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Improving Maternal Outcomes through Quantifying Blood Loss in Cesarean Sections

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Abstract

Problem: Postpartum hemorrhage is a preventable, leading cause of maternal death in the United States and is a direct result of a delay in diagnosis, intervention, and treatment of postpartum hemorrhage. Inaccurate measurement of blood loss from the use of estimation instead of quantitative techniques leads to a failure to recognize and respond appropriately. While there are risk factors for postpartum hemorrhage, all pregnant women are at risk.

Methods: This Quality Improvement (QI) project used a descriptive cohort study design, utilizing a retrospective chart review, to evaluate the quantification of blood loss during cesarean sections on maternal outcomes. Data was collected six months prior to the implementation of quantification of blood loss (QBL) and six months after the implementation of QBL.

Results: A total of 2,269 patients' charts were reviewed with 466 patients found to have had a postpartum hemorrhage and met inclusion criteria. There were 179 EBL participants and 287 QBL participants whose charts were reviewed for rate of mild, moderate, or severe PPH, uterotonic administration, blood product transfusion, surgical intervention, and ICU admission. The overall PPH rate was 15.2% in the EBL group and 27% in the QBL group. Severe PPH rate did decrease from 26.8% to 21% with the implementation of QBL even though it was not a statistically significant finding (p=.180). However, a decrease in the rate of severe PPH is clinically significant. Surgical intervention decreased from 6.1% to 5.2% (p=.421) with the implementation of QBL; while this is not statistically significant, it is clinically significant. Uterotonic use

(p=.441), blood product administration (p=.399), and ICU admissions (p=.503) did now show statistically significant improvement in maternal outcomes.

Implications: The implementation of quantification of blood loss did not improve maternal outcomes but the advantage of accurate measurement of blood loss is a crucial step for healthcare providers to provide timely and appropriate interventions for their patients. The decrease in the rate of severe PPH along with the decrease in the rate of surgical intervention show the implementation of QBL is making a difference. QBL is not only beneficial in cesarean sections, but also for all births, and improving the outcomes to postpartum women across the United States. Repeating this project at a hospital with different demographics and socioeconomic levels could yield different data results and show improvement in maternal outcomes with the implementation of QBL.

Improving Maternal Outcomes Through Quantifying Blood Loss in Cesarean Sections

Postpartum hemorrhage (PPH) is a preventable, leading case of maternal morbidity and mortality in the United States and occurs in approximately 2.9% of all births (Bingham et al., 2018). Every day women die from postpartum hemorrhage resulting from failure to recognize excessive blood loss and lack of early initiation of effective interventions ("Retired: Quantification of Blood Loss: AWHONN Practice Brief Number 1," 2015). The American College of Obstetricians and Gynecologists' (ACOG) defines postpartum hemorrhage as "a cumulative blood loss greater than or equal to 1,000 mL or blood loss accompanied by signs and symptoms of hypovolemia within 24 hours after birth" ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017, p. e168). Mild PPH is defined as a cumulative blood loss greater than 1,000 mL; moderate PPH is continued bleeding and a less than 1,500 mL blood loss; and a severe PPH is a cumulative blood loss of greater than 1,500 mL (Maternal, 2017). The rate of postpartum hemorrhage, especially severe hemorrhage, has been steadily increasing since the 1990's with the rate of severe complications during the postpartum hospitalization period increasing by 114% (Seacrist et al., 2019).

The California Pregnancy-Associated Mortality Review (2017) reports that many maternal deaths are caused by preventable errors. Increased maternal morbidity and mortality is a direct result of delay in diagnosis, interventions, and treatment of PPH (Maternal, 2017). There are several reasons for these delays in care. First, healthcare providers fail to recognize and respond to clinical warning signs. Also, inaccurate measurement of blood loss results from use of estimation instead of quantitative techniques. In addition, nurses and providers miss the significance of abnormal vital signs. Lastly, as is often the case with poor outcomes, ineffective communication between nurses and providers contributes to morbidity and mortality from PPH (Maternal, 2017). Delays in diagnosis, intervention, and treatment results in escalation in severity of PPH (Hancock et al., 2015).

