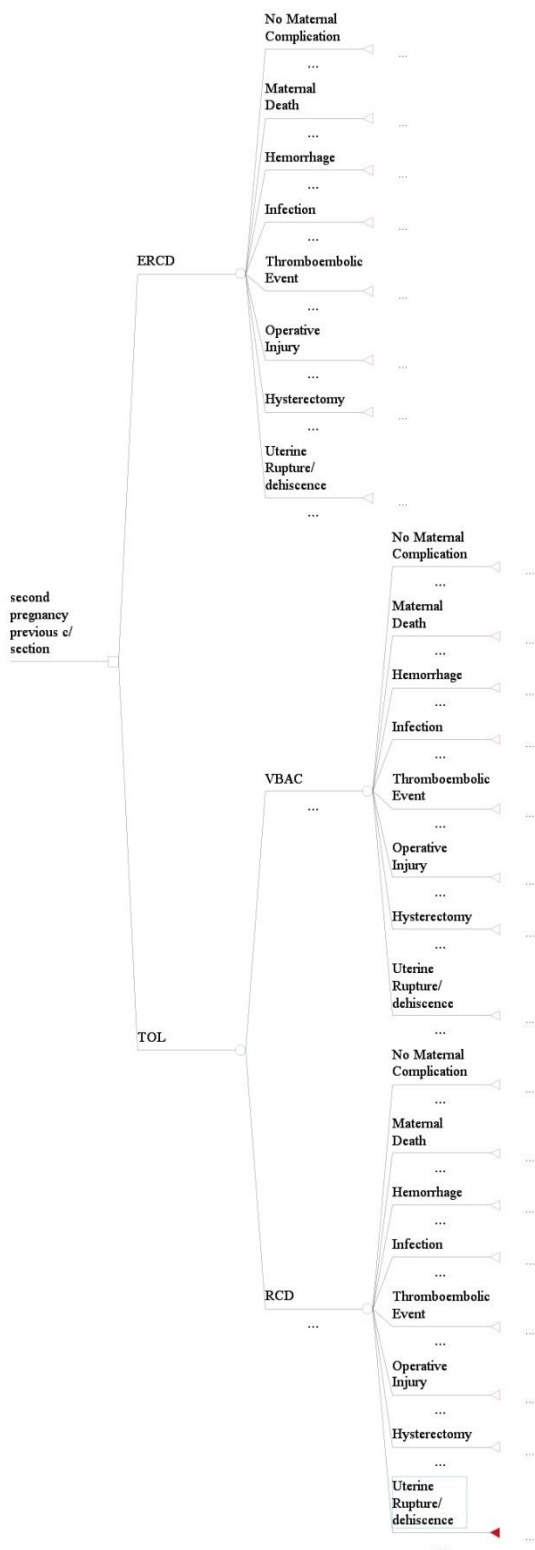


Figure 1. Maternal decision tree.

A second tree was constructed to consider the clinical events, complications and event probabilities incurred by the baby as a result of the mother's decision between an ERCD and a TOL (Figure 2). This decision tree has, broadly speaking, the same appearance as the mother's tree, and it depicts events and complications that the baby incurred for each procedure. These events and complications are chance nodes from each mode of delivery and are labeled as no complications, respiratory distress, sepsis, HIE, and neonatal death.

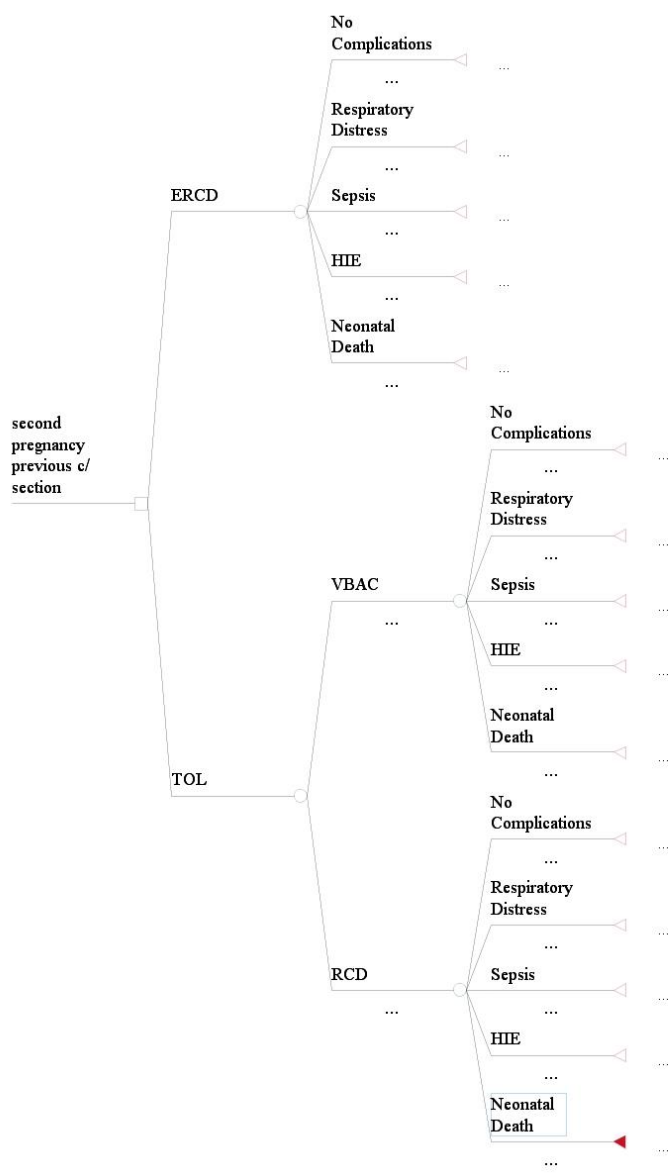


Figure 2. Baby decision tree

**Perspective.** This cost-effectiveness study analyzed costs from the perspective of the health-care payer. Health-care payers for this study were self-pay, Medicaid, Medicare, and private insurance. All cost components that went into the development of this model were determined by estimates of cost-to-charge ratios for hospital care reflected as direct medical costs to the health-care payer.

**Data source.** The data source for costs in this study was the Agency for Healthcare Research and Quality's (AHRQ) Healthcare Cost and Utilization Project (HCUP), (HCUPnet, 2012). A query was performed of the 2010 HCUPnet for cost data from health-care payers, which included self-pay, Medicaid, Medicare, and private insurance. AHRQ sponsors HCUP (2012), which is a "family of powerful health-care databases, software tools, and products designed to advance health-care research as it relates to health services, policy, and clinical research" (HCUP, 2012, p. 1). HCUP (2012) is the largest collection of multiyear, all-payer, encounter-level data based on inpatient, ambulatory and emergency department billing records including all listed clinical diagnoses and procedures, discharge status, and patient demographics since 1988. As a federal-state-industry partnership to compile and create a national information resource, HCUP (2012) brings together data from many organizations: state data organizations, such as hospital associations and state health departments; private data organizations, such as the American Hospital Association; and the federal government. Hospital costs included in HCUP (2012) are from community hospitals, defined as short-term, nonfederal, general and other hospitals, excluding prisons and Indian Health Service. The HCUP database includes obstetrics and gynecology encounters totaling approximately 4 million birth records. HCUP (2012) data is derived from the State Inpatient Databases (SID), State Ambulatory Surgery Databases (SASD), and State Emergency Department Databases (SEDD) to derive three nationwide stratified sample databases: the National Inpatient Sample (NIS), the Kids' Inpatient Database (KID), and the Nationwide Emergency Department Sample (NEDS).

***HCUPnet data.*** HCUPnet (2012) is a free, interactive, publicly available online query system based on aggregated tables which AHRQ established from the NIS HCUP data. As a stratified sample of hospitals, NIS is 20% of the SID, totaling 1,000 hospitals and 8 million records. This sample is stratified by five characteristics: U.S. region, urban/rural, teaching status of hospital, ownership/control of hospital, and bed size. Researchers may query by diagnoses and procedures using the International Classification of Diseases, 9th revision, Clinical Modification (ICD-9-CM) codes, Diagnosis Related Groupings (DRG) codes, and Clinical Classification Software (CCS) categories. HCUPnet (2012) CCS classifies data into clinically meaningful categories, facilitating understanding of clinically grouped patterns. HCUPnet provides estimates on selected outcome measures including number of patients discharged from the hospital, length of hospital stay, total hospital charges, and total costs.

HCUPnet (2012) issues reports of descriptive statistics of specific diagnoses and procedures by year and ICD-9-CM, DRG, and CCS codes. Cost and effectiveness estimates for 2010 for the cost-effectiveness analyses in this study were taken from queries of the HCUPnet data. Tables were created, across all payers and all U.S. regions including 45 states. Median cost estimates were derived using cost-to-charges ratios and effectiveness measures were taken from mean length of hospital stay for mother and baby.

***Estimates from the peer-reviewed literature.*** Probability estimates for the maternal and baby events pathways in the decision analysis were obtained from peer-reviewed literature (DeLuca, Boulvan, Irion, Berner, & Pfister, 2009; Go, Emeis, Guise, & Schelonka, 2011; Hibbard, Ismail, Wang, Te, & Karrison, 2001; Hook, Kiwi, Amini,

Fanaroff, & Hack, 1997; Kamath et al., 2009; Landon et al., 2004; Levine, Ghai, Barton & Strom, 2001; Menacker et al., 2010; O'Shea, Klebanoff, & Signore, 2010; Patel & Jain, 2010; Spong et al., 2007; Yee, Amin, & Wood, 2008).

**Target population.** The target population for this analysis was women in their second pregnancy when the first pregnancy resulted in a cesarean delivery choosing between an ERCD and a TOL. These women were low-risk, at-term, and singleton pregnancies, with the fetal head as the presenting part.

**Time Horizon.** Gold et al. (1996) recommended that a time horizon adopted for cost-effectiveness analysis should be long enough to capture all relevant effects of the intervention being studied. The time horizon for this study was from time of hospital admission of the mother for delivery until she and the baby were discharged from the hospital. This encompassed the cost to the health-care payer for the mode of delivery and possible events and complications incurred by both the mother and baby during their length of stay. No discounting was necessary because direct medical costs were all from the same year with no modification necessary for future estimates.

### **Model Assumptions**

In specifying the structure of the decision analysis model, certain assumptions were made. Maternal clinical events and complications for each decision were obtained from the peer-reviewed medical literature based on a meta-analysis performed by Rossi and Addario (2008), who documented these events as the most common complications. Although some of these maternal complications are rare events, when they occur they are a high expense in direct medical costs and may add to the length of hospital stay for the mother and baby. Base case probabilities were established from the estimate of the event

that was most likely to occur. Another assumption was that in the event of maternal death the mother died at delivery. This assumption was important because a death later, after delivery, would incur additional costs by the day, varying by the complication, and may not always be directly attributable to the mode of delivery. Additionally, in the event of fetal death, the model assumes fetal death also occurs at time of delivery. This assumption was important because, as with the mother, additional costs would be incurred which would vary according to the complication, and may not always be a casualty of the mode of birth.

### **Cost measures**

Given the perspective of this analysis (the health-care payer), only direct medical costs were used in the cost-effectiveness analysis. These costs were as follows: (a) direct medical costs incurred for hospitalization for ERCD and TOL for mother and baby, and (b) direct medical costs related to events and complications from modes of delivery (ERCD and TOL) for mother and baby. Clinical complication costs for both the mother and baby were derived from the HCUPnet aggregated cost estimates using 2010 data. HCUPnet cost data uses cost-to-charge ratios only for hospital costs, not including physician fees or outpatient costs.

The use of aggregated cost data such as available from HCUPnet is supported by Berwick et al. (2008) since the considerations of population-level measures is a precondition to credibly pursuing the “triple aim.” Additionally, looking at care utilization among pregnant women is consistent with Berk and Monheit (2001) strategy of focusing cost containment strategies on conditions that affect large percentages of populations. This focus allows for a concentration on health-care spending that reflects a



concern over equity and the efficiency with which resources are used. Therefore, the value of using aggregate cost data from HCUPnet (2012) from the perspective of the health-care payer (Medicaid, Medicare, self-pay and private insurance) accounts is that aggregation averages out the uneven distribution of health-care expenditures among different health-care payers by weighting high costs alongside low costs. Berk and Monheit found that the top 5% of health-care expenditures among the privately insured doubled what was spent by the uninsured. Using HCUPnet's (2012) aggregated cost structure allows the general focus of health-care cost for the population of women in their second pregnancy when their first pregnancy resulted in a cesarean delivery.

**Querying HCUPnet.** Using a step-by-step query process in HCUPnet, one starts with using national statistics, identifying oneself as a researcher, then specifying how he or she wants to query, which is by diagnosis and procedure codes; next, the researcher chooses a year (in this case, 2010). The next step is divided into choices for queries using different coding systems for instance, ICD-9-CM, DRG, or CCS. For this study, the choice of coding system varied by the clinical events and complications contingent on codes already determined (see Tables 1- 6). Some clinical events and complications required the use of only ICD-9-CM codes to derive cost estimates and some clinical events and complications required ICD-9-CM codes as well as DRG and/or CCS codes.

The next selection in the HCUPnet query was for outcomes and measures which produced statistics including number of discharges, mean length of stay (days), mean hospital costs, percentage of deaths, and discharge status (to home, assisted living facility, or rehabilitation, or funeral home or mortuary). The last selection was for type of patient and hospital, which in this study was for all hospitals and all patients. This

produced a table with weighted national estimates from 2010 HCUP NIS, based on data collected by individual states and provided to AHRQ. When using HCUPnet with specific ICD-9-CM codes or combination of codes no standard error is given. Statistics based on 10 or fewer weighted cases are noted as not reliable and are suppressed. Cost estimates for maternal deaths were not available from HCUPnet due to the low number of cases, so these cost estimates were obtained from the peer-reviewed literature (Chung et al., 2001 and Grobman et al., 2000).

