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Implementation of Quantitative Blood Loss Following Cesarean Section Birth

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Implementation of Quantitative Blood Loss Measurement Following Cesarean Birth

Estimated blood loss (EBL) is a process of visually estimating blood loss following birth, while quantitative blood loss (QBL) is the physical measurement of blood loss following birth. Utilizing EBL may delay recognition of postpartum hemorrhage (PPH), which can then delay appropriate interventions and treatment. QBL is performed by utilizing scales to weigh blood-soaked items and assessing suction canister volumes for a more accurate measurement of blood loss compared to visual estimation (The American College of Obstetricians and Gynecologists [ACOG], 2019). Over time, studies have demonstrated QBL as a more accurate measurement for obstetric blood loss (ACOG, 2019). Providers have the potential to overestimate or underestimate actual blood loss when visual estimation is completed. An overestimation may lead to unnecessary treatments, while an underestimation may lead to lack of interventions (ACOG, 2019). Improving accuracy in measurement with quantification of blood loss improves the ability for patients to receive appropriate care and treatment. Accuracy in obstetric blood loss is imperative for identification of and implementation of interventions for postpartum hemorrhage (PPH) (ACOG, 2019). The Association of Women's Health, Obstetric and Neonatal Nurses (AWHONN) (2021) likewise recommends quantification of blood loss for every birth, due to PPH continuing as a main cause of maternal mortality. Postpartum hemorrhages that require blood transfusion have increased and again, are recognized as a leading cause of maternal morbidity (AWHONN, 2021).

When excessive blood loss is identified accurately and quickly, rapid identification of PPH cause and initiation of treatment can be expedited (Wormer et al., 2024). AWHONN (2021) explains that QBL objectively measures blood loss aiding in timely, appropriate escalation of interventions which can influence patient outcomes. Postpartum hemorrhage is traditionally defined as blood loss greater than 500mL with a vaginal birth or greater than 1,000mL with a cesarean birth (Wormer et al., 2024). However, this definition was redefined by ACOG in 2017. Currently, PPH is defined as a cumulative blood loss greater than 1,000mL in addition to signs and symptoms of hypovolemia within 24 hours of birth, regardless of the delivery route (Wormer et al., 2024). Identifying increasing blood loss by way of QBL will allow the initiation of rapid treatment.

Postpartum hemorrhage has four main causes that can be remembered with the four T’s mnemonic. The four T’s include: tone (uterine atony), trauma (laceration, rupture, hematoma), tissue (retained tissue), and thrombin (coagulopathy) (Evensen et al., 2017). PPH can occur after any birth, even those without risk factors. Postpartum hemorrhage is a significant problem due to potential harm and is a main contributor to maternal morbidity (ACOG, 2019). According to ACOG, of maternal deaths in the United States, 11% are caused by PPH and 54-93% of the deaths related to PPH could be prevented (ACOG, 2019). When institutions adopt QBL protocols for improved accuracy in blood measurement, PPH can be identified sooner, allowing for earlier intervention. Maternal morbidity and mortality related to all causes of PPH can be minimized with rapid team-based care (Evensen et al., 2017). Inaccurate estimation of obstetric blood loss by health care providers is a primary cause of delayed staff response to PPH (ACOG, 2019). Similarly, AWHONN (2021) explains that inaccurately assessing maternal blood loss leads to delays in both response and management of PPH.

In a cesarean section birth, providers begin the quantification process when the infant is born or after amniotic membranes are ruptured. The amniotic fluid in the suction canister should be measured before the placenta is delivered. Following placental delivery, the level of fluid in the suction canister is measured prior to use of irrigation fluid (ACOG, 2019). The scrub team should notify the circulating RN before irrigation, so they can accurately assess the volume in the suction canister. Finally, all blood-soaked items are weighed, added together, and converted to milliliters blood loss in which 1 gram is equal to 1mL.