Visual estimation of blood loss (EBL) following both vaginal and cesarean delivery is a convenient method that has been a common practice (Lertbunnaphong et al., 2015). Estimation of blood loss is a subjective method in which the assessor approximates amount of blood loss by visual analysis. Approximation of blood loss leaves room for error. Visual estimation is inaccurate with underestimation of blood loss being more common than overestimation (Saoud et al., 2019). An underestimation of blood loss by 33-50% is common with visual EBL ("Retired: Quantification of Blood Loss: AWHONN Practice Brief Number 1," 2015). Simulation training has been utilized to improve EBL without improvement in the accuracy of measurement (Lertbunnaphong et al., 2015). The Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN) recommends that cumulative blood loss be measured and quantified in every birth ("Retired: Quantification of Blood Loss: AWHONN Practice Brief Number 1," 2015). Quantification of blood loss leads to earlier recognition, faster response, and improved communication ("Retired: Quantification of Blood Loss: AWHONN Practice Brief Number 1," 2015). This technique involves weighing materials saturated with blood, as well as, capturing volumes of blood in graduated drapes or cylinders (Patel et al., 2006; "Quantitative Blood Loss in Obstetric Hemorrhage," 2019).

The purpose of this project is to determine if quantifying blood loss at cesarean delivery improves maternal outcomes due to early recognition of PPH, intervening sooner, and decreasing unnecessary interventions. The aim of the project is to improve maternal outcomes by quantifying blood loss in every cesarean section. On completion, this project will answer the following question:

I. In postpartum women age 18 or older who delivered via cesarean section and in the post-delivery hospitalization period; what is the effect of quantification of blood loss compared to visual estimation of blood loss on maternal outcomes:

   A. Rate of mild/moderate/severe PPH
   B. Rate of uterotonic administration in postpartum women who experienced a PPH
   C. Rate of blood product transfusions in postpartum women who experienced a PPH
   D. Rate of surgical interventions in postpartum women who experienced a PPH
   E. Rate of ICU admissions in postpartum women who experienced a PPH
   F. Demographics: age, race/ethnicity, gravida/para

Literature Review

An electronic literature search was conducted using the following databases: CINAHL, Cochran, GOOGLE Scholar, MEDLINE, and PubMed. An initial search using "postpartum hemorrhage" and "estimation of blood loss" resulted in over 3,800 articles. A narrowed search was conducted using the terms "postpartum hemorrhage estimated blood loss", "postpartum hemorrhage quantification of blood loss", "postpartum hemorrhage visual estimation of blood loss", and "ACOG postpartum hemorrhage". Article titles and abstracts were reviewed against the study criteria. Where no abstracts were available, the whole article was reviewed. After reading the title and abstract, 27 articles were chosen based on studies relevant to estimated and quantified blood loss.

Postpartum hemorrhage is a leading cause of maternal death (Al Kadri et al., 2010; Bingham et al., 2018; Hancock et al., 2015; Marshall et al., 2017; Saoud et al., 2019; Seacrist et al., 2019; Sloan et al., 2010; Stafford et al., 2008) and accounts for 11% of the maternal mortality in the United States (Saoud et al., 2019). Between 1994 – 2006 the rate of PPH increased 43% (Seligman et al., 2017) occurring in nearly 5% of all births (Bingham et al., 2018; Marshall et al., 2017; Seacrist et al., 2019). Postpartum hemorrhage is a preventable cause of maternal morbidity and mortality (Main et al., 2015; Maternal, 2017; Seacrist et al., 2019; Zamudio et al., 2017).

The American College of Obstetricians and Gynecologists (ACOG) defines PPH as cumulative blood loss greater than or equal to 1000 mL or blood loss accompanied by signs or symptoms of hypovolemia within 24 hours after the birth process (Main et al., 2015 & "Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Risk factors for postpartum hemorrhage include: multiple gestation, advanced maternal age, induction of labor (Gabel & Weeber, 2012); uterine atony, retained placenta, coagulopathy, hypertensive disorders in pregnancy, polyhydramnios, chorioamnionitis, trauma, history of PPH, placental abnormalities (Seacrist et al., 2019); cesarean section (Seligman et al., 2017); and prolonged labor ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Even without risk factors, all women can experience postpartum hemorrhage ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017).