**Timing adjustments for costs.** Costs that are incurred at different timeframes need to be adjusted to ensure that all costs are based on a common year (Grey et al., 2011). All costs estimates from HCUPnet were from 2010. Only costs estimates for maternal death, which were taken from the peer-reviewed literature in the years 2000 and 2001, were from another year. Following the recommendation of Grey et al. (2011), the medical consumer price index, which reflects the change in cost to the medical consumer, was used to standardize these past cost estimates to 2010.

### **Effectiveness measures**

Effectiveness measures what an intervention achieves in “real” world conditions or via routine clinical practice (Rascati, 2009). When establishing effectiveness measurements for health interventions, consideration of events that can influence the outcomes of the population studied is necessary and effectiveness is measured in clinical units (Rascati, 2009). The outcome or effectiveness measure utilized in the study was length of hospital stay (LOS) in number of days. Each clinical event and complication for the mother and baby due to an ERCD or TOL has the potential to add days to a hospitalization. In this study, LOS is a negative effectiveness measure. That is, lower

LOS indicates greater effectiveness and is a preferable outcome. LOS for the mother is considered from admission of mother until she goes home. This might include the mother's time in labor prior to the birth, which is not always a contributing factor to her complication event rate. LOS for the baby is considered from the birth of the baby (admission) until he or she goes home. For this research, HCUPnet (2012) estimates were used for length of hospital stay and obtained by the same process as for costs.

### **Model Inputs**

By convention, model costs and probabilities are entered under the branches emanating from the chance node. These model probabilities represent the likelihood of uncertain maternal and baby clinical events and possible complications stemming from the choice between ERCD and TOL. The model costs represent the cost of hospitalization for these events. The effectiveness measure used was length of hospital stay (see Tables 1–6).

The following sections enumerated by ERCD or TOL for the mother and baby include definitions of possible complications, probabilities of such events, and their calculated costs.

#### **ERCD maternal events, possible complications, probabilities and costs.**

*No Complications.* ERCD is defined as a woman in her second pregnancy with a previous cesarean delivery for the first pregnancy, who is scheduling repeat cesarean delivery at 39 weeks gestation for a set time and who is not in labor. The probability used for “no complications” was calculated by summing up the probabilities across complications and then subtracting from one. Median cost was calculated using ICD-9-

CM 654.21, 669.7, CCS 134, and DRG 765 and 766 and produced a cost estimate of \$4,752. The mean LOS was 2.8 days.

***Hemorrhage.*** Hemorrhage is defined as the loss of blood in the post-partum period (after delivery of baby) of more than 1000 ml following a cesarean delivery (Begley, Gyte, Devane, McGuire, & Weeks, 2011). The probability of this event was 0.024 (Chung et al., 2001; Macario et al., 2004). Median cost was calculated using ICD-9-CM 666.02, 666.1, and 654.21 and produced a cost estimate of \$58,067. The mean LOS was 9.3 days.

***Infection.*** This definition includes sepsis and uterine, urinary, pulmonary, or wound infections (Chung et al., 2001). The probability of this event was 0.075 (Chung et al., 2001; Macario et al., 2004). Median cost was calculated using ICD-9-CM 654.21 and CCS 168 and produced a cost estimate of \$17,526. The mean LOS was 3.2 days.

***Thromboembolic event.*** This event is defined as a lodgment of a blood clot causing blockage of a vein. As a rare event, this would include a deep vein thrombolysis, pulmonary embolism, and amniotic embolism during hospitalization for delivery at term. The base case probability for this event was 0.001 (Grobman et al., 2000) and alternate case probability was 0.007 (Macario et al., 2004). Median cost was calculated using ICD-9-CM 673.21 and produced a cost estimate of \$76,132. The mean LOS was 10 days.

***Operative injury.*** This is defined as a laceration of uterine arteries or injury to viscera other than the uterus during the course of the operative delivery (Chung et al., 2001). The base case probability was 0.0001 (Grobman et al., 2000) and alternate case probability was 0.0039 (Macario et al., 2004). Median cost was calculated using ICD-9-CM 674.34 and produced a cost estimate of \$24,867. The mean LOS was 4.7 days

***Hysterectomy.*** This event is defined as an operative procedure to remove the uterus. The base case probability of this event was 0.0014 (Cheng et al., 2011) and alternate case probability 0.0039 (Chung et al., 2001). Median cost was calculated by using CCS 124 + 195 and produced a cost estimate of \$73,460. The mean LOS was 6.9 days.

***Uterine rupture/dehiscence.*** Uterine rupture is defined as a defect through the entire uterine wall that requires operative intervention. Uterine dehiscence is the separation of a uterine wound or a uterine surgical scar. These are considered together in this study because they are detected most often during surgery and are classified under the same ICD-9-CM code. The base case probability of the event was 0.0014 (Landon et al., 2004) and alternate case probability 0.0008 (Chung et al., 2001). Median cost was calculated by using ICD-9-CM 665.11 and produced a cost estimate of \$24,768. The mean LOS was 3.7 days.

***Maternal death.*** This event is considered at time of delivery. The base case probability for this event was 0.0002 (Macario et al., 2004) and alternate case probability 0.0004 (Landon et al., 2004). The HCUP query using ICD-9-CM code 669.9 for maternal sudden death produced no cases. Costs were determined by values stated in the published literature of \$2,150 (Chung et al., 2001) and \$100,000 (Grobman et al., 2000), adjusted to 2010 dollars using the medical CPI to \$2,647.21 and \$126,629.50, respectively. The mean LOS by assumption was 0 days.

Table 1. *Model Input Maternal ERCD*

Maternal ERCD	Codes from HCUPnet (2010)	Base case probability	Alternate case probability	Direct Costs Estimates	LOS (in days)	Source
No complication	ICD-9-CM-654.21, 669.7, CCS 134, and DRG 765 and 766	.8969 <sup>1</sup>	.8023	\$4752	2.8	Landon 2004 <sup>1</sup>
Hemorrhage	ICD-9-CM 666.02, 666.1, and 654.21	.024 <sup>1</sup>	.074 <sup>2</sup>	\$58,067	9.3	Macario 2004 <sup>1</sup> , Chung 2001 <sup>1</sup> , Hibbard 2001
Infection	ICD-9-CM 654.21 and CCS 168	.075 <sup>1</sup>	.02 <sup>2</sup>	\$17,526	3.2	Marcario 2004 <sup>1</sup> , Chung 2001 <sup>1</sup> , Spong 2007
Thromboembolic event	ICD-9-CM 673.21	.001 <sup>1</sup>	.0007 <sup>2</sup>	\$76,132	10	Landon 2004 <sup>1</sup> , Macario, 2004 <sup>2</sup>
Operative injury	ICD-9-CM 674.34	.0001 <sup>1</sup>	.0039 <sup>2</sup>	\$24,867	4.7	Grobman, 2000 <sup>1</sup> , Macario, 2004 <sup>2</sup>
Hysterectomy	CCS 124 + 195	.0014 <sup>1</sup>	.0039 <sup>2</sup>	\$73,460	6.9	Cheng, 2011 <sup>1</sup> , Chung, 2001 <sup>2</sup>
Uterine rupture/dehiscence	ICD-9-CM 665.11	.0014 <sup>1</sup>	.0008 <sup>2</sup>	\$24,768	3.7	Landon, 2004 <sup>1</sup> , Chung, 2001 <sup>2</sup>
Maternal Death	ICD-9-CM 669.9	.0002 <sup>1</sup>	.0004 <sup>2</sup>	\$2,150 <sup>3</sup> (\$2,647) & \$100,000 <sup>1</sup> (\$126,629)	0	Grobman 2000 <sup>1</sup> , Landon, 2004 <sup>2</sup> , Chung 2001 <sup>3</sup>

**TOL followed by VBAC- maternal events, possible complications, probabilities and costs.**

**No complications.** TOL followed by a VBAC is defined as a woman in her second pregnancy with a previous cesarean delivery for the first pregnancy who has had a successful TOL and a vaginal birth without complications. The probability for “no complications” was calculated by summing up the probabilities across complications and then subtracting from one. Median cost was calculated by using ICD-9-CM, DRG, and CCS codes (respectively) 654.21, 774, 196+189 and produced a cost estimate of \$4,113. The mean LOS was 2.8 days.

**Hemorrhage.** Hemorrhage is defined as blood loss with a vaginal delivery greater than 500 ml. (Begley, Gyte, Devane, McGuire, & Weeks, 2011). The probability of this event is 0.012 (Chung et al., 2001; Macario et al., 2004). Median cost was calculated by using ICD-9-CM codes 666.02 and 666.1, and produced a cost estimate of \$25,076. The mean LOS was 4.1 days.

**Infection.** Infection is defined the same as with ERCD. The probability of this event is 0.034 (Chung et al., 2001; Macario et al., 2004). Median cost of this event was calculated by using ICD-9-CM and CCS codes 654.21, 168 and produced a cost estimate of \$17,526. The mean LOS was 3.2 days.

**Thromboembolic event.** Thromboembolic event is also defined the same as with ERCD. The base case probability of this event is 0.0002 (Chung et al., 2001; Macario et al., 2004) and the alternate case probability is 0.0004 (Landon et al., 2004). Median cost was calculated by using ICD-9-CM code 671.51 and produced a cost estimate of \$59,936. The mean LOS was 7.9 days.

***Operative injury.*** Operative injury is defined the same as for ERCD and includes severe vaginal lacerations. The probability of this event is 0.001 (Chung et al., 2001; Macario et al., 2004). Median costs were calculated by using ICD-9-CM code 674.30 and produced a cost estimate of \$18,949. The mean LOS was 3.6.

***Hysterectomy.*** Hysterectomy is defined as surgery to remove the uterus after a successful VBAC. The base case probability of this event is 0.0002 (Chung et al., 2001) and alternate case probability is 0.002 (Landon et al., 2004). Median cost was calculated by using CCS code 124+195 and produced a cost estimate of \$73,460. The mean LOS was 6.9 days.

***Uterine rupture/dehiscence.*** The definitions for uterine rupture/dehiscence are the same as for ERCD. The base case probability of this event is 0.007 (Landon et al., 2004) and alternate case probability is 0.0005 (Chung et al., 2001; Macario et al., 2004). Median cost was calculated by using ICD-9-CM code 665.11 and produced a cost estimate of \$24,768. The mean LOS was 3.7 days.

***Maternal death.*** Maternal death is defined as death of the mother at delivery. The probability of this event is 0.00002 (Chung et al., 2001; Macario et al., 2004). ICD-9-CM code 669.9 for maternal sudden death produced no results. Costs were determined by values stated in the published literature of \$2,150 (Chung et al., 2001) and \$100,000 (Grobman et al., 2000), discounted to \$2,647.21 and \$126,629.50, respectively. The mean LOS by assumption was 0 days.



Table 2. Model Inputs Maternal TOL Followed by VBAC

Maternal TOL- VBAC	Codes from HCUPnet (2010)	Base case probability	Alternate case probability	Direct Costs Estimates	LOS (in days)	Source
No complications	ICD-9-CM, DRG, and CCS codes (respectively) 654.21, 774, 196+189	.94378 <sup>1</sup>	.9301	\$4,113	2.8	Landon 2004 <sup>1</sup>
Hemorrhage	ICD-9-CM codes 666.02, 666.1	.012 <sup>1</sup>	.008 <sup>2</sup>	\$25,076	4.1	Chung 2001 <sup>1</sup> , Macario 2004 <sup>1</sup> , Gregory 2008
Infection	ICD-9-CM and CCS codes 654.21, 168	.034 <sup>1</sup>	.023 <sup>2</sup>	\$17,526	3.2	Chung 2001 <sup>1</sup> , Macario 2004 <sup>1</sup> , Loebel 2004
Thromboembolic event	ICD-9-CM code 671.51	.0002 <sup>1</sup>	.0004 <sup>2</sup>	\$59,936	7.9	Macario 2004 <sup>1</sup> , Landon 2004 <sup>2</sup>
Operative injury	ICD-9-CM code 674.30	.001 <sup>1</sup>	.001	\$18,949	3.6	Macario 2004 <sup>1</sup>
Hysterectomy	CCS code 124+195	.0002 <sup>1</sup>	.002 <sup>2</sup>	\$73,460	6.9	Chung 2001 <sup>1</sup> , Landon 2004 <sup>2</sup>
Uterine rupture/dehiscence	ICD-9-CM code 665.11	.007 <sup>1</sup>	.0005 <sup>2</sup>	\$24,768	3.7	Landon 2004 <sup>1</sup> , Macario 2004 <sup>2</sup>
Maternal death	ICD-9-CM code 669.9	.00002 <sup>1</sup>	0	\$2,150 (\$2647.21) \$100,000 (\$126,629.50)	0	Chung 2001 <sup>1</sup> , Macario 2004 <sup>1</sup>

**TOL followed by an RCD- maternal events, possible complications,  
probabilities and costs.**

**No complications.** No complications is defined as the situation for a woman in her second pregnancy with a previous cesarean delivery for the first pregnancy, who has a TOL which results in a cesarean delivery. The probability for “no complications” was calculated by summing up the probabilities across complications and then subtracting from one. Median cost was calculated by using ICD-9-CM code 660.61 and produced a cost estimate of \$5,614. The mean LOS was 3.3.