Routine administration of drugs after birth to contract the uterus, known as uterotonics, have become the standard practice across the world (Gallos et al., 2019). If uterine atony is identified, additional uterotonic medications may be needed in addition to Oxytocin, which is routinely given at the time of delivery for active management of postpartum bleeding (ACOG, 2019). Additional uterotonics commonly used for medical management of PPH caused by uterine atony include Methylergonovine, Carboprost, and Misoprostol (Wormer et al., 2024). Additionally, uterine tamponade using an intrauterine balloon may be considered if bimanual massage and uterotonic medications have failed to control the PPH. When PPH has a cause other than atony, the provider should tailor the treatment modality specific to the cause (Wormer et al., 2024).

On a labor and delivery unit an opportunity for quality improvement has been identified. Currently, the unit uses EBL methods for cesarean deliveries rather than quantifying the blood loss. Approximately 100 cesarean section births are performed each month at this institution with a PPH rate ranging from 7-23%. The IHI Model for Change framework is an essential part of the Institute for Healthcare Improvement's "rapid cycle improvement" concept (Kourtis & Burns, 2019). This framework will be used to guide this quality improvement project. The purpose of this project is to implement a QBL calculation protocol in all cesarean section births with goals of identifying abnormally increased blood loss earlier and rapid PPH intervention, and therefore, improving maternal outcomes. The question for this project is:

In adult, female patients age 18-49 years old undergoing a cesarean section birth, does implementation of a QBL protocol improve the recognition of postpartum hemorrhage over a three-month period?

Focusing on the systems level, the primary outcome measure of interest is the rate of PPH identified using QBL in the first 24 hours following birth. The secondary outcome measure is compliance with documentation of QBL for cesarean births following implementation of the QBL protocol.

Review of Literature

PubMed, Medline (EBSCO) and CINAHL were utilized to conduct a literature search. Some of the key search terms included for the literature search were *quantitative blood loss, estimated blood loss, postpartum hemorrhage, cesarean section, and earlier identification*. The Boolean operators AND and OR were used in this search. During the initial search, 627 articles were found with the inclusion of the key search phrases. The inclusion criteria for this search comprised of studies from the past 5 years, published in the English language, and cesarean section deliveries had by females of all ages and races. Exclusion criteria included vaginal deliveries, maternal hemorrhage greater than 24 hours after delivery, studies performed greater than five years ago, and studies not in

English. After applying inclusion and exclusion criteria, 458 publications were generated of which 11 publications were then selected for the literature review.

Several research studies assessed accuracy of obstetric blood loss assessments during cesarean section births. A systematic review and meta-analysis by Ruiz et al. (2023) was performed to compare the effectiveness of different diagnostic methods for postpartum blood loss. Fourteen studies were included for the analysis. Accuracy of EBL depends on variables such as the experience of the professionals assessing it (Ruiz et al., 2023). Additionally, EBL is found to be flawed with potential for overestimation and underestimation, which can waste unnecessary resources including blood transfusions and delayed recognition and treatment, which can compromise the postpartum woman's health. In the analysis, when EBL and QBL were compared, the studies found QBL to detect blood loss with greater accuracy in PPH cases (Ruiz et al., 2023). The recommendation for diagnosis of PPH in all types of childbirth is measurement with QBL and should be applied to low and high-risk women. Benefits of QBL include reducing maternal morbidity, allowing timely care, providing an objective measurement impacting PPH recognition and treatment, reducing unnecessary transfusions, increasing staff awareness without increasing workload, contributing to early and conscious use of uterotonics, and presenting better results when compared to EBL (Ruiz et al., 2023).

A study by Bhatt et al. (2022), found that utilization of QBL in an algorithm to determine immediate resuscitative interventions improved maternal outcomes. According to Bhatt et al. (2022) when EBL was documented alone, it trended significantly lower on average than the EBL when it was documented in addition to QBL for cesarean deliveries. Additionally, cesarean sections that had EBL and QBL both documented had higher numbers of blood transfusions compared to those who had only EBL documented. Bhatt et al. (2022) discovered that EBL may be underestimating actual blood loss, which has potential impact on the care and interventions patients receive.