Often a significant amount of blood loss occurs before the woman becomes symptomatic and hemodynamically unstable ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Early recognition of blood loss in conjunction with prompt, adequate, and appropriate treatment improves maternal outcomes (Hancock et al., 2015; Main et al., 2015; Maternal, 2017; Natrella et al., 2017; "Practice Bulletin No. 183: Postpartum Hemorrhage," 2017; Saoud et al., 2019; Seacrist et al., 2019; Seligman et al., 2017; Zamudio et al., 2017). This reduces the need for costly, unnecessary treatments and increased length of hospital stay (Gabel & Weeber, 2012; Hancock et al., 2015; Maternal, 2017; Natrella et al., 2017; Seacrist et al., 2019; Zamudio et al., 2017). Lack of early and adequate treatment caused by a disregard of clinical warning signs may lead to severe bleeding and ultimately maternal death (Gabel & Weeber, 2012; Maternal, 2017). Prompt recognition and intervention prevents need for costly treatments and lengthy hospital stays (Gabel & Weeber, 2012; Hancock et al., 2015; Maternal, 2017; Natrella et al., 2017; Seacrist et al., 2019; Zamudio et al., 2017). Improving the accuracy of measuring blood loss is a crucial step in preventing maternal morbidity and mortality (Hancock et al., 2015).

When a postpartum hemorrhage occurs, intervention and treatment is guided by etiology and amount of blood loss ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). When uterine atony is the cause, the recommended first line treatment is uterotonic agents ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Common uterotonic agents used are oxytocin, methylergonovine (Methergine), carboprost (Hemabate), misoprostol (Cytotec), and tranexamic acid (TMX) ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). With retained placenta or membrane, manual evacuation of the uterus is indicated. If uterotonic use fails to adequately control the bleeding, escalation to additional interventions and increased intensity of care and support are indicated ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). American College of Obstetricians and Gynecologists (ACOG) recommends a tamponade technique when uterotonics and bimanual massage fail to provide adequate uterine contractions to control bleeding ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). A Bakri balloon, Foley catheter, or uterine packing may be used for a uterine tamponade ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). If uterotonics, manual uterine evacuation, and uterine tamponade do not control the bleeding, uterine artery embolization or surgical intervention maybe indicated ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Uterine compression sutures or B-Lynch technique is the second line of treatment for uterine atony ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). If all treatments fail, a hysterectomy is considered and is a definitive treatment for postpartum hemorrhage ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Initiation of blood products is based on the cumulative blood loss and the woman's hemodynamic status ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Typical blood product replacement therapy is packed red blood cells, fresh frozen plasma, platelets, and cryoprecipitate ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Prothrombin Complex and fibrinogen concentrate, or recombinant factor VII may be indicated in a massive hemorrhage ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Type of blood product, number of units, and timing of transfusion are guided by the cumulative blood loss and the woman's vital signs ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). While each of these interventions have benefit, they are not without risks and possibility of complications ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). Increased intensity of care, such as admission to the intensive care unit (ICU), is recommended with escalation of treatment and interventions ("Practice Bulletin No. 183: Postpartum Hemorrhage," 2017). The American College of Obstetricians and Gynecologists (ACOG) and the California Maternity Quality Care Collaborative (CMQCC) recommend each hospital institution develop postpartum hemorrhage protocols to guide the use of these treatments (Maternal, 2017; "Practice Bulletin No. 183: Postpartum Hemorrhage," 2017).