**Hemorrhage.** Hemorrhage is defined the same as for ERCD. The probability of this event is 0.021 (Chung et al., 2001; Macario et al., 2004). Median cost was calculated by using ICD-9-CM codes 666.02, 666.1 and produced a cost estimate of \$58,067. The mean LOS was 9.3 days.

**Infection.** Infection is defined the same as for ERCD. The base case probability of this event is 0.19 (Macario et al., 2004) and alternate case probability is 0.03 (Grobman et al., 2000). Median cost was calculated by using ICD-9-CM and CCS codes 654.21, 168 and produced a cost estimate of \$17,526. The mean LOS was 3.2 days.

**Thromboembolic event.** Thromboembolic event is defined the same as for ERCD and VBAC. The base case probability of this event is 0.0008 (Chung et al., 2001; Macario et al., 2004) and the alternate case probability is 0.003 (Grobman et al., 2000). Median cost was calculated by using ICD-9-CM code 673.21 and produced a cost estimate of \$76,132. The mean LOS was 10 days.

**Operative injury.** Operative injury is defined the same as for ERCD. The base case probability of this event is 0.034 (Chung et al., 2001; Macario et al., 2004) and the alternate case probability is 0.02 (Grobman et al., 2000). Median cost was calculated by

using ICD-9-CM code 674.30 and produced a cost estimate of \$24,867. The mean LOS was 3.6 days.

***Hysterectomy.*** Hysterectomy is defined the same for ERCD. The probability of this event is 0.004 (Chung et al., 2001; Macario et al., 2004). Median cost was calculated by using CCS code 124+195 and produced a cost estimate of \$73,460. The mean LOS was 6.9 days.

***Uterine rupture/dehiscence.*** Uterine rupture/dehiscence is defined the same as for ERCD. The probability of this event is 0.019 (Chung et al., 2001; Macario et al., 2004). Median cost was calculated by using ICD-9-CM code 665.11 and produced a cost estimate of \$24,768. The mean LOS was 3.7 days.

***Maternal death.*** This event is defined as death of the mother at delivery. The probability of this event is 0.00017 (Macario et al., 2004). ICD-9-CM code 669.9 for maternal sudden death produced no results. Costs were determined by values stated in the published literature of \$2,150 (Chung et al., 2001) and \$100,000 (Grobman et al., 2000), discounted to \$2,647.21 and \$126,629.50, respectively. The mean LOS by assumption was 0 days.

Table 3. *Model Inputs for Maternal TOL Followed by an RCD*

Maternal TOL-RCD	Codes from HCUPnet (2010)	Base case Probability	Alternate case Probability	Direct Costs Estimates	LOS (in days)	Source
No complication	ICD-9-CM code 660.61	.731 <sup>1</sup>	.834	\$5,614	3.3	Macario 2004 <sup>1</sup>
Hemorrhage	ICD-9-CM codes 666.02, 666.1, 654.21	.021 <sup>1</sup>	.09 <sup>2</sup>	\$58,067	9.3	Chung 2001 <sup>1</sup> , Macario 2004 <sup>1</sup> , Hibbard 2001
Infection	ICD-9-CM and CCS codes 654.21, 168	.19 <sup>1</sup>	.03 <sup>2</sup>	\$17,526	3.2	Macario 2004 <sup>1</sup> , Grobman 2000 <sup>2</sup>
Thromboembolic event	ICD-9-CM code 673.21	.0008 <sup>1</sup>	.003 <sup>2</sup>	\$76,132	10	Macario 2004 <sup>1</sup> , Chung 2001 <sup>1</sup> , Grobman, 2000 <sup>2</sup>
Operative injury	ICD-9-CM code 674.30	.034 <sup>1</sup>	.02 <sup>2</sup>	\$24,867	3.6	Macario 2004 <sup>1</sup> , Chung 2001 <sup>1</sup> , Grobman 2000 <sup>2</sup>
Hysterectomy	CCS code 124+195	.004 <sup>1</sup>	.004 <sup>1</sup>	\$73,460	6.9	Chung 2001 <sup>1</sup>
Uterine rupture/dehiscence	ICD-9-CM code 665.11	.019 <sup>1</sup>	.019 <sup>1</sup>	\$24,768	3.7	Macario 2004 <sup>1</sup> , Chung 2001 <sup>1</sup>
Maternal death	ICD-9-CM code 669.9	.00017 <sup>1</sup>	0	\$2,150 <sup>1</sup> (\$2,647) & \$100,000 <sup>2</sup> (\$126,629)		Chung 2001 <sup>1</sup> , Grobman 2000 <sup>2</sup>

**ERCD baby events, possible complications, probabilities and costs.**

*No complications.* No complications is defined as a baby born at 39 weeks gestation from an ERCD without complications. The probability for “no complications” was calculated by summing up the probabilities across complications and then subtracting from one. Median cost was calculated by using ICD-9-CM code V 30.01 and CCS 218 and produced a cost estimate of \$4,598. The mean LOS was 4.7 days.

*Respiratory distress.* Respiratory distress is defined as signs inclusive of tachypnea (rapid respirations), retractions, grunting, nasal flaring, and cyanosis on room air, or requiring treatment with any of the following: supplemental oxygen, nasal continuous positive pressure, endotracheal intubation, or exogenous surfactant (Yee et al., 2008). The base case probability of this event is 0.059 (Kamath et al., 2009) and the alternate case probability is 0.10 (Yee et al., 2008). Median cost was calculated by using ICD-9-CM codes V30.01, 770.89 and produced a cost estimate of \$63,588. The mean LOS was 10.9 days.

*Sepsis.* Sepsis is defined as the immune system’s reaction to a serious infection. In an infant, the symptoms may involve the respiratory, gastrointestinal and central nervous systems. Sepsis is most often confirmed by bacteria found in a blood culture (Deluca et al., 2009). The probability of this event is 0.02 (Hook et al., 1997). Median cost was calculated by using ICD-9-CM codes V30.01, 771.81 and produced a cost estimate of \$19,706. The mean LOS was 9.5 days.

*Hypoxic Ischemic Encephalopathy (HIE).* HIE is defined as an injury to the brain thought to be caused by hypoxia during the birth (Go et al., 2011). The base case probability of this event is 0.0032 (Gregory et al., 2008) and the alternate case probability

was 0 (Landon et al., 2004). Median cost was calculated by using ICD-9-CM codes V30.01, 768.73 and produced a cost estimate of \$63,891. The mean LOS was 24.7 days.

**Neonatal death.** Neonatal death is defined as the death of a baby who is born live, and then dies (Go et al., 2011). The probability of this event is 0.0005 (Landon et al., 2004) and alternate probability is 0.0008 (Menacker et al., 2010). The cost was calculated by using ICD-9-CM codes V 30.01, 656.41 and produced a cost of \$4,626. The mean LOS by assumption was 0.

Table 4. *Model Input Baby-ERCD*

Baby-ERCD	Codes from HCUPnet (2010)	Base case Probability	Alternate case Probability	Direct Costs Estimates	LOS (in days)	Source
No complication	V 30.01 CCS-218	.9173 <sup>1</sup>	.860	\$4,598	4.7	Kamath 2009 <sup>1</sup>
Respiratory distress	V 30.01 770.89	.059 <sup>1</sup>	.10 <sup>2</sup>	\$63,588	10.9	Kamath 2009 <sup>1</sup> , Patel 2010 <sup>2</sup>
Sepsis	V 30.01 771.81	.02 <sup>1</sup>	.027 <sup>2</sup>	\$19,706	9.5	Hook 1997 <sup>1</sup> , Loebel 2004 <sup>2</sup>
HIE	V 30.01 768.73	.0032 <sup>1</sup>	0 <sup>2</sup>	\$63,891	24.7	Gregory 2008 <sup>1</sup> , Landon 2004 <sup>2</sup>
Neonatal death	V 30.01 656.41	.0005 <sup>1</sup>	.0008 <sup>2</sup>	\$4,626	0	Landon 2004 <sup>1</sup> , Menacker 2010 <sup>2</sup>

**TOL followed by a VBAC baby events, possible complications, probabilities and costs.**

**No complications.** No complications is defined as a normal baby born without complications to a woman who has had a cesarean delivery with her first pregnancy, and delivered vaginally. The probability for “no complications” was calculated by summing

up the probabilities across complications and then subtracting from one. Median cost was calculated by using ICD-9-CM code V 30.00 and produced a cost estimate of \$1,975. The mean length of stay was 2.5 days.

***Respiratory distress.*** Respiratory distress is defined the same as for ERCD. The probability of this event is 0.012 (Kamath et al., 2009). Median cost was calculated by using ICD-9-CM codes V30.00, 770.89 and produced a cost estimate of \$63,588. The mean LOS was 10.9 days.

***Sepsis.*** Sepsis is defined the same as for ERCD. The probability of this event is 0.02 (Go et al., 2011). Median cost was calculated by using ICD-9-CM codes V30.00, 771.81 and produced a cost estimate of \$19,706. The mean LOS was 9.5 days.

***HIE.*** HIE is defined the same as for ERCD. The probability of this event is 0.0008 (Spong et al., 2007). Median cost was calculated by using ICD-9-CM codes V30.00, 768.73 and produced a cost estimate of \$63,891. The mean LOS was 24.7.

***Neonatal death.*** Neonatal death is defined the same as for ERCD. The probability of this event is 0.0006 (Manacker et al., 2010). Median cost was calculated by using ICD-9-CM codes V30.00, 656.41 and produced a cost estimate of \$4,626. The mean LOS was by assumption 0 days.

Table 5. *Model Input Baby TOL-VBAC*

Baby-TOL-VBAC	Codes from HCUPnet (2010)	Base case Probability	Alternate case Probability	Direct Costs Estimates	LOS (in days)	Source
No complication	V 30.00	.9665 <sup>1</sup>	.961	\$1,975	2.5	Kamath 2009 <sup>1</sup>
Respiratory distress	V 30.00 770.89	.012 <sup>1</sup>	none	\$63,588	10.9	Kamath 2009 <sup>1</sup>
Sepsis	V 30.00 771.81	.02 <sup>1</sup>	.12 <sup>2</sup>	\$19,706	9.5	Go 2011 <sup>1</sup> , Hook 1997 <sup>2</sup>
HIE	V 30.00 768.73	.0008 <sup>1</sup>	none	\$63,891	24.7	Spong 2007 <sup>1</sup>
Neonatal death	V 30.00 656.41	.0007 <sup>1</sup>	none	\$4,626	0	Menacker 2010 <sup>1</sup>

**TOL followed by a RCD baby events, possible complications, probabilities and costs.**

***No complications.*** No complications is defined as a baby born without complications to a mother who had a cesarean for her first delivery and then had a TOL that resulted in another cesarean delivery. The probability for “no complications” was calculated by summing up the probabilities across complications and then subtracting from one. Median cost was calculated by using ICD-9-CM codes V30.01, and produced a cost of \$4,598. The mean LOS was 4.7.

***Respiratory distress.*** Respiratory distress is defined the same as for ERCD. The probability of this event is 0.059 (Kamath et al., 2009). Median cost was calculated by using ICD-9-CM codes V30.01, 770.89 and produced a cost estimate of \$63,588. The mean LOS was 10.9.



**Sepsis.** Sepsis is defined the same as for ERCD. The probability of this event is 0.12 (Patel & Jain, 2010). Median cost was calculated by using ICD-9-CM codes V30.01, 771.81 and produced a cost estimate of \$19,706. The mean LOS was 9.5 days.

**HIE.** HIE is defined the same as for ERCD. The probability of this event is 0 (Spong et al, 2007). Median cost was calculated by using ICD-9-CM codes V30.01, 768.73 and produced a cost estimate of \$63,891. The mean LOS was 24.7 days.

**Neonatal death.** Neonatal death is defined the same as for ERCD. The probability of this event is 0.0009 (Spong et al., 2007). Median cost was calculated by using ICD-9-CM codes V30.01, 656.41 and produced a cost estimate of \$4,698. The mean LOS by assumption was 0.

Table 6. *Model Inputs Baby-TOL-RCD*

Baby-TOL-RCD	Codes from HCUPnet (2010)	Base case Probability	Alternate case Probability	Direct Cost Estimates	LOS (in days)	Source
No complication	V30.01	.8201 <sup>1</sup>	.820	\$4,598	4.7	Kamath 2009 <sup>1</sup>
Respiratory distress	V30.01 770.89	.059 <sup>1</sup>	none	\$63,588	10.9	Kamath 2009 <sup>1</sup>
Sepsis	V 30.01 771.81	.12 <sup>1</sup>	.02 <sup>2</sup>	\$19,706	9.5	Patel 2010 <sup>1</sup> , Hook 1997 <sup>2</sup>
HIE	V30.01 768.73	0 <sup>1</sup>	none	\$63,891	24.7	Spong 2007 <sup>1</sup>
Neonatal death	V30.01 656.41	.0009 <sup>1</sup>	.0011 <sup>1</sup>	\$4,626	0	Spong 2007 <sup>1</sup>

### Calculation of Cost-Effectiveness.

Cost-effectiveness analysis involves a “numerical estimate of magnitude of effect of an intervention on health outcome” (Mandelblatt et al., 1996, p. 135). When an intervention under study is both more effective and less costly than the alternative, it is

said to dominate the alternative. The presentation of cost-effectiveness results includes calculating average cost-effectiveness ratios (ACER, Grey et al., 2011) and incremental cost-effectiveness ratios (ICER). These ratios can help answer clinical practice dilemmas. When one of the interventions is more expensive and more effective than the other, the ICER is used to decide the extent of the added cost for each unit in health improvement. When the ICER, used as the difference in the cost divided by the difference in effectiveness, yields a negative number, this designates that one intervention, the dominant option, is both more effective and less expensive than the other, dominated option (Rascati, 2009).