Similarly, a retrospective cohort study by Orzolek et al. (2023) found EBL to be an underestimation of calculated blood loss (CBL). The study authors identified a tertiary hospital setting and examined blood loss from term cesarean deliveries of singleton infants. Orzolek et al. (2023) identified both EBL and QBL groups while reviewing six months of deliveries. The study's objective was determining the difference between CBL and two measurement techniques (QBL and EBL) in milliliters for cesarean deliveries. The authors found a positive value of 172 mL for EBL and negative value of -106 mL for QBL (Orzolek et al., 2023). Orzolek et al. (2023) found that EBL may have been an underestimation of blood loss. The differences between CBL and recorded blood loss was larger in the EBL group compared to the QBL group ($p < .001$) (Orzolek et al., 2023).

A study by Ladouceur and Goldhort (2019) focused on education of registered nurses and doctors in altering their current practice from visually estimating blood loss to quantifying blood loss. The study was performed at a midwestern U.S. urban community hospital that as 1,200 annual births in which postpartum blood loss was being visually estimated (Ladouceur & Goldhort, 2019). Forty-three intrapartum nurses and 17 physicians participated in this study. The goal was for three consecutive months to use QBL for 85% of births. A baseline survey was performed to assess the providers knowledge of the QBL method. After the survey, staff received a 10-minute educational presentation by a clinical nurse specialist (CNS) on QBL. The CNS attended deliveries on day and night shifts, provided support, evaluated correct use of new drapes, and answered any questions providers had (Ladouceur & Goldbort, 2019). After data analysis, it was determined that there was a compliance rate at an average of 89% for the time period studied. Ladouceur and Goldbort (2019) concluded that providing QBL education increased both nurses and physicians’ consciousness of the importance of QBL and why it should be their new standard of care when assessing obstetric blood loss. Prevention of maternal morbidity and mortality is crucial and more accurately measuring postpartum blood loss is critical in the process.

A study by Blosser et al. (2021) evaluated the capability of EBL and QBL to predict the need for blood transfusion in postpartum patients. The EBL group consisted of 848 patients with cesarean deliveries, while the QBL group consisted of 828 cesarean deliveries. Blosser et al. (2021) found a higher rate of blood loss in QBL compared to EBL, however, there was no difference in the rate of blood transfusions. QBL did outperform EBL in predicting a ≥ 10-point drop in hematocrit. Blosser et al. (2021) found QBL to be more sensitive in detection of clinically significant blood loss, which could in turn lead to earlier recognition of PPH and interventions.

An additional study by Torres et al. (2020) determined accuracy of EBL versus QBL with targeted outcomes of blood transfusion and hemoglobin drop ≥ 3 gm/dL after cesarean birth. Forty women received red blood cell transfusions and 132 had a hemoglobin drop of drop ≥ 3 gm/dL. The majority of cases had QBL which exceeded EBL (Torres et al., 2020). QBL and EBL were found to perform similarly in scheduled and non-emergent cesarean deliveries for identifying hemorrhage with their targeted outcomes (Torres et al., 2020).

Quantifying blood loss improves PPH recognition, subsequently impacting maternal morbidity and mortality (ACOG, 2019). When QBL was implemented in one hospital, the rate of diagnosed hemorrhage among vaginal and cesarean deliveries tripled (Blosser et al., 2021). Recognition of an obstetric hemorrhage is an essential first step to escalate treatment and management of a patient's bleeding. ACOG (2019) explains that 40% of PPH occur in low-risk women. Accurately assessing actual blood loss is important for early diagnosis of excessive blood loss, leading to increased awareness, diagnosis, and response time to PPH.