Blood loss is predominately estimated by the health care provider at the time of birth (Gabel & Weeber, 2012; Natrella et al., 2017). While visual EBL is the most frequently practiced method of determining blood loss (Ali Algadiem et al., 2016; Main et al., 2015; Natrella et al., 2017), its often unreliability and inaccuracy is remarkable (Al Kadri et al., 2010; Ali Algadiem et al., 2016; Brant, 1967; Duthie et al., 1991; Gabel & Weeber, 2012; Hancock et al., 2015; Natrella et al., 2017; Saoud et al., 2019; Stafford et al., 2008). The inaccuracy of visual EBL is reflected in both overestimation and underestimation of blood loss (Al Kadri et al., 2010; Gabel & Weeber, 2012; Natrella et al., 2017; Stafford et al., 2008; Zamudio et al., 2017).

Underestimation is more common with excessive blood loss (Gabel & Weeber, 2012). In fact, the larger the blood loss the greater the underestimation (Gabel & Weeber, 2012). Blood loss may be underestimated by as much as 30 – 50% (Al Kadri et al., 2010; Gabel & Weeber, 2012; Hancock et al., 2015; Main et al., 2015; Natrella et al., 2017). Underestimation delays recognition and intervention causing deterioration in hemodynamic status of the woman, increased need for surgical intervention, and maternal death (Ali Algadiem et al., 2016; Maternal, 2017). Overestimation occurs most often with smaller blood losses (Gabel & Weeber, 2012). Gabel & Weeber (2012) report that in the occurrence of low blood loss, estimated blood loss by the provider was overestimated by as much as 540%. Training in estimation of blood loss is minimal and ability to assess blood loss visually is a skill that varies by provider (Stafford et al., 2008). Years of experience or training do not improve the accuracy of estimating blood loss (Ali Algadiem et al., 2016; "Quantitative Blood Loss in Obstetric Hemorrhage," 2019; "Retired: Quantification of Blood Loss: AWHONN Practice Brief Number 1," 2015; Toledo et al., 2007). Even with high fidelity simulation training, visual estimation of blood loss was found to be underestimated by 32% (Hancock et al., 2015). Inaccurate estimation of blood loss can result in both unnecessary interventions, with untoward side effects for the woman, or delay in necessary interventions resulting in maternal morbidity. Accurate measurement of blood loss guides the timing of appropriate interventions.

Quantification of blood loss (QBL) is an objective method of measurement. Quantifying blood loss can be done by weighing items, direct collection of blood into a basin or bag, and gravimetric methods (Gabel & Weeber, 2012; Natrella et al., 2017; "Quantitative Blood Loss in Obstetric Hemorrhage," 2019b). Determination of blood loss is more accurate when these quantitative blood loss measurement techniques are used (Al Kadri et al., 2010; Gabel & Weeber, 2012; Hancock et al., 2015; Lertbunnaphong et al., 2015; Natrella et al., 2017; Patel et al., 2006; "Quantitative Blood Loss in Obstetric Hemorrhage," 2019a; Schorn, 2010; Toledo et al., 2007; Zamudio et al., 2017). The use of QBL is a better tool to detect actual postpartum hemorrhage ("Quantitative Blood Loss in Obstetric Hemorrhage," 2019). The California Maternity Quality Care Collaborative (CMQCC) recommends that the quantification of blood loss begin immediately after a woman has given birth and continue until bleeding slows (Gabel & Weeber, 2012). The CMQCC also found that a key cause of PPH mortality and morbidity was the lack of ongoing quantitative blood loss measurement (Maternal, 2017). Using the recommendations of the CMQCC, a protocol of how to quantify blood loss in a vaginal and cesarean birth have been outlined by both ACOG and AWHONN (Maternal, 2017; "Practice Bulletin No. 183: Postpartum Hemorrhage," 2017; "Retired: Quantification of Blood Loss: AWHONN Practice Brief Number 1," 2015). The fact remains that quantitative assessment of cumulative blood loss immediately after birth that continues until the bleeding slows, leads to early recognition and intervention (Gabel & Weeber, 2012; Maternal, 2017).

A Plan-Do-Study-Act (PDSA) framework is a commonly preferred method used for quality improvement in healthcare and can provide the method for structuring the development of change (Taylor et al., 2013). In a PDSA cycle the improvements in outcomes are achieved through identification of the change needed, testing the change, measuring the outcomes, interventions or goals are adjusted, and the cycle begins again. The PDSA cycle assists in the understanding of the impact of the intervention (Taylor et al., 2013). Therefore, utilizing a PDSA cycle in evaluating the quantification of blood loss during cesarean sections will be useful in improving maternal outcomes.