Cost-effectiveness calculations can be depicted as the comparison of alternatives in a graph. This graph takes place in the north-east portion of the cost-effectiveness plane. When one alternative or intervention is dominated by the other it is more expensive and less effective. The slope of the line between the two alternatives represents the ICER. In this study, there will appear to be a positive slope between dominated alternatives in the cost-effectiveness graph due to the use of a negative effectiveness measure.

**Average cost-effectiveness ratio.** The ratio of cost to effectiveness for a single treatment gives a comparison that is made “in relation to doing nothing or no treatment,” this is referred to as an ACER (Gray et al., 2011, p. 14; Rascati, 2009, p. 48). For this research, an ACER would be, for example, calculated by dividing cost for the mother for ERCD by LOS for the mother for ERCD (cost/LOS). The benefit of doing this calculation is that it shows the cost and effectiveness (cost per one unit of effectiveness) of each intervention alone.

**Incremental cost-effectiveness ratio (ICER).** An ICER, as used in health services research, compares the differences between cost and health outcomes of two alternative interventions that compete for the same resources. ICERs generally describe the additional cost per additional health outcome (Grey et al., 2011). When using a negative effectiveness measure, it is useful to calculate the negative of the usual ICER for comparative purposes.

The numerator in the ICER represents the difference between the cost of the two interventions being compared (the net cost). In this study, the numerator used was cost of ERCD minus cost of TOL. The denominator is the difference in effectiveness between these two interventions (the net effectiveness). The net effectiveness of the intervention is an estimated difference in outcomes related to a health state that may occur as a consequence of the intervention and its alternative (Rascati, 2009). The health-related outcome used as a measure of effectiveness in this study was length of hospital stay, so the denominator for the ICER was the length of stay for ERCD minus the LOS for TOL. Formulas for the ICERs for mother and baby are shown below (see Figure 3).

$$-\left( \frac{CostA - CostB}{EffectA - EffectB} \right)$$

*Mother*

$$-\left( \frac{CostA - CostB}{EffectA - EffectB} \right)$$

*Baby*

*Figure 3.* ICERs for mother and baby.

### **Sensitivity Analysis**

Sensitivity analysis is performed using selected uncertain parameters of a decision analysis model to test whether the results of a cost-effectiveness analysis would change

based on changing the values of the uncertain parameter. One-way sensitivity analyses were performed in this study to bring critical focus to important uncertain parameters related to maternal complications, including cost of maternal mortality and the probabilities of thromboembolic event, hemorrhage, and infection. In addition, one-way sensitivity analyses were performed for the baby for the probabilities of complications of respiratory distress syndrome, sepsis, and neonatal mortality.

As an example, cost estimates for maternal mortality based on the costs of one day in an intensive care unit ranged from \$2,150 (Chung et al., 2001) to \$100,000 (Grobman, 2000). Such a wide variation could change the outcome of the cost-effectiveness analysis. Thus, these values were used as base case and alternate case estimates.

Additional sensitivity analyses were performed using estimates of maternal LOS for uncomplicated ERCD of 3.92 days and uncomplicated VBAC of 2.55 days reported by Guise et al., (2010). These estimates varied from 2010 HCUPnet (2012) estimates for uncomplicated ERCD of 2.8 days and uncomplicated VBAC of 2.8 days. Changes in estimated values for these key outcomes could change the outcome of the cost-effectiveness analysis.

This analysis was presented in table format with the value of each probability or cost varied compared for each strategy, ERCD or TOL. The subsequent columns in each table are for costs, net incremental costs, effectiveness (LOS), and net incremental effectiveness. The final columns in each table are for ACERs and ICERs. When parameter estimates in a sensitivity analysis are varied, the assumptions of the decision model must be maintained. In particular, the probabilities need to always add to one. In

this study, probabilities for uncomplicated ERCD, RCD, and VBAC were adjusted as other probabilities varied in order to maintain this assumption.

### **Summary**

Haddix et al. (2003) specified the core elements of a decision analysis as follows: (a) specify a decision problem or objective, (b) structure a decision model, (c) estimate probabilities, (d) value consequences (outcomes), (e) analyze the base case, and (f) evaluate uncertainty (sensitivity analyses). These components of a decision analysis were defined in this chapter. This chapter also included detailed explanations of queries performed in HCUPnet, figures derived from TreeAge for the decision analysis for mother and baby. It includes tables that display model inputs, including codes and categories used to derive estimates for costs and LOS and probabilities taken from peer-reviewed literature.

## **Chapter 4**

### **Results**

The first objective of this study was to establish probabilities for possible events and complications for ERCD and TOL in a second pregnancy. The second objective was to determine the cost and effectiveness (LOS) associated with each procedure, ERCD and TOL. Tables 1–6 display probabilities for the mother and baby from peer-reviewed published literature, as well as costs, and effectiveness (LOS) measures calculated from HCUPnet (2012) from the year 2010. The third objective was to calculate the ICER between ERCD and TOL for the mother and baby. This chapter includes those results.

The first section provides study findings for the mother from the cost-effectiveness analysis comparing ERCD and TOL. The second section presents the same information for the baby. Subheadings for each section are cost-effectiveness comparing ERCD and TOL, incremental cost-effectiveness ratio, and sensitivity analysis.

#### **For the Mother**

##### **Cost-Effectiveness Comparing ERCD and TOL**

Figure 4 displays the decision analysis including probabilities, costs, and LOS for base case scenarios in decision tree format comparing ERCD and TOL in a second pregnancy for the mother. Figure 5 displays the results of the cost-effectiveness analysis comparing ERCD and TOL in a second pregnancy for the mother. In general, TOL was found to be the preferred option over ERCD in a second pregnancy. Specifically, of the possible modes of delivery, TOL was the most preferred overall at \$6,388.07/3.0 (Cost\LOS).

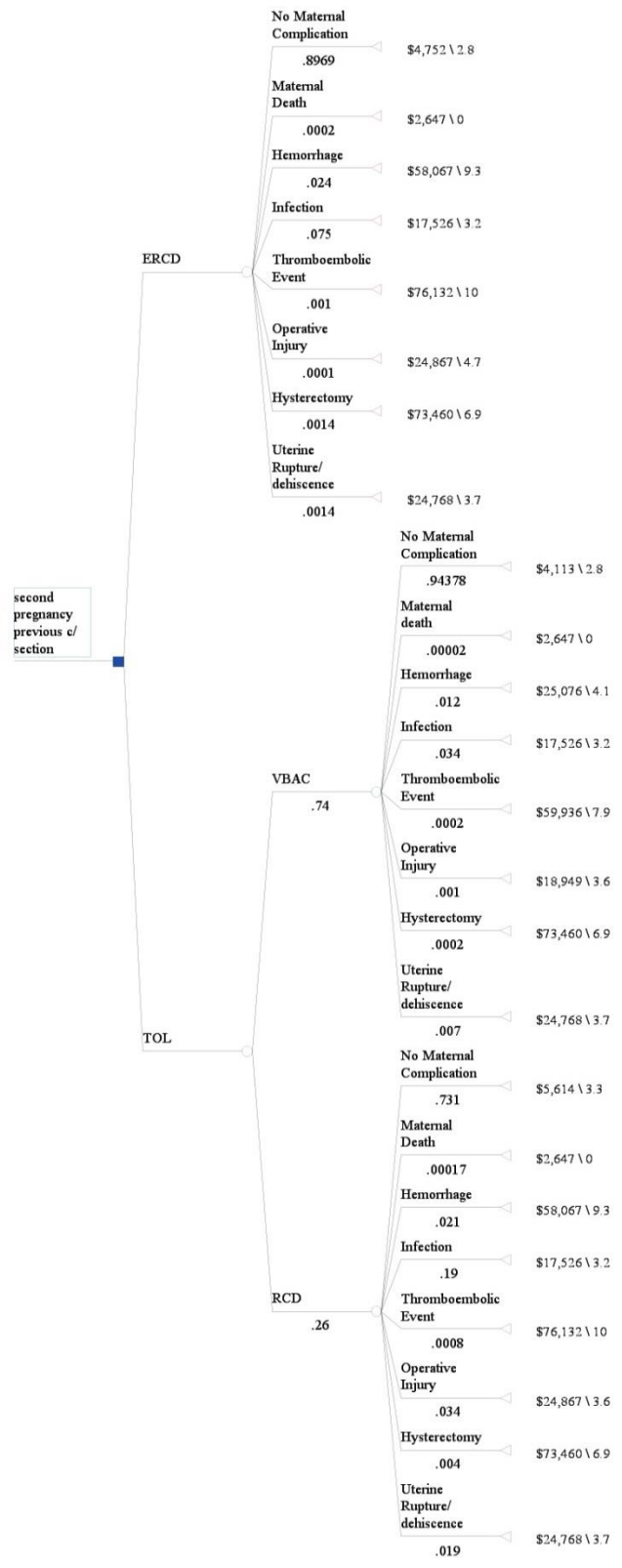


Figure 4. Mother decision tree.

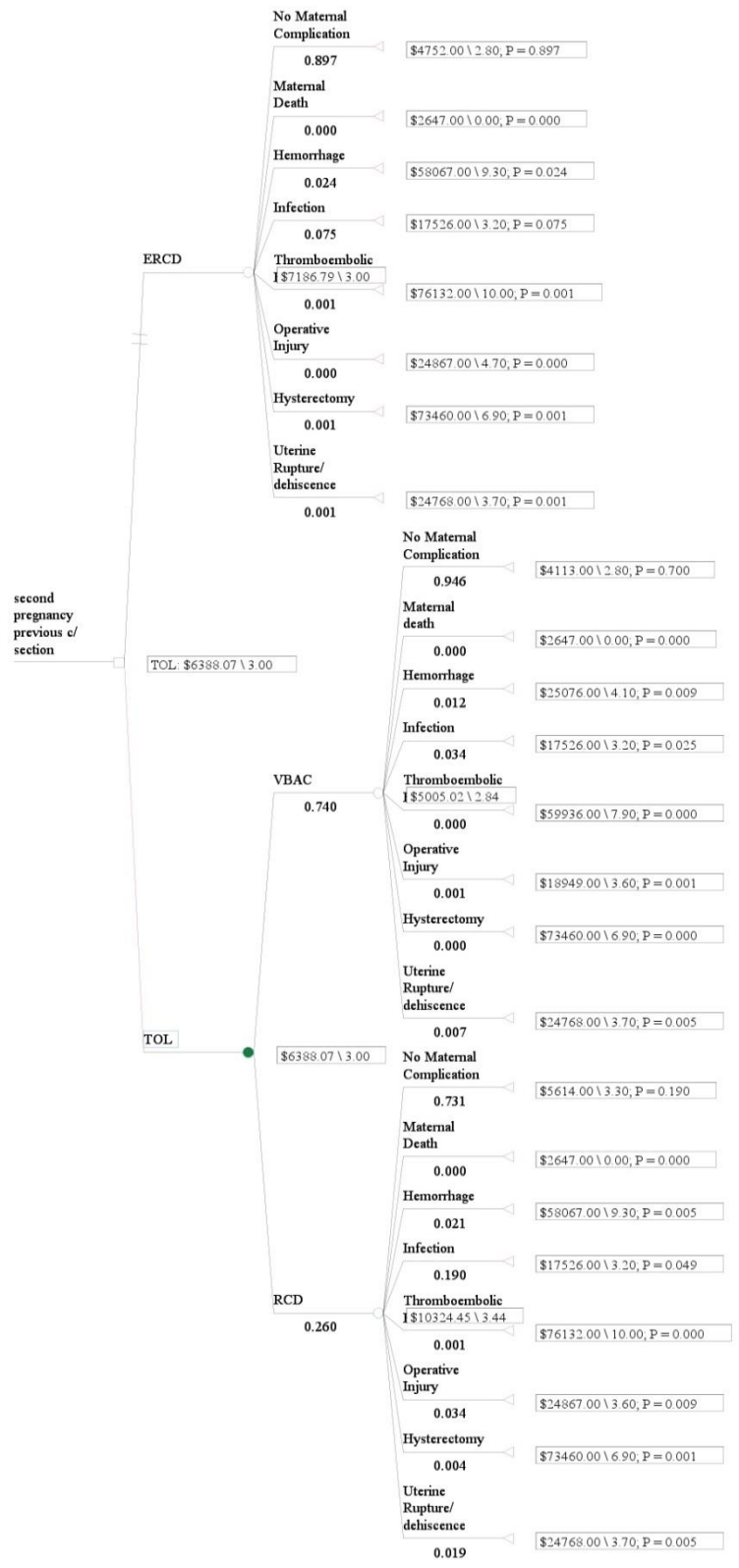
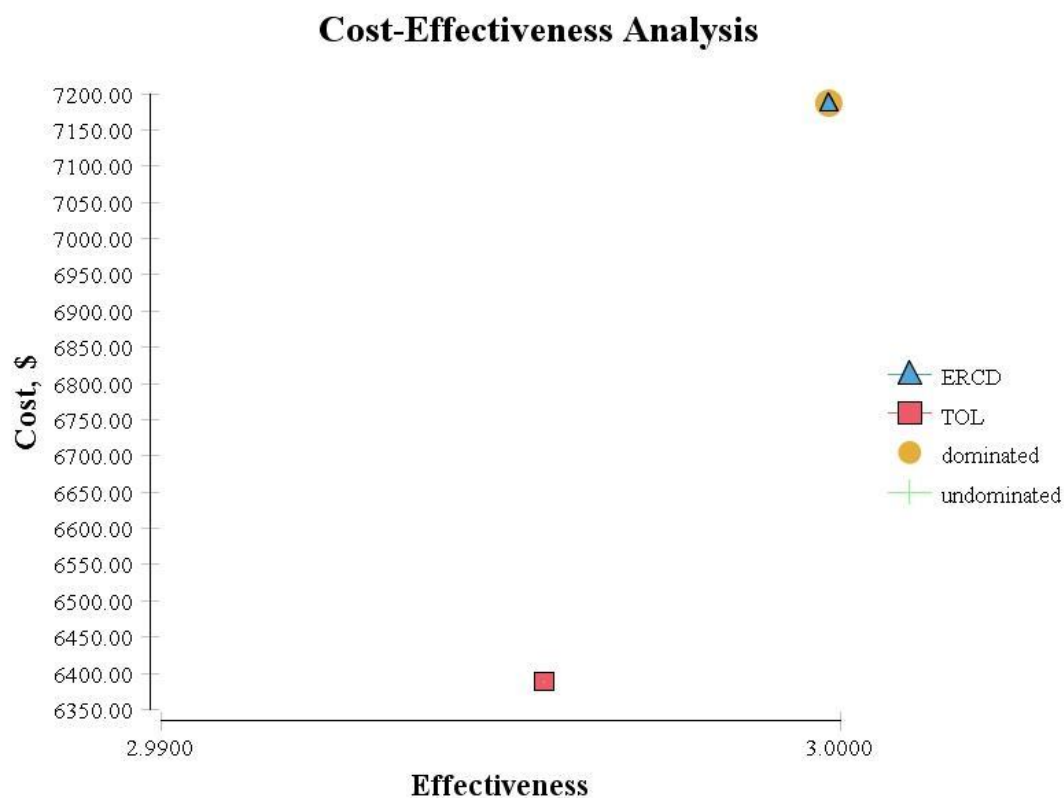