Literature Gaps

Gaps in the literature on patient outcomes exist in comparing QBL versus EBL. While evidence supports QBL as more accurate in identifying actual blood loss than visual estimation of blood loss, more research is needed to study actual patient outcomes. There is a lack of high level meta-analysis and randomized control trials (RCTs) on the use of QBL. Further research should be performed comparing and contrasting differences in patient outcomes based on specific demographics including maternal age, race, BMI, gestational age, infant birth weight, and parity (nulliparity versus multiparity). Further limitations in the literature review, found that given the quality of available studies, there was inconsistent evidence regarding overestimation or underestimation with use of EBL versus QBL. Regardless, QBL is remains the recommended standard for accurately identifying postpartum blood loss thus facilitating earlier intervention.

Framework

The IHI Model for Change framework was selected to guide this project (Kourtis & Burns, 2019). In this framework, the plan-do-study-act (PDSA) process continuously cycles in order to systematically evaluate new ideas. The steps of PDSA include developing a plan to test change, carrying out the plan to test the change, evaluating the impact of the change, and determining whether it results in effective change with positive outcomes (Kourtis & Burns, 2019). In this QI project, a plan is being developed on an inpatient unit to implement QBL calculation for all cesarean deliveries (do). Over the next three months, evaluation of patient outcomes and PPH interventions will be assessed (study), which will determine whether the change has been effective in providing positive patient outcomes and should be adopted (act).

Methods

Design

This quality improvement (QI) project used a descriptive, observational design. A pre-post-test design was used to assess documentation of cesarean birth PPH, QBL documentation, and demographic data among female patients undergoing cesarean section between February and April of 2024.

Setting

The setting for the QI project was a Midwestern, suburban hospital recognized by the American Nurses Credentialing Center (ANCC) as a Magnet hospital with an 18-bed labor and delivery unit. The labor and delivery unit performs approximately 3,400 deliveries per year and 1,200 of those are cesarean sections. The cesarean rate from Q4 2022 to Q3 2023 (12 months) was 37.05%. Approximately 100 cesarean births occur monthly on this labor and delivery unit. Of those births, approximately 7-23% experience PPH.

Sample

A convenience sample of women ages 18 to 49 years old undergoing cesarean birth at the hospital between February and April 2024 was used. Inclusion criteria included cesarean section births for women ages 18 to 49 years old. Exclusion criteria for the project included women under the age of 18, over the age of 49, vaginal birth, and delayed PPH. As approximately 100 cesarean section births take place each month, the expected sample size was 300 post-implementation.

Data Collection/Analysis

Data was collected from the hospital's EMR reporting system and was reviewed following the implementation of the QBL intervention. Data reports were generated by the onsite committee members for the project and were forwarded via email without any Health Insurance Portability and Accountability Act violations. Demographic data collected included age, race, and gravida/parity. In addition, cesarean section births who had PPH documented was collected, along with documented QBL. Data was stored on password-protected computers owned by the primary and secondary investigators, and de-identified and coded as A1, A2, A3, etc. Descriptive statistics and inferential tests were used to describe the sample population and determine statistical significance.

Approval Processes

Approval for implementation of QBL in cesarean births as a quality improvement project was supported by the labor and delivery nurse manager. Then, the study was approved by the hospital system's Evidence Based Practice (EBP)/Research Council. Next, the project was approved by the hospital IRB. Additionally, the study gained approval from the University of Missouri – St. Louis IRB. Ethical considerations for this project included a vulnerable population and risk of increased intervention related to increased PPH recognition. IRB approval was needed from both the project site and the University of Missouri – Saint Louis.

Procedures

QBL Personnel and Process

Personnel present in the operating room during cesarean section deliveries include a circulating nurse, anesthesia provider, obstetrician, RN first assist, scrub technician, neonatal nurse, and pediatric care provider. A hanging scale was present in each of the three operating rooms. Nurses circulating cesarean section deliveries used the provided hanging scales to weigh lap pads, lap counter bags, peri pads, drapes, and other blood-soaked items. The hanging scales provided a weight measurement in grams. One gram in weight equals one milliliter in fluid volume. The lap counter bags provided in the operating room hold 10 lap pads each and may be hung directly on the hanging scale.