Method

Design

A descriptive cohort study design, utilizing a retrospective chart review, was used for this quality improvement project. A quality improvement process using the Plan-Do-Study-Act (PDSA) cycle was used to evaluate the quantification of blood loss during cesarean sections.

Setting

A large inpatient women's services unit at a not for profit catholic hospital, located in the suburbs of a large metropolitan area, with a population of over three million people was the setting for this study. This unit employs 220 nurses, 3 nurse practitioners, 24 nurse midwives, and serves both the metropolitan and surrounding rural areas. One hundred thirty physicians along with an obstetrical anesthesia group have practice privileges on this unit. This hospital houses the largest Level III Neonatal Intensive Care Unit in the region. In 2018, there were 8,720 babies delivered: the most deliveries in the metropolitan area. This unit is open 24 hours a day and 365 days a year and cares for any woman who has a confirmation of pregnancy through the second week of the postpartum period.

Sample

A convenience sample of postpartum patients aged 18 years or older, who delivered via cesarean section, from time of delivery to discharge from hospital were studied. The study period will be May 1, 2018 through October 30, 2018 (pre-quantification of blood) and January 1, 2019 through June 30, 2019 (post-quantification of blood loss). Inclusion criteria include women 18 years of age or older, who delivered via cesarean section, and experienced a postpartum hemorrhage (blood loss of 1000 mls or greater) between time of delivery and discharge from the hospital. Exclusion criteria include any woman less than 18 years of age or older than 45 years of age, multiple gestation delivered outside of operating room setting, vaginal delivery, and delivered outside of the hospital.

Approval Process

This project was approved by the chair of the department, department manager and the executive director of nursing. The quantification of blood loss (QBL) protocol was approved for use by Obstetrical Anesthesia Group, Perinatal Safety Committee members, and OB Leadership Committee in August 2018 and was implemented into practice on October 31, 2018.

Institutional Review Board (IRB) approval was obtained from the University of Missouri – St. Louis (UMSL) and additionally from the hospital. I am seeking approval from the UMSL College of Nursing Doctoral Committee and the UMSL graduate school. There are no foreseen risks or ethical considerations for this project.

Data Collection and Analysis

Data was collected via a retrospective medical record review. Prior to implementation of QBL protocol, data was collected from May 1, 2018 through October 30, 2018 to look at EBL, interventions and treatments, and outcomes. The chart review contained data extracted from the medical record that contained: age, race/ethnicity, gravity/parity, vital signs, EBL, medication administration and times, method of delivery, blood product administration, labor and delivery operating room case log, interventional radiology (IR) procedures, and intensive care unit (ICU) admissions. After implementation of QBL protocol, a retrospective chart review from January 1, 2019 to June 30, 2019 will occur to compare the data.

The data was stored on a password protected computer and encrypted USB flash drive by the primary investigator. All data was de-identified and coded and coded as E1, E2, E3, etc. for the PPH prior to the QBL protocol and Q1, Q2, Q3, etc. for PPH patients after the implementation of the QBL protocol to protect patient confidentiality (Appendix A). All data retrieved will be permanently deleted upon completion of the project. The data analytics include the use of SPSS, Chi-squared analysis, and the Fisher's exact test analysis.

Procedures

A team of key stakeholders was formed in January 2018, including the primary investigator Obstetric Anesthesia, QBL champions, perinatal safety committee members, Women's Services Department Chair, Women's Service's Leadership team, unit nursing staff, and unit scrub technicians. The team reviewed the CMQCC Obstetric Hemorrhage Report, ACOG recommendations, and the literature for the best practice measures for interventions for postpartum hemorrhage. At that time, the unit was estimating blood loss instead of quantifying blood loss. The unit was following a standardized algorithm for treating postpartum hemorrhage that had been developed prior to the formation of this team. Following the recommendations of CMQCC and ACOG, quantification of blood loss was adopted as standard practice. The decision of the team was to implement quantification of blood loss in cesarean sections starting October 31, 2018.