Figure 5. Maternal cost-effectiveness analyses.



### Incremental Cost-Effectiveness Ratio

Figure 6 displays a graphical plot of cost and effectiveness for the base case results of the cost-effective analysis comparing ERCD and TOL in a second pregnancy for the mother. ERCD is dominated by TOL because costs of ERCD are higher and effectiveness is lower. The lower effectiveness is reflected in higher LOS graphically. TOL was the cost-effective alternative.



*Figure 6.* Cost-Effectiveness Graph using Base Case Probabilities for Cost-Effectiveness Analysis Comparing ERCD and TOL in a Second Pregnancy.

Table 7 displays base case results for incremental cost-effectiveness comparing ERCD and TOL in a second pregnancy for the mother. The ACER reflects the cost per one unit of effectiveness (LOS), which were \$2,132.48/day for TOL and \$2395.73/day

for ERCD. The ICER, as defined in Figure 4, is the negative of the ratio of the difference in costs between ERCD and TOL to the difference in effectiveness between ERCD and TOL. In this case, \$7,186.79 minus \$6,388.13 divided by 2.9996 minus 2.956 leads to an incremental cost difference of \$798.66 and incremental effectiveness of .0042. ERCD was dominated by TOL. The incremental cost-effectiveness ratio between ERCD and TOL was -\$190,501.76/LOS. This negative ICER is consistent with dominance, and hence, cost-effectiveness.

Table 7. *Cost-Effectiveness Comparing ERCD and TOL for the Mother in a Second Pregnancy*

Strategy	Cost	Incremental Cost	LOS (Eff)	Incremental Eff (LOS)	ICER	C/E (ACER)
TOL	\$6,388.13		2.9956			\$2,132.48
ERCD	\$7,186.79	\$798.66	2.9998	0.0042	-\$190,501.76	\$2,395.73

### **Sensitivity Analysis**

A one-way sensitivity analysis was performed to bring critical focus to the selected uncertain probability estimates from the peer-reviewed literature of thromboembolic events for ERCD and RCD; infection for ERCD, RCD and VBAC; and hemorrhage for ERCD, RCD and VBAC. Cost estimates were varied for maternal mortality for ERCD, RCD, and VBAC. Table 8 includes base case probabilities and the alternative case probabilities for each strategy. Table 9 includes the varied cost estimates for maternal mortality. Subsequent columns of these tables represent costs of the strategy, incremental costs, effectiveness (LOS), and incremental effectiveness. The final calculations are the ACER (C/E) and the ICER for each parameter estimate varied.

Table 8. *Sensitivity Analysis: Cost-Effectiveness Analysis Comparing ERCD and TOL in a Second Pregnancy Applying Base Case and Alternative Probabilities Maternal Values*

Probability varied	Strategy	Cost	Incr Cost	Eff	Incr Eff	ACER	ICER
<b>Hem-E</b>							
0.024*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-0.0042	\$2,395.93	-\$190,502
0.074	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$9,852.54	\$3,464.41	3.3248	-0.325	\$2,963.34	-\$10,660
<b>Hem-RCD</b>							
0.021*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-0.0042	\$2,395.93	-\$190,502
0.09	TOL	\$7,329.14		3.1076		\$2,388.11	
	ERCD	\$7,186.79	\$142.35	2.9998	-0.1078	\$2,395.93	-\$1,320.50
<b>Hem-VB</b>							
0.008	TOL	\$11,591		3.0038		\$3,858.78	
	ERCD	\$7,186.79	\$4,404.21	2.9998	-0.004	\$2,395.93	-\$1,101,053
0.012*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-0.0042	\$2,395.93	-\$190,502
<b>Inf-ERCD</b>							
0.02	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,889.36	\$1501.23	3.1528	-0.154	\$2,502.34	-\$68,238
0.075*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-0.0042	\$2,395.93	-\$190,502
<b>Inf-RCD</b>							
0.03	TOL	\$6,422.20		2.9997		\$2,140.95	
	ERCD	\$7,186.79	\$764.59	2.9998	-0.0001	\$2,395.93	-\$7,645,900
0.19*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-0.0042	\$2,395.93	-\$190,502
<b>Inf-VBAC</b>							
0.023	TOL	\$11,591		3.0000		\$3,863.67	
	ERCD	\$7,186.79	\$4,404.21	2.9998	-0.0002	\$2,395.93	-\$22,021,050
0.034*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-0.0042	\$2,395.93	-\$190,506

Table 8. Continued

Probability varied	Strategy	Cost	Incr Cost	Eff	Incr Eff	ACER	ICER
Throm-E							
0.00	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-0.0042	\$2,395.93	-\$190,502
0.001*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,258.17	\$870.04	2.9926	-0.0072	\$2,425.37	-\$120,839
Throm-RC							
0.0	TOL	\$6,402.80		3.0014		\$2,133.27	
	ERCD	\$7,186.79	\$783.99	2.9998	-0.0016	\$2,395.93	-\$489,994
0.0008*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-0.0042	\$2,395.93	-\$190,502

Hem-E- hemorrhage ERCD

Hem-VB-hemorrhage VBAC

Throm-E- Thromboembolic event ERCD

Throm-RC- Thromboembolic event RCD

\*Base case

Table 9. *Sensitivity Analysis: Cost-Effectiveness Analysis Comparing ERCD and TOL in a Second Pregnancy Applying Base Case and Alternative Costs for Maternal Values*

Cost varied	Strategy	Cost	Incr cost	Eff	Incr eff	ACER	ICER
Mat mort							
\$2,647.00*	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-.0042	\$2,395.73	-\$190,502
\$126,629.00	TOL	\$6,388.13		2.9956		\$2,132.48	
	ERCD	\$7,186.79	\$798.66	2.9998	-.0042	\$2,395.73	-\$190,502

Mat mort- Maternal mortality

\*Base case

The findings from this one-way sensitivity analysis were that varying the parameter uncertainties did not affect the overall outcome of the cost-effectiveness analysis for the mother. For instance, increasing the probability of hemorrhage in an ERCD by 0.05 increased the cost estimate to \$9,852.54, increased the incremental cost to \$3,464.41, increased the LOS to 3.32 days, and increased the incremental effectiveness to 0.325. ERCD continued to be dominated by TOL; whereas, increasing the probability of

hemorrhage in a VBAC by .004 increased the cost estimate to \$11,591, increased the incremental cost to \$4,404.21, increased the LOS to 3.00 days, and the incremental effectiveness remained the same at 0.004. ERCD continues to be dominated by TOL. Therefore, the results of this cost-effectiveness analysis remain insensitive to the parameter uncertainties applied and are proven robust.

A two-way sensitivity analysis was performed to bring critical focus to the selected uncertain probability estimates of LOS for ERCD and TOL (see Table 10). Changing the effectiveness rate (LOS) to the reported values used by Guise et al. (2010) in a two-way sensitivity analysis revealed the model to be insensitive to varying the parameters. ERCD continues to be dominated by TOL. Therefore, the model is robust.

Table 10. *Two-Way Sensitivity Analysis: Cost-effectiveness Analysis comparing ERCD and TOL in a Second Pregnancy varying LOS for Maternal Values*

Effectiveness varied	Strategy	Cost	Incr cost	Eff	Incr eff	ACER	ICER
LOS	TOL	\$6,388.13		2.55		\$2,50515	
	ERCD	\$7,186.79	\$798.66	3.92	1.37	\$1833.36	-\$582.46

### **For the Baby**

#### **Cost-Effectiveness Comparing ERCD and TOL**

Figure 7 displays the decision analysis, including probabilities, costs, and LOS for base case scenarios in the decision tree format comparing ERCD and TOL in a second pregnancy for the baby. Figure 8 displays the results of the cost-effectiveness analysis comparing ERCD and TOL in a second pregnancy, also for the baby. In general, TOL was found to be the preferred intervention over ERCD in a second pregnancy.

Specifically, of the possible modes of delivery, TOL was the most preferred strategy overall at \$4,883.77\3.49 (Cost\LOS).

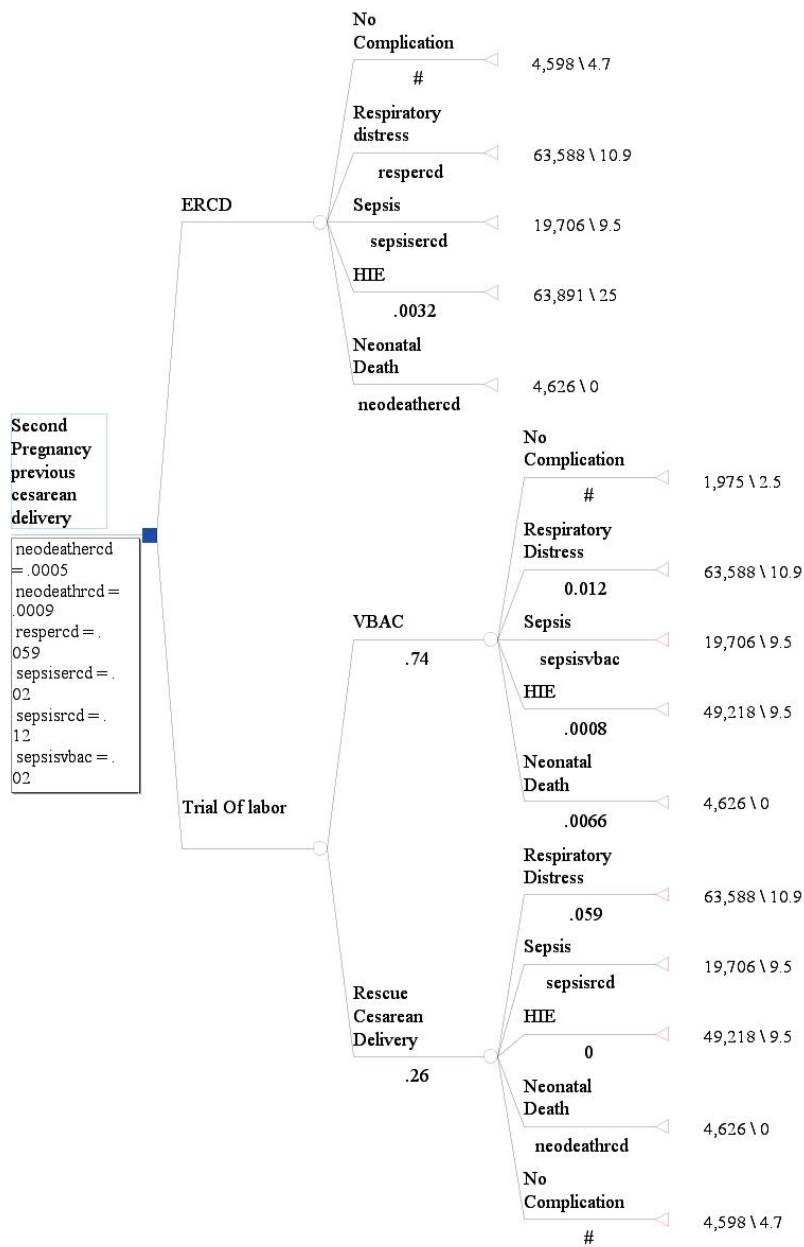


Figure 7. Baby decision tree.