The first step in QBL measurement involves utilizing suction canisters. The suction canisters are labeled with a volume scale in milliliters in order for staff to simply look at the canister and determine the volume of fluid present. Anesthesia staff made note of the volume present in the suction canister after birth of the newborn prior to delivery of the placenta and then again at the end of the case. The RN wrote down the end of case volume and the pre-placental volume on a worksheet, which can be seen in Appendix B. The next step in measuring QBL was weighing of blood-soaked items. Soft goods to weigh included lap pads, lap count bags, under buttocks pads, blue towels, white towels, and red bags. The number of soft goods used was noted, so an accurate dry weight could be calculated and subtracted from the total wet weight. The dry weight chart can be found in the middle of the worksheet displayed in Appendix B. Finally, a fundal rub was done in the operating room prior to transferring the patient back to her room. A graduated bowl was placed below the patient during this fundal rub so that blood volume can be measured. The blood volume expressed from the initial fundal rub was included in the QBL. The pre-placental volume was subtracted from the end of case volume for the total blood volume of canister. The total dry weight was subtracted from the total wet weight of soft goods used for the total of blood in soft goods. To calculate the final QBL, the total blood volume of canister and total of blood in soft goods were added together, along with the blood volume expressed from the initial fundal rub, and then the volume of saline irrigation used for the case was subtracted. The final calculation steps can be found on the far-right side of the worksheet shown in Appendix B. The worksheet was color-coded to ensure ease of use for RNs.

QBL Worksheets and Documentation

The circulating RN was responsible for documentation of the calculated QBL in the EHR. The RN was to select "QBL Calc – C/S" in the Delivery Summary to access the tab needed for QBL documentation (Appendix A). They then entered their manually calculated QBL into the section labeled "QBL Total Blood Loss – Cesarean: Other Items" (Appendix A). This created the total QBL for the case. Primary and secondary investigators adapted a QBL calculation worksheet (Appendix B) using California Maternal Quality Care Collaborative (CMQCC) as a reference. The QBL calculation worksheets were printed and placed in each OR so that they were readily available to RNs in each cesarean section birth. Nurses use printed "count sheets" currently in each cesarean delivery. The QBL calculation worksheets were placed in the cabinet next to the count sheets, so the RN could conveniently grab one count sheet and one QBL worksheet prior to the procedure.

Once the QBL worksheet had been filled out and all calculations were complete, the RN was to enter the total QBL into the Delivery Summary as shown in Appendix A. If additional blood loss was measured after leaving the operating room, the RN could return to the same area of the EHR and add the additional blood volume value. The QBL calculator has a “running total” and would add the additional measured volume to the initially documented value. The circulating RNs saved their QBL calculation worksheet, placed a patient label on it, and placed it in the QBL worksheet folder at the nurse’s station. Saving the completed worksheets ensured trustworthiness of RNs performing and documenting QBL.

RN Education

Staff nurse education of the project begun by discussing QBL on a staff meeting held in April 2023. Discussion continued with RN staff, scrub technicians, anesthesia staff, and obstetricians until project implementation begun in February 2024. These individuals made up the key stakeholders and therefore, their participation in the project was crucial. Prior to implementing this project, staff education occured through staff meetings and huddles. Another meeting was held January 23, 2024, to discuss QBL in cesarean section births. The primary and secondary investigators created a handout including the steps of calculating QBL and properly documenting QBL (Appendix C). Charge RNs reminded staff of the project in the daily and nightly huddles prior to each day and night shift. During huddles, the charge RN reviewed the QBL worksheet and “QBL How To” sheets with staff. Additionally, the labor and delivery unit nursing shared governance (UNSG) council received education on QBL performance and documentation. Involving UNSG allowed for QBL "champions" to be selected. As the primary and secondary investigators could not be present for each cesarean section birth, the QBL champions were able to be an additional resource for staff RNs as QBL implementation was rolled out. The UNSG council includes both day and night shift nurses. Champions were selected for both day and night shift to ensure resources were evenly distributed and available. When staffing allowed, the labor and delivery unit staffed an additional "QBL RN" to attend cesarean births throughout the shift to assist the circulating RNs in completing QBL.