Prior to implementation, the unit nursing staffs, and scrub technicians were trained on quantifying blood loss. Residents, Obstetric Anesthesia, and midwives were notified through email of the practice change of quantifying blood loss in cesarean sections and the implementation date. An email was also sent by the Chief of the

Department to all attending physicians on the practice change. Worksheets for quantifying blood loss along with scales were placed in each operating room on the unit. “How to quantify blood loss” fact sheets were also placed in the peri-op area and in each operating room.

Results

A total of 2,269 patients’ charts were reviewed for this study (Table 1). Of those, 466 (N=466) had a postpartum hemorrhage and meet inclusion criteria. The sample group had 179 EBL participants and 287 QBL participants. Participant’s age ranged from 18 to 45 years old (M= 32.45, SD= 4.233). The greatest number of postpartum hemorrhages occurred in the 25-35-year-old group for both the EBL group (N=114) and the QBL group (N=186). Participants in the 18-24 years old range had the least postpartum hemorrhages in both the EBL (N=17) and the QBL groups (N=40). Participants in this study identified as Asian, Black, Caucasian, Hispanic, Other, or Unknown (Table 2). Caucasians had the greatest number of postpartum hemorrhages in both the EBL group (N=131) and in the QBL group (N=204). Black participants followed in the EBL group (N=29) and in the QBL group (N=51). The participant’s gravidity ranged from 1 to 8 (M=2, SD= 1.415). Gravidity was divided into 3 groups: primiparity, multiparity, and grand multiparity. Multiparous participants had the highest number of PPH in the EBL group (N=102) and in the QBL group (N=141). However, the primiparous participants in the QBL group (N=122) and the EBL group (N=63) followed close behind. Grand multiparous participants had the lowest incidence of PPH in the EBL group (N=14) and in the QBL group (N=24).

The overall PPH rate was 21% (466/2237), when looking at the EBL group the PPH rate was 15.2% (179/1171) and 27% (287/1066) in the QBL group. The mean for overall blood loss for the mean for EBL was 810.33 mls and 841.42 mls for the QBL group. When looking at overall PPH blood loss, the mean for the EBL group was 1188.44 mls and for the QBL group it was 1434.45 mls. A Mann-Whitney test was conducted to evaluate whether the overall PPH blood loss and the overall blood loss amounts were affected by using QBL. The results show there is statistical significance in both the overall blood loss group (U=475146.000, z=-3.365, p=.001) and the overall PPH blood loss group (U=11217.500, z=-10.112, p=.000). The rate of mild PPH in the EBL group was 9.4% (N=17) and 14% (N=40) in the QBL group. The rate of moderate PPH in the EBL group was 64% (N=114) and 65% (N=186) in the QBL group. The rate of severe PPH in the EBL group was 26.8% (N=48) and 21% (N=60) in the QBL group.

A chi-squared test analysis was performed on the demographical data (age, race/ethnicity, and gravidity) and the five variables (rate of mild, moderate, severe PPH; rate of uterotonic administration; rate of blood product administration; rate of surgical intervention; and rate of ICU admissions) on both the EBL and QBL groups to determine if there was a statistical significance between the groups (Figure 1). Results indicated that there was no statistical significance between PPH for EBL or for QBL and age (p= .180), or race/ethnicity (p=.228), or gravidity (p=.190). Rate of mild/moderate/severe PPH between the EBL group and the QBL group resulted in no statistical significance (p=.180). Uterotonic use in the EBL group was 42% (N=75) and in the QBL group was 41% (N=117) with no statistical significance resulted (p = .442). Blood product administration occurred in 8.9% (N=16) of the EBL participants and in 10% (N=29) of the QBL participants with no statistical significance noted (p=.399). Surgical intervention resulted in no statistical significance (p=0.421) with an occurrence in 6.1% (N=11) of the EBL participants and in 5.2% (N=15) of the QBL participants. Due to a low number of participants in the rate of ICU admissions, a Fisher's exact test analysis was performed. Due to the very low number of ICU admissions (p=.503), a true analysis between the EBL group 0.05% (N=1) and the QBL group 1% (N=3) could not be made.