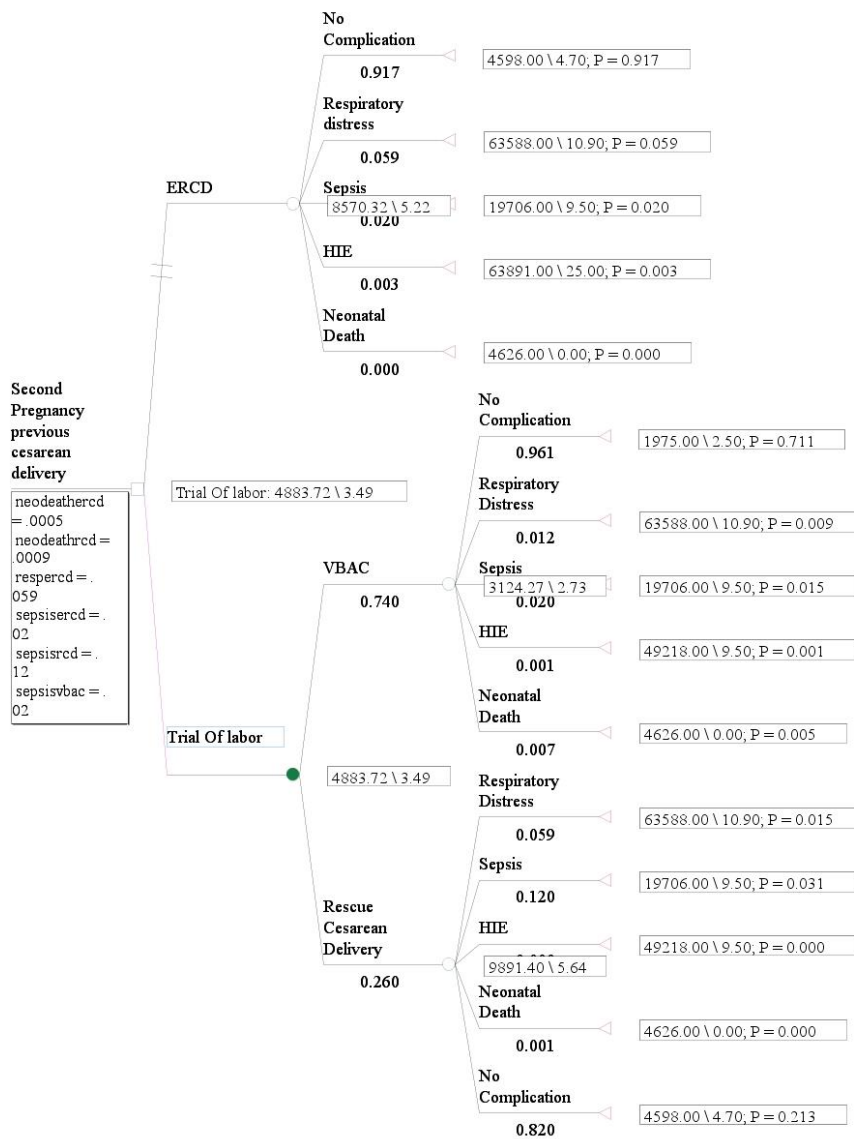


Figure 8. Baby cost-effectiveness analyses.



### Incremental Cost-Effectiveness Ratios

Figure 9 displays a graphical plot of cost and effectiveness for the base case results of the cost-effective analysis comparing ERCD and TOL in a second pregnancy for the baby. ERCD is dominated by TOL because costs of ERCD are higher and effectiveness is lower. The lower effectiveness is reflected in higher LOS graphically. TOL is the cost-effective alternative.

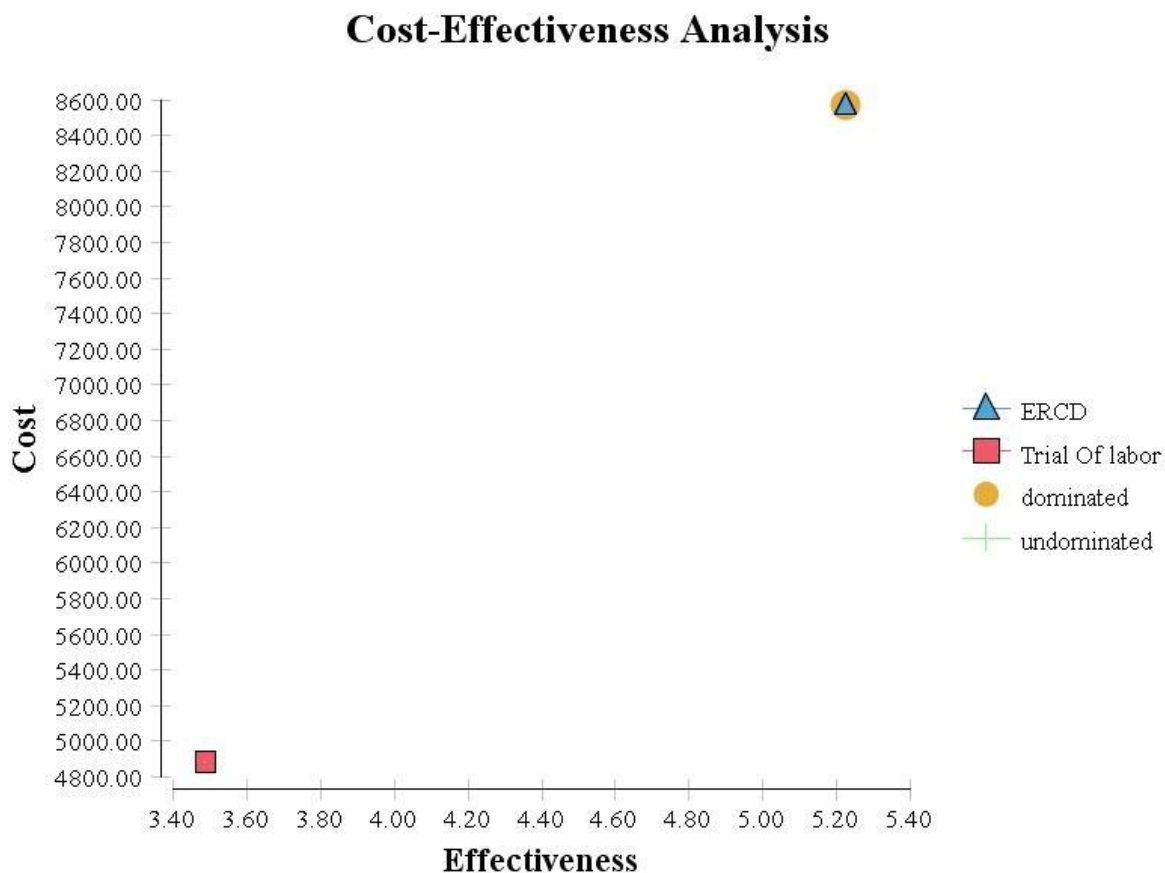


Figure 9. Cost-effectiveness graph for baby.

Table 11 displays base case results for incremental cost-effectiveness comparing ERCD and TOL in a second pregnancy for the baby. ERCD was dominated by TOL. ACER reflected the cost per one unit of effectiveness (LOS), TOL \$1,393.31/day and

ERCD \$1,640.44/day. The ICER, as defined in Figure 3, is the negative of the costs of ERCD minus TOL to the difference of effectiveness of ERCD minus TOL. In this case, \$8,570.32 minus \$4,883.72 divided by 5.22 minus 3.49 leading to an incremental cost of \$3,686.60 and incremental effectiveness of 1.74 days. ERCD was dominated by TOL. The incremental cost-effectiveness ratio was -\$2,120.55/LOS. This negative ICER is consistent with dominance, and hence, cost-effectiveness.

Table 11. *Incremental Cost-Effectiveness for Baby*

Strategy	Cost	Incremental Cost	LOS (Eff)	Incremental LOS	ICER	C/E (ACER)
TOL	\$4,883.72		3.49			\$1,401.00
ERCD	\$8,570.32	\$3,686.60	5.22	-1.74	-\$2,120.55	\$1,640.44

### **Sensitivity Analysis**

A one-way sensitivity analysis was performed to bring critical focus to the specific uncertain parameters, which varied the probabilities from the peer-reviewed literature for respiratory distress syndrome ERCD, sepsis ERCD, sepsis VBAC, sepsis RCD, neonatal mortality ERCD, and neonatal mortality RCD. Table 12 includes base case probabilities and the alternative case probability for each strategy. Subsequent columns represent costs of the strategies, incremental costs, effectiveness (LOS), and incremental effectiveness. The final columns are the calculations for the ACER (C/E) and the ICER based on variations for each parameter uncertainty.

Table 12. *Sensitivity Analysis: Cost-Effectiveness Analysis Comparing ERCD and TOL in a Second Pregnancy Applying Base Case and Alternative Probabilities Baby Values*

Probability varied	Strategy	Cost	Incr Cost	Eff	Incr Eff	ACER	ICER
<b>RDS-E</b>							
0.059	TOL	\$4,883.72		3.49		\$1,401.00	
	ERCD	\$8,570.32	\$3,686.60	5.22	1.74	\$1,640.44	-\$2120.55
0.1	TOL	\$4,483.72		3.49		\$1,401.00	
	ERCD	\$10,988.91	\$6,105.19	5.48	1.99	\$2,005.78	-\$3063.75
<b>Sepsis-E</b>							
0.02	TOL	\$4,883.72		3.49		\$1,401.00	
	ERCD	\$8,570.32	\$3,686.60	5.22	1.74	\$1,640.44	-\$2,120.55
0.027	TOL	\$4,883.22		3.49		\$1,401.00	
	ERCD	\$8,676.08	\$3,792.36	5.26	1.77	\$1,650.07	-\$2,140.20
<b>ND-E</b>							
0.0005	TOL	\$4,883.22		3.49		\$1,401.00	
	ERCD	\$8,570.32	\$3,686.60	5.22	1.74	\$1,640.44	-\$2120.55
0.0008	TOL	\$4,883.22		3.49		\$1,401.00	
	ERCD	\$8,570.32	\$3,686.61	5.22	1.74	\$1,648.88	-\$2,122.27
<b>ND-RCD</b>							
0.0009	TOL	\$4,883.72		3.49		\$1,401.00	
	ERCD	\$8,570.32	\$3,686.60	5.22	1.74	\$1,640.44	-\$2,120.55
0.0011	TOL	\$4,883.72		3.49		\$1,401.09	
	ERCD	\$8,570.32	\$3,686.60	5.22	1.74	\$1,640.44	-\$2,120.25
<b>Sepsis-RC</b>							
0.02	TOL	\$4,490.91		3.36		\$1,336.15	
	ERCD	\$8,570.32	\$4,079.41	5.22	1.86	\$1,640.44	-\$2,189.33
0.12	TOL	\$4,883.72		3.49		\$1,401.00	
	ERCD	\$8,570.32	\$3,686.60	5.22	1.74	\$1,640.44	-\$2,120.55
<b>Sepsis-VB</b>							
0.02	TOL	\$4,883.72		3.49		\$1,400.00	
	ERCD	\$8,570.22	\$3,686.60	5.22	1.74	\$1,640.44	-\$2,120.55
0.12	TOL	\$6,195.81		4.00		\$1,547.45	
	ERCD	\$8,570.32	\$2,374.51	5.22	1.22	\$1,640.44	-\$1,945.49

RDS-E-respiratory distress syndrome ERCD

ND-E-neonatal death ERCD

ND-RCD-neonatal death RCD

Sepsis-RC- sepsis RCD

The findings from this one-way sensitivity analysis were that varying the parameter uncertainties did not affect the overall outcome of the cost-effectiveness analysis. For instance, increasing the probability of respiratory distress in an ERCD by

0.41 increased the cost estimate to \$10,988.91, increased the incremental cost to \$6,105.19, LOS to 5.48, and incremental effectiveness to 1.99. ERCD continued to be dominated by TOL; whereas, decreasing the probability of sepsis in a RCD by 0.10 increased the cost estimate to \$4,440.91, increased the incremental cost to \$4,079.41, LOS to 3.36, and incremental effectiveness to 1.86. ERCD continues to be dominated by TOL. Therefore, the results of this cost-effectiveness analysis remain insensitive to the parameter uncertainties applied and are robust.

## **Chapter 5**

### **Discussion**

This chapter is divided into six sections. The first section provides a brief overview of the study problem. The second section includes a recap of the study's findings in terms of the research objectives of establishing probabilities of complications, determining costs, determining outcomes (LOS), and calculating incremental cost-effectiveness ratios for ERCD and TOL for mother and baby. This chapter ends by considering this study's implications for practice, policy, and research.

#### **Background of the Problem**

As noted in the Introduction, cesarean deliveries are the most common surgical procedure in the United States, totaling 1.5 million childbearing women in 2010 (Guise et al., 2010). One-third of normal, low-risk first pregnancies result in cesarean deliveries (Zhang et al., 2010). For most of the 20th century, providers thought that once a woman had a cesarean delivery, all her future pregnancies would also end the same way (Guise et al., 2010). Cesarean deliveries cost more than \$8 billion annually and account for more than half of childbirth-related hospitalization expenses (Guise et al., 2010).

Cost-effectiveness analysis is an important tool for comparing therapies based on their effectiveness and costs (Gold et al., 1996; Rascati, 2009; Siegal, 2005). Using a cost-effectiveness analysis enhances the ability of health-care providers, administrators, and policymakers to allocate health-care resources in a systematic rather than intuitive manner. An increasing number of both administrators and insurers in public and private health-care systems in the US are utilizing cost-effectiveness analysis to make their coverage decisions (Siegal, 2005).