Results

The total number of patients in the pre-intervention group was 283 (n = 283). The total number of patients in the post-intervention group was 330 (n = 330). The category of gender was female (n = 613, 100%). The most frequent race in the post-intervention group was Caucasian (n = 255, 77.27%) as seen in Appendix H, Table 4. A pie chart was used to display race in the post-intervention group showing that Caucasian was the high majority, and can be found in Appendix G, Figure 4. The age most frequent in the post-intervention group was 33 (n = 39, 11.82%), which is also described in Appendix H, Table 4. Appendix G also includes Figure 5 which is a Barplot displaying patient's ages in the post-implementation group, and Figure 6 which is a Barplot displaying the number of deliveries a patient has had, known as Parity. When visualizing the Barplot of ages, it is noticeable that most patients ranged from 29 to 39, while much fewer patients were 18 to 28 or 40 to 49. When visualizing the Barplot of Parity, the majority in the post-intervention group were on their second delivery.

The most frequently observed category for PPH in the pre-intervention group was No (*n* = 243, 85.87%). The most frequently observed category for PPH in the post-intervention group was No (*n* = 268, 81.21%). Frequencies and percentages are presented in Appendix E, Table 1. The most frequently observed category for QBL compliance in the pre-intervention group was No (*n* = 283, 100%). The most frequently observed category for QBL compliance in the post-intervention group was Yes (*n* = 196, 59.39%). Frequencies and percentages are presented in Appendix E, Table 2.

Discussion

There were 283 patients in the pre-intervention group, of which none had QBL documented. Of the 330 patients in the post-intervention group, 196 of them had QBL documented. Following the implementation of QBL in cesarean births, a 59.39% compliance rate was shown and is presented in a bar graph in Appendix F, Figure 3.

Figure 1 and Figure 2 can be found in Appendix D, including two bar graphs displaying the number of PPHs in the pre-intervention group versus the post intervention group. In the pre-intervention group, 40 of the 283 patients experienced PPH. In the post-intervention group, 62 of the 330 patients experienced PPH. This equates to 14.13% for the pre-intervention group compared to 18.79% in the post-implementation group. A frequency table is displayed in Appendix E, Table 1representing these findings. According to this data, PPH was detected slightly more frequently in the post-intervention group.

As shown in Appendix E, Table 3, the results of the Chi-square test were not significant based on an alpha value of .05, $\chi^2(1) = 0.29$, $p = .592$, suggesting that PPH in the pre-intervention and post-intervention groups could be independent of one another.

This implies that the observed frequencies were not significantly different than the expected frequencies (Intellectus Statistics, 2023).

Conclusion

While the analysis from this QI project did not detect a statistically significant difference in PPH recognition in the pre-intervention group versus the post-intervention group, QBL remains the more accurate way of measuring blood loss after birth when compared to EBL. In this project, compliance with QBL performance and documentation increased from February to March and March to April. Further studies are needed to continue assessing the effects of QBL on patient safety and care. One recommendation is to continue QBL in cesarean births at this facility and have unit staff take over collecting further data regarding compliance and PPH rates. Other variables to consider assessing in regard to QBL may be considered by the unit. They could assess data from specific providers and could also collect data including specific blood losses to assess the frequency of volumes in the 300s, 400s, 500s, and so on. PPH could also be measured specific to Parity to assess if hemorrhage occurs more frequently with a first delivery versus second, and so on.

References

American College of Obstetricians and Gynecologists (ACOG). (2019). ACOG committee opinion: Quantitative blood loss in obstetric hemorrhage. *Obstetrics & Gynecology, 134*(6), 150-156.