Discussion

This quality improvement project reviewed six months of data for participants who had estimation of blood loss during their cesarean section (n=1,167) and six months of data for quantification of blood loss (n=1,070). Of these 2,237 participants, 466 (n=4) met criteria for having a postpartum hemorrhage; along with meeting the inclusion criteria. Thirty-two participants were excluded based on exclusion criteria. The chi-squared and fishers exact test analysis yielded a p-value that was greater than .05. Therefore, there was no statistical significance noted in maternal outcomes between EBL and QBL implementation when analyzing all five variables (rate of mild, moderate, severe PPH; rate of uterotonic administration; rate of blood product administration; rate of surgical intervention; and rate of ICU admissions). While not statistically significant, there was clinical significance in the overall rate of postpartum hemorrhages, the severe postpartum hemorrhage rate, the rate of surgical intervention, and the rate of uterotonic administration.

The rate of PPH went from 15.2% with EBL to 27% with the implementation of QBL; which shows PPH is being more accurately diagnosed and in turn is clinically significant. The inaccuracy of visual EBL is commonly reflected in underestimation of blood loss when blood loss is excessive (Al Kadri et al., 2010; Gabel & Weeber, 2012; Hancock et al., 2015; Main et al., 2015; Natrella et al., 2017). QBL is a more accurate tool to detect actual postpartum hemorrhage ("Quantitative Blood Loss in Obstetric Hemorrhage," 2019), which in turn will lead to early recognition of blood loss, adequate and appropriate treatment (Gabel & Weeber, 2012; Maternal, 2017), and is a crucial step in preventing maternal morbidity and mortality (Hancock et al., 2015). With the implementation of QBL, the rate of severe postpartum hemorrhage (blood loss greater than 1,500 mL) decreased from 26.8% to 21% which is clinically significant. Delays in recognition, diagnosis, appropriate intervention, and treatment can result in escalation in the severity of a postpartum hemorrhage (Hancock et al., 2015). With the implementation of QBL the incidence of severe PPH was decreased which is the goal of QBL and ultimately decreases maternal morbidity and mortality (Gabel & Weeber, 2012; Maternal, 2017). The Mann Whitney test showed statistical significance in the use of QBL versus EBL and blood loss ($U=11217.500$, $z=-10.112$, $p=.000$). Sharing this finding with healthcare providers will hopefully push for facilities to adopt QBL as standard practice in both cesarean sections and vaginal deliveries. QBL is not only beneficial in cesarean sections, but for all births, and improving the outcomes to postpartum women across the United States.

The rate of surgical intervention also decreased from 6.1% in the EBL group to 5.2% in the QBL group and the rate of uterotonic administration decreased from 42% in the EBL group to 40.1% in the QBL group. Surgical intervention can come with additional risk or loss of fertility. With accurate calculation of blood loss, PPH being recognized and treated sooner, and the need for uterotonic administration and surgical interventions are decreased. While there was not statistical significance in improving maternal outcomes, the clinical significance shows the use of QBL is a movement in the right direction of providing timely and appropriate care for postpartum women. With continued education and future studies may show a statistical significance in improving maternal outcomes.

There were several limitations to the study. One limitation is this study only looked at the demographical make up of women who had a PPH and not of all women who had a cesarean section. Due to this limitation it could not be determined if age, race, or gravidity influenced maternal outcomes. Another significant limitation was inconsistencies in documentation of PPH, interventions and treatments, and actual blood loss documentation once the postpartum woman left the operating room. Inconsistencies in the healthcare team following the PPH protocol was another limitation. It is unclear how these inconsistences affected the data. Reeducation on PPH documentation and use of the PPH protocol across the whole health care team is recommended. While there were difficulties in extracting data during chart reviews, and some participants may not have been identified, there was an adequate sample size obtained in this study. Using the G*Power calculator, the sample size needed was 52 participants. A potential limitation was as healthcare providers began to see what actual blood loss is with the use of QBL, did QBL potentially trigger interventions before blood loss met PPH criteria. This is a positive result of the implementation of QBL, it is unclear to know if this affected the data and outcomes.