The literature search for this study found that only a few researchers compared the cost-effectiveness of ERCD and TOL. Much of the current published literature related to cesarean deliveries focuses on safety, demographics, geographic differences, and clinical management issues, but little has been published on the overall economic consequences of ERCD (Cunningham et al., 2010, Guise et al., 2010). Peer-reviewed articles describe a few studies on the economic consequences of repeat cesarean deliveries compared to VBAC from the perspectives of the health-care payer or the woman and her family (Clark et al., 2000; Chung et al., 2001; DiMaio et al., 2002; Grobman et al., 2000; Macario et al., 2004). To date, to my knowledge, no researcher has compared cost-effectiveness for ERCD and TOL in a second pregnancy and their possible complications to the mother and baby from the perspective of the health-care payer. This research filled that knowledge gap by completing the following research objectives:

1. Establish the probabilities of complications incurred by the mother and baby for ERCD and TOL in a second pregnancy.
2. From the perspective of the payer, determine the cost associated with ERCD and TOL by the mother and the baby in a second pregnancy.

From the perspective of the payer, determine the outcomes (length of stay) associated with ERCD and TOL by the mother and the baby in a second pregnancy.

3. Determine and calculate an incremental cost-effectiveness ratio for ERCD and TOL for the mother and baby in the second pregnancy.

### **Recap of Study Findings**

This section discusses the findings of this study, which compared the cost-effectiveness of ERCD and TOL for the mother and baby in a second pregnancy when the first pregnancy resulted in a cesarean delivery.

**Research Objective 1 – Probability Estimates**

Probability estimates for the maternal and baby event pathways were assigned using peer-reviewed literature (DeLuca et al., 2009; Go et al., 2011; Hibbard et al., 2001; Hook et al., 1997; Kamath et al., 2009; Landon et al., 2004; Levine et al., 2001; Menacker et al., 2010; O’Shea et al., 2010; Patel & Jain, 2010; Spong et al., 2007; Yee et al., 2008) (see Tables 1–6). The most likely complications for mothers across delivery types were hemorrhage and infection, and the probability of maternal operative injury was notably higher for RCD than for ERCD or VBAC. Complications were notably higher for RCD than for ERCD or VBAC.

**Research Objective 2 – Costs**

Cost estimates were derived from HCUPnet (2012) for the year 2010, except for maternal mortality, for which the estimates came from the peer-reviewed literature (Chung et al., 2001; Grobman et al., 2000). The calculated average cost to the health-care payer of an ERCD for the mother and baby were \$7,187 and \$8,570, respectively. The calculated average cost to the health-care payer for a TOL for the mother and baby were \$6,388 and \$4,884, respectively. The maternal costs calculated for this study were in the range reported in the published literature, which varied from a low of \$2,600 (Clark et al., 2000) to a high of \$7,700 (Macario et al., 2004). The peer-reviewed literature between 2000 and 2012 lacks any data on costs associated with the baby. These cost estimates are presented in Tables 1–6. The most costly complications for the mothers were the relatively rare occurrences of hysterectomy and thromboembolic events. For babies, the most costly complications were respiratory distress and hypoxic ischemic encephalopathy.

**Research Objective 2 – Effectiveness Outcomes**

The outcome of interest, length of hospital stay, was determined using HCUPnet (2012) data for the year 2010. The calculated average LOS for an ERCD for the mother and the baby were 3 and 5.22 days, respectively. The calculated average LOS for a TOL for the mother and baby, were 3 and 3.49 days, respectively. These results were in contrast to maternal LOS estimates from Guise et al. (2010), who reported LOS for ERCD was 3.92 days and for TOL was 2.55 days. LOS estimates for the baby have no comparison in the peer-reviewed literature. These effectiveness estimates are presented in Tables 1–6.

Across delivery types, the complication associated with the longest length of stay for the mothers was a thromboembolic event, and as expected, length of stay for this event was higher for a cesarean delivery than for a VBAC. For babies, hypoxic ischemic encephalopathy was associated with the longest length of stay.

**Research Objective 3 – Cost-Effectiveness Determination**

The average and incremental cost-effectiveness ratios were calculated by comparing ERCD and TOL separately for the mother and the baby. TOL dominated ERCD in all scenarios. This means that the results of the cost-effectiveness analysis established that a TOL was more cost effective than an ERCD for the mother and the baby. These cost-effectiveness calculations are presented in Table 7.

**Sensitivity Analysis**

Sensitivity analyses were conducted for selected uncertain probability estimates from the peer-reviewed literature (Cheng et al., 2011; Chung et al., 2001; Grobman et al., 2000; Hibbard et al., 2001; Landon et al., 2004; Macario et al., 2004). The findings from



the one-way sensitivity analyses for the mother and baby did not affect the overall outcome of the cost-effectiveness analysis. Varying the possible event probabilities, which at times increased the LOS, did not affect the model's integrity. Hence, the model remained robust.

A two-way sensitivity analysis was also conducted by varying the outcome data, LOS. Varying LOS for both an ERCD and a TOL did not affect the model's integrity, further demonstrating the robustness of the model.

### **Comparison to Previous Literature**

Peer-reviewed literature includes studies on the economic consequences of repeat cesarean deliveries compared to TOL from the perspectives of the health-care payer or the woman and her family (Chung et al., 2001; Clark et al., 2000; DiMaio et al., 2002; Grobman et al., 2000; Macario et al., 2004).

Chung et al. (2001), Clark et al. (2000), and Macario et al. (2004), using hypothetical populations of women when performing their cost-effectiveness analyses, demonstrated a TOL without complications to be more cost-effective than an ERCD for the mother. DiMaio et al. (2002) and Grobman et al. (2000) used, in addition, neonatal morbidity and mortality as their outcome measures, reporting a TOL without complications to be more cost-effective than an ERCD for mother and baby. Notably, Clark et al., Chung et al., DiMaio et al., and Grobman et al. restricted their perspectives by using cost estimates from their own health-care facilities.

While the main findings of this study were broadly consistent with the work of previous authors on this topic (Chung et al., 2001; Clark et al., 2000; DiMaio et al., 2002; Grobman et al., 2000; Macario et al., 2004), this study adds to the literature by using

national data from 2010 on costs and outcomes derived from HCUPnet (2012). Moreover, using the perspective of the health-care payer versus a single health-care system allows for greater generalizability. Also, considering costs and outcomes for the babies alongside those for the mothers, as was done in this study, produces a more comprehensive view of the cost-effectiveness of ERCD versus TOL than was possible in earlier studies, which lacked cost and outcomes for the babies.

### **Limitations**

As with any research study, this dissertation has several limitations. The major ones pertain to the HCUPnet (2012) data, cost-effectiveness analysis assumptions, probability determinations, physician idiosyncratic coding practices, and determination of effectiveness measure.

#### **Limitations due to HCUPnet Data**

Using HCUPnet (2012) data, presents several limitations. First, although using summary HCUPnet data for cost estimates enhances national generalizability in regard to cost estimates for ERCD and TOL, this summary data also limits generalizability because the researcher is not able to drill down into subgroups such as race, ethnicity, and specific insurance plans. This limitation restricted the breadth and depth of potential analysis, which could have been enhanced if the full National Inpatient Sample data set were analyzed using SPSS or similar software, which may, moreover, have allowed for the calculation of the probabilities directly from the primary data. Second, using only one year's cost estimates additionally limited what might be found with a longitudinal view of cost estimates for each of these alternatives. Finally, HCUP (2012) contains only hospital data. It lacks fees for inpatient providers, radiology and pharmacy, and

laboratory work costs. Because of this, the costs determined in this study are not the total direct costs.

### **Limitations due to Cost-Effectiveness Analysis Assumptions**

A cost-effectiveness analysis is traditionally performed when there is a real choice between two treatment options or procedures. A woman whose first pregnancy resulted in a cesarean delivery has a choice with her second pregnancy as to mode of delivery when she presents with a low-risk term pregnancy and has no risk factors. Some delivery settings do not offer TOL due to lack of necessary staff and availability of their facility for emergency deliveries. Most often these restraints are in rural areas. This is a preference-sensitive decision, meaning a woman has a choice between an ERCD and a spontaneous TOL. A decision analysis about costs of one choice versus the other adds important information to this decision and is most accurate when the following conditions are met: decision-tree structure truly represents the alternative approach, probabilities of occurrence of chance actions are accurate, and final consequences or outcomes are considered.

For this study, probabilities of each event of this decision analysis were taken from the published literature (DeLuca et al., 2009; Go et al., 2011; Hibbard et al, 2001; Hook et al., 1997; Kamath et al., 2009; Landon et al., 2004; Levine et al. 2001; Menacker et al., 2010; O'Shea et al., 2010; Patel & Jain, 2010; Spong et al., 2007; Yee et al., 2008), and cost estimates used were derived from HCUPnet (2012) data from 2010. While the use of national-level cost estimates is a strength of this study, it is possible that some of the probabilities drawn from the peer-reviewed literature have become outdated over time. The complications considered in this study's decision analysis were chosen to

allow for transparency of key structural assumptions, and are the most common complications. However, incremental costs for ERCD and TOL for mother and baby were relatively large, and the finding that TOL has lower cost would likely remain robust even if the study expanded the pool of complications under consideration.

Although the complications that are used in the decision trees have distinct billing codes and are billed separately, these probable events do not always occur in isolation. It is possible that one complication might cause the next and give rise to cascading complications. Thus, assuming these complications are mutually exclusive and not accounting for cost-effectiveness probabilities of co-occurrences are limitations of this analysis.

### **Limitations due to Physician Idiosyncratic Coding Practices**

HCUPnet (2012) used data derived from provider medical coding reported by a stratified sample of 1,000 hospitals. Not knowing the extent to which providers across the country use the same medical coding practices is a limitation because it introduces a possible measurement error, which would decrease the precision of derived estimates. Individual providers may have idiosyncratic coding practices, and coders may have been trained to use the same codes but in different ways. As an example, cesarean deliveries are coded according to whether they are primary or repeat. There is also a code for second and subsequent cesarean delivery. It is possible that for some providers the “repeat” cesarean code is routinely used instead of the “second and subsequent” cesarean code. Additionally, each possible complication for mother and baby is a combination of ICD-9-CM procedural codes, DRGs and CCSs. Last, it is also unknown whether or not the complications are all accounted for with codes used by the health-care providers.

### **Limitations of Effectiveness Measure (LOS)**

Gold et al. (1996) and Rascati (2009) emphasized effectiveness as a measurement that achieves health improvements and pertains to clinical practice. This study utilized length of hospital stay as the effectiveness measure because it is measurable, most often a sign of health improvement, and the HCUPnet (2012) data included LOS along with the ICD-9-CM codes for each complication. A limitation of using LOS is that it only accounts for pregnancy complications that occur during a hospitalization. It does not account for other possible complications that might occur to the mother and baby after discharge.

### **Implications**

This section will discuss possible implications of this research for practice, policy, and research. Many of the points raised are based on the limitations listed above.

#### **Implications for Practice**

This study's focus on women's decision-making about mode of delivery for a second pregnancy with a previous cesarean has practice implications for issues such as shared decision-making, education of health professionals, integration of shared decision-making into prenatal care, and the relationship between changes in practice and cost to payers, patients and providers. Each is discussed in the sections to follow.

**Shared decision-making.** Many studies on shared decision-making focus on the patient's perspective. In such cases, shared decision-making has a potential to decrease the patient's decisional conflict because the process assists with identifying the patient's values, informs the patient of treatment options, and reduces the proportion of patients that are passive in decision-making. It can also decrease costs. For example, Stacey et

al. (2011) conducted a Cochrane review with 20,000 participants from 86 randomized controlled trials. They found that shared decision-making was associated with 25% fewer major elective invasive surgeries chosen by patients compared to conservative treatment options.

**Integrating teaching models into professional education.** Shared decision-making can provide students studying to be health professionals in fields such as medicine, nursing, and pharmacy with several important skills and resources. It can teach them how to encourage, support, and guide patients with values clarification; inform them about treatment options; and empower them to make their own decisions. This approach would be especially useful if taught through interprofessional, collaborative team-based education, which encourages a broad range of ideas, knowledge, and perspectives. Team-based education is also important because it prepares students to be members and leaders of a health-care team that can enhance the quality and outcome of patient care.

Moreover, teaching shared decision-making with knowledge of how insurance works, including billing practices, and differentiating types of costs and charges could aid new and experienced practitioners. With this knowledge, these practitioners would be able to ask questions about costs and encourage transparency on the part of the payers. This knowledge could also facilitate the sharing of cost information as part of shared decision-making.

**Shared decision-making and prenatal care.** Shared decision-making during maternity care entails choices specific to prenatal care, delivery, and postpartum and is an ongoing, interactive process between a woman and her health-care provider. This

process encompasses coordination of the woman's and her family's needs and preferences, based on evidence that can help them make informed choices.

As part of prenatal care, shared decision-making has been used for genetic testing options with established decision aids (Informed Medical Decision Foundation, 2011). Using the genetic testing model for shared decision-making in professional continuing education could enhance the delivery of maternity care services. By using shared decision-making as an overall practice model, women in a second pregnancy with a previous cesarean would be offered their choices in this manner. Stacey et al. (2011), in their systematic review of 20,000 patients from 86 randomized controlled trials, found that decisional aids decrease decisional tension and improve communication between providers and patients, thus creating a safe and respectful environment conducive to patients' optimal information processing. Transforming maternity care to use shared decision-making overall is a multistakeholder effort that could include core competencies established by professional organizations or regulatory boards, as well as professional education sessions that offer continuing education credits.