This study did look at race/ethnicity and PPH; however, repeating the study looking at the correlation between social determinants and the rate and severity of PPH would be beneficial in evaluation of outcomes as well. Additionally, further study evaluating long term outcomes could expand the evaluation of QBL and maternal outcomes. For instance, was the length of postpartum recovery impacted, was breastmilk production impacted, or were ADL's or work affected by the severity of PPH. Finally, it is recommended to repeat the study after reeducation of the healthcare team on documentation of blood loss and the PPH protocol for treatment and interventions.

Conclusion

Postpartum hemorrhage is a preventable cause of maternal morbidity and mortality (Saoud et al., 2019) and accounts for 11% of all maternal deaths in the United States (Saoud et al., 2019). The CMQCC found that a key cause of PPH morbidity and mortality was the lack of ongoing quantitative blood loss measurement (Maternal, 2017). Early recognition of blood loss in conjunction with prompt, adequate, and appropriate treatment improves maternal outcomes (Hancock et al., 2015; Main et al., 2015; Maternal, 2017; Natrella et al., 2017; "Practice Bulletin No. 183: Postpartum Hemorrhage," 2017; Saoud et al., 2019; Seacrist et al., 2019; Seligman et al., 2017; Zamudio et al., 2017). Quantification of blood loss permits this early recognition, leading to prompt treatment, and intervention (Gabel & Weeber, 2012; Maternal, 2017). This quality improvement project provided clinical evidence that maternal outcomes are improved with the use of QBL and highlights the importance of its continued use. The incidence of PPH increased by 11.4%, evidence that QBL is giving a more accurate blood loss, leading to early recognition of PPH. The evidence is also seen in the reduction of severe PPH by 5.8% and in the reduction of surgical intervention by 0.8%. By using

QBL, the healthcare team is recognizing PPH sooner, initiating treatment earlier, and reducing the escalation to severe blood loss and the need for surgical intervention.

Often, practice or policy changes are implemented; but the evaluation of the change is rarely done, leaving many to wonder if the change was beneficial or not, and if it provided better outcomes. While there is plenty of research on the benefits of QBL there are gaps in the literature on how QBL actually affects outcomes. This project provides clinical evidence that changing from EBL to QBL does improve maternal outcomes. Healthcare providers can take an active role in improving maternal outcomes for postpartum women by implementing QBL as standard practice for calculating blood loss. Continued education of obstetric healthcare teams across the country on how quantitative assessment of cumulative blood loss, and quantifying blood loss from immediately after birth until the bleeding slows, will lead to early recognition, intervention, and improved maternal outcomes.

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Appendix A

Data Collection Tool Estimating & Quantifying Blood Loss

(Excel Spreadsheet)

0 = E 1 = Q	Subject ID	Age	Race/Ethnicity	Gravida	Para	Total Amount Of Blood Loss	Severity Of PPH	Were Uterotonics Given	Which Uterotonic were given	# of Uterotonics given	Were blood products given	Which blood products were transfused	Number blood products transfused	Was a Surgical Intervention Performed	Which Surgical interventions were performed.	Number surgical interventions	ICU Admission
0	E1																
0	E2																
0	E3																
0	E4																
1	Q1																
1	Q2																
1	Q3																
1	Q4																

Appendix B

Table 1 Total Number of Participants

Total Charts Reviewed	**2269**
Number of excluded participants	32
Number of EBL participants	1171
Number of EBL PPH participants	179
Number of QBL participants	1066
Number of QBL PPH participants	287

Appendix C

Table 2 Demographics – Race/Ethnicity

Race/Ethnicity Participants	**EBL**	**QBL**
Caucasian	131	204
Black	29	51
Asian	4	4
Other	4	19
Hispanic	8	8
Unknown	2	1
Total	179	287

Appendix D

Figure 1 – Maternal Outcomes for EBL and QBL