**Change in Practice.** As this study demonstrated for payers, a TOL is more cost-effective than an ERCD for a woman at term in her second pregnancy with a previous cesarean. A decrease in surgical procedures, such as ERCDs, will lower costs for health-care payers, which usually means lower costs for patients. The study demonstrates that increasing the use of TOL could save costs for payers without increasing LOS for the mothers. It also demonstrates that TOL could substantially decrease LOS for babies. These savings could give payers an incentive to invest in shared decision-making models that might increase the use of TOL. However, it will take time for providers to use

shared decision-making models with patients to decide for ERCD or TOL, if those models include costs to payers. It might also be difficult for individual practitioners to accept this as part of their scope of practice and responsibility in maternity care and other areas.

Nonetheless, given the pervasive concern about health-care costs, if clinicians use decision aids that include each procedure's actual cost, it could help the individuals who (estimated currently at 60%) rely on high patient cost-sharing plans to help defray the costs of their care; as of 2014 is estimated that in the US, 17.4 million people fall into this category (American's Health Insurance Plans, 2014; Panchai, Rae, & Claxton, 2012). Providers might frame cost as an issue that patients and clinicians "share" and discuss as part of the growing focus on patient-centered care and patient engagement. This way of framing cost also means that both clinicians and patients need to see cost as part of their purview, and providers need to see it as part of their scope of practice. Questions about inclusion of family members and others on the health-care team as part of this decision-making discussion would need to be addressed.

### **Implications for Policy**

Under a reformed health-care system, discussions about shared decision-making, patient engagement and new types of delivery and payment systems abound. Hence, discussions of the policy implications of shared decision-making from a payer's perspective need to take into consideration the constantly changing context of care, which includes evolving structures, processes, and outcomes measures. Some of the policy issues that shared decision-making raises are bundled payments, alternative delivery



settings that might promote cost savings and facilitate shared decision-making, and health policy and politics as they pertain to the topics raised in the study.

**Bundled payments.** Typically, health care is paid for on a fee-for-service or unit-of-care-delivered basis. The ACA (2010) established the Centers for Medicare and Medicaid Innovation and authorized one billion dollars to test payment reform models that include paying for a set of services to treat a given condition or provide a given treatment as a bundled payment. This single payment to providers or health-care facilities (or jointly to both) covers all treatments given for that condition. These payments are made on the basis of the expected cost of a defined clinical episode of care that may include several practitioner types, settings of care, and services or procedures over a given period of time. Most pilot studies of bundled payments have been for defined clinical conditions, including congestive heart failure, total joint replacement, and type 2 diabetes (Catalyst for Payment Reform, 2011). When designing a bundle of care, consideration for improving value is built in by including clear quality metrics focused on desired clinical outcomes that providers must achieve to maximize their payments.

With over 4 million women giving birth annually, increased use of bundled payments for maternity care could yield dramatic cost savings to the overall health-care system. Prenatal care is at present paid to health-care providers through a “global” payment system. This system incorporates aspects of “normal” prenatal care—up to 60 days after the birth for the mother—and the provider’s delivery fees. Pediatric providers bill for the baby’s care separately from care for the mother. Hospitals and birth centers are also paid a global fee for normal deliveries. Occurrences outside of normal are paid in a fee-for-service manner.

Prospectively paying an entity (health plan, provider group, hospital system) for a normal episode of pregnancy, including prenatal care, baby care, delivery, and 60 days after the delivery, as a bundled payment could demonstrate cost savings for health care overall (Catalyst for Payment Reform, 2010). Settling payments after the episode would require making adjustments to accounts for outliers.

Instituting this policy change has real potential to improve care coordination and quality, while reducing costs to the health-care system as a whole. Bundling all services and care given for a maternity episode also has the potential to encourage evidence-based practices and clear quality metrics, and to focus on desired clinical outcomes, all of which achieve maximum payment to the health-care providers.

Effective implementation of bundled payment systems relies heavily on setting optimal reimbursement rates. The Center for Healthcare and Quality Payment Reform (Center for Healthcare and Quality Payment Reform, 2013) identifies models for maternity care in Illinois and California as having great potential for innovative payment reform. Each of these states has instituted a bundled payment model with decreasing cost, while maintaining or improving quality.

Provisions for alternative delivery settings or structures might promote cost savings for maternity care. Birth centers, alternative delivery settings, are a safe option for an out-of-hospital birth and are typically one-fourth the cost of a hospital birth (Center for Healthcare and Quality Payment Reform, 2013). Only women without any previous pregnancy complications are low risk enough to deliver in a free-standing birth center. A woman in her second pregnancy with a previous cesarean, no matter the reason for the cesarean, is unable to deliver at a birth center.

**Policy Stakeholders.** This study's findings would be of interest to several policy stakeholders, such as state insurance commissioners, health-care payers (which can vary by state) and administrative leaders in health-care systems. Bundled payments show the possibility of decreasing national-level health-care spending by 4.5% (Hussey et al., 2011). An alternative approach to payment for maternity care would not only save health-care payers money by bundling care but might improve outcomes by scheduling fewer ERCDs and encouraging more TOLs. These cost savings might encourage stakeholders to promote high quality care at a lower cost.

### **Implications for Research**

This next section will identify implications of this study for future research. Major topics are use of HCUPnet (2012) data, replicating this decision model using one payer, and establishing a QALY for ERCD and TOL.

**Using HCUPnet (2012) data.** Using 2010 HCUPnet (2012) data provided an opportunity to use specific diagnosis and procedure codes to establish costs for ERCD and TOL for the mother and baby. Additionally, as a free, publicly available project supported by AHRQ, HCUPnet (2010) provides easy accessibility for researchers. Cost in this research was a measurement of the amount paid by the health-care payers to health-care facilities for the care, not necessarily the cost incurred by the health-care entity to deliver the care. In performing a cost-effectiveness analysis, cost estimates are necessary. Despite its limitations (discussed previously), using HCUPnet (2012) summary data to quantify costs for ERCD and TOL for the mother and baby, as in this study, offers a model for other researchers interested in using national-level estimates.

The peer-reviewed literature lacked evidence on actual costs of care associated with the baby for ERCD and TOL. Quantifying the cost of this care could be a potential future research project. Also, including the cost of care for the mother-baby dyad could support researchers, health-care decision makers, health-care payers, and health-care providers with relevant cost data when establishing payment models and plans for care and when instituting the use of decision aids. When formulating payment models, health-care payers weigh the pros and cons of available alternatives, taking into account potential variations in patients and providers, which include costs.

**Replication of the decision model with different payers.** This research focused on health-care payers, but not any specific payer, in order to enhance generalizability across payers. Future research could separate out specific payers using the same methodology to inform policies under consideration in an entity. The Center for Medicare and Medicaid Services, for instance, might duplicate this model using only Medicaid cost estimates with the aim of providing states with estimates that can be used for bundled payments for normal deliveries.

The addition of reliable cost estimates to, for instance, the VBAC calculator developed by Grobman et al. (2009) could help extend and disseminate the results of this study. This tool was designed for educational use with obstetrical providers and women to predict the probability of successful VBAC. The educational value of this tool and its use to promote shared decision-making would be enhanced by the inclusion of reliable cost estimates for TOL and ERCD.

**Establishing a QALY for ERCD and TOL.** Traditionally, QALYs are used as the preference-sensitive outcome measure in cost-effectiveness analysis. In this study,

LOS was the measurable outcome because QALYs have not been established for the decision between ERCD and TOL. Future research establishing a QALY for ERCD and TOL for the mother and the baby would strengthen and broaden the cost-effectiveness analysis in this area.

### **Conclusion**

Healthy People 2020 (2011) set a goal of decreasing repeat cesarean delivery rates by 10% by 2020. Engaging a woman in shared decision-making to decide between ERCD and TOL, encouraged by health-care payers, would provide an opportunity to reduce health-care costs by reducing the rate of elective repeat cesarean deliveries and could assist with meeting this goal.

Analysis of actual direct cost data from HCUPnet (2012) from the year 2010 indicated the expected cost of an ERCD to be \$7,187 for the mother and \$8,570 for the baby, whereas a TOL was \$6,388 for the mother and \$4,884 for the baby. Using these findings, decreasing the ERCD rate (502,000 repeat cesarean deliveries in HCUPnet for 2010) by 10% could lower health-care spending by approximately \$225 million per year (mother and baby ERCD total cost – mother and baby TOL total cost)\*ERCD rate\*.10= (\$15,757-\$11,272)\*502,000\*.1=\$225,147,000.

The results of this cost-effectiveness analysis demonstrate a TOL to be more cost-effective than an ERCD, even knowing that the LOS for the mother is very similar for both procedures. The most significant finding of this dissertation is how much better a TOL is in cost and effectiveness for the baby, which has not been previously demonstrated in the peer-reviewed literature. The probability of a complication is greater for both the mother and baby with an ERCD than with a TOL. Health-care payers could

promote reduction of the ERCD rate through changes in the benefit design and payment models. Providing direct cost estimates for health-care payers could inform national initiatives to reduce the number of ERCDs, improve the health of mothers and babies, and reduce costs.

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## **Appendix A**

### **Definitions**



**Average cost-effectiveness ratio** – A ratio that compares the cost and effectiveness of a one treatment.

**Cesarean delivery** – Extraction of an infant, placenta, and membranes through an incision in the maternal abdominal and uterine wall.

**Decision analysis** – Explicit, quantitative, systematic approach to decision-making under conditions of uncertainty in which probabilities and consequences of each possible event are explicitly stated.

**Dehiscence** – The separation of a wound or a surgical scar.

**Direct medical costs** – Costs of medically related inputs used directly to provide a treatment (Rascati, 2009).

**Dominance** – The state in which an intervention being studied is both more effective and less costly than the alternative.

**Elective repeat cesarean delivery** – Cesarean delivery for a subsequent pregnancy after having a cesarean for a previous birth. This is a planned procedure after 39 weeks gestation.

**HCUPnet (2012)** – A free, interactive, publicly available, online query system based on aggregated tables that AHRQ established from the NIS HCUP data.

**Health-care payer** – An entity responsible for payment of health-care services (Haddix, Teutsch, & Corso, 2003).

**Health-care provider** – A health-care professional licensed within medicine or allied health professional who provides preventative, curative, promotional, or rehabilitative health care services to individuals, families, or communities.

**Hemorrhage** – The loss of blood in the post-partum period (after delivery of baby) of more than 500 ml following a vaginal delivery or 1000 ml following a cesarean delivery (Begley, Gyte, Devane, McGuire, & Weeks, 2011).

**Hysterectomy** – Surgical removal of the uterus.

**Incremental cost-effectiveness ratio** – The ratio of the differences in costs between two alternatives to the difference in effectiveness of the same two alternatives.

**Indirect medical costs** – Costs associated with loss of work or inability to work or engage in leisure activities after a medical intervention

**Informed decision-making** – The process by which a “reasoned choice is made by a reasonable individual using relevant information about the advantages and disadvantages of all possible courses of action, in accord with that individual’s beliefs” (Bekker et al., 1999, p. 1).

**Length of Stay** –Time spent in a hospital, measured from admission to discharge.

**Low transverse uterine incision** – Most common surgical method for performing a cesarean delivery; an incision made transversely in the lower segment of the uterus.

**Maternal mortality** – Death occurring to the mother during childbirth hospital stay.

**Neonate death** – Death occurring to the baby during childbirth hospital stay.

**Nulliparous** – Relating to a woman who has not given birth.

**One-way sensitivity analysis** – Mathematical calculation that isolates one parameter at a time in a decision analysis to indicate the degree of influence each parameter has on the outcome of the entire analysis.

**Operative injury** – Unintended injury during surgery to another organ, muscle, blood vessel, or tissue surrounding the surgical area.

**Placenta accreta** – Implantation of the placenta over a uterine scar where the placenta has grown into the scar tissue.

**Placenta previa** – Implantation of the placenta at the cervical opening below the baby.

**Point of service** – Refers to the specific time the health-care service is provided, such as during a clinic visit.

**Quality-adjusted-life-years (QALY)** – An outcome measured as life years gained, adjusted (weighted) by patient preferences for various health states (Rascati, 2009).

**Rescue cesarean delivery** – A cesarean delivery that is performed when a TOL fails.

**Respiratory distress syndrome** – Breathing disorder that affects newborns, usually developed in the first few hours of life.

**Sensitivity analysis** – Mathematical calculation that isolates or considers parameters involved in a decision to indicate the degree of influence each parameter has on the outcome of the entire analysis. It is used to measure the uncertainty of the probability.

**Sepsis** – Infection that is life-threatening.

**Shared decision-making** – A collaborative process that allows patients and their providers to make health decisions together, considering best scientific evidence as well as the patient's preferences and values.

**Thromboembolism** – Lodgment of a blood clot causing blockage of a vein. There is an increased chance of thromboembolism in pregnancy due to a hyper-coagulated state. Deep vein thrombosis (DVT) and pulmonary embolism (PE) are the most named complications to the veins in pregnancy. Thromboembolism is a rare event.

**Trial of labor** – The process starting with spontaneous labor for a woman after her first delivery resulted in a cesarean. The goal is a vaginal delivery after a cesarean.

**Uterine rupture** – Full thickness disruption of the uterine wall and accompanying clinical evidence of uterine rupture (from ICD-9-CM).

**Utility** – In economics, this is a representation of preferences assigned to some set of goods and services.

**Vaginal birth after cesarean** – With a previous pregnancy resulting in a cesarean delivery, the subsequent pregnancy resulted in vaginal delivery.

**VBAC rate** – Successful VBAC divided by all women with previous cesareans. The HCUPnet data are stated in number per 1000.

**Appendix B**  
**Abbreviations**

ERCD	Elective repeat cesarean delivery
VBAC	Vaginal birth after cesarean
TOL	Trial of labor
ACOG	American College of Obstetricians and Gynecologists
RCD	Rescue cesarean delivery

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