Association of Women's Health, Obstetric, and Neonatal Nurses (AWHONN). (2021). Quantification of blood loss: AWHONN Practice Brief Number 13. *Nursing for Women's Health*, *25*(4), 503–505. https://doi.org/10.1016/j.nwh.2021.04.005

Bhatt, A., Hughes-Hogan, L., Mitchell, T., Nair, S., Chuang, M., Chen, S. L., & Reddy, S. (2023). Impact of measuring quantification of blood loss versus estimation of blood loss during cesarean deliveries. *International Journal of Gynaecology and Obstetrics*, *160*(2), 670–677. https://doi.org/10.1002/ijgo.14337

Blosser, C., Smith, A., & Poole, A. T. (2021). Quantification of blood loss improves detection of postpartum hemorrhage and accuracy of postpartum hemorrhage rates: A retrospective cohort study. *Cureus*, *13*(2), e13591. https://doi.org/10.7759/cureus.13591

Evensen, A., Anderson, J. M., & Fontaine, P. (2017). Postpartum hemorrhage: Prevention and treatment. *American Family Physician*, *95*(7), 442–449.

Gallos, I., Williams, H., Price, M., Pickering, K., Merriel, A., Tobias, A., Lissauer, D., Gee, H., Tunçalp, Ö., Gyte, G., Moorthy, V., Roberts, T., Deeks, J., Hofmeyr, J., Gülmezoglu, M., & Coomarasamy, A. (2019). Uterotonic drugs to prevent postpartum haemorrhage: A network meta-analysis. *Health Technology Assessment*, *23*(9), 1–356. https://doi.org/10.3310/hta23090

Hire, M. G., Lange, E. M. S., Vaidyanathan, M., Armour, K. L., & Toledo, P. (2020). Effect of quantification of lood loss on activation of a postpartum hemorrhage protocol and use of resources. *Journal of Obstetric, Gynecologic & Neonatal Nursing*, *49*(2), 137–143. https://doi.org/10.1016/j.jogn.2020.01.002

Intellectus Statistics [Online computer software]. (2023). Intellectus Statistics. https://statistics.intellectus360.com

Kourtis, S. A., & Burns, J. P. (2019). Frameworks for quality improvement in pediatric intensive care: A concise review. *Pediatric Investigation*, *3*(2), 117–121. https://doi.org/10.1002/ped4.12134

Ladouceur, M. K., & Goldbort, J. (2019). A proactive approach to quantification of blood loss in the perinatal Setting. *Nursing for Women's Health*, *23*(6), 471–477. https://doi.org/10.1016/j.nwh.2019.09.007

McHugh, M. L. (2013). The chi-square test of independence. *Biochemia Medica*, *23*(2), 143-149. https://doi.org/10.11613/BM.2013.018

Orzolek, C., Durie, D., Flicker, A., Giacobbo, A., Quinones, J., & Qureshey, E. (2023). Quantitative blood loss in cesarean delivery is more accurate than visual estimation. *Obstetrics & Gynecology*, *141*(5), 27S. https://doi.org/10.1097/01.AOG.0000930048.52342.92

Ruiz, M. T., Azevedo, N. F., Resende, C. V., Rodrigues, W. F., Meneguci, J., Contim, D., Wernet, M., & Oliveira, C. J. F. (2023). Quantification of blood loss for the diagnosis of postpartum hemorrhage: A systematic review and meta-analysis. *Brazilian Journal of Nursing*, *76*(6), e20230070. https://doi.org/10.1590/0034-7167-2023-0070

Torres, K., McKenna, D., & Wiegand, S. (2020). A comparison of quantified versus estimated blood loss at the time of cesarean delivery. *American Journal of Obstetrics & Gynecology*, *222*(1), S550-551. https://doi.org/10.1016/j.ajog.2019.11.895

Wormer, K. C., Jamil, R. T., & Bryant, S. B. (2024). Acute postpartum hemorrhage. *StatPearls*. https://www.ncbi.nlm.nih.gov/books/NBK499988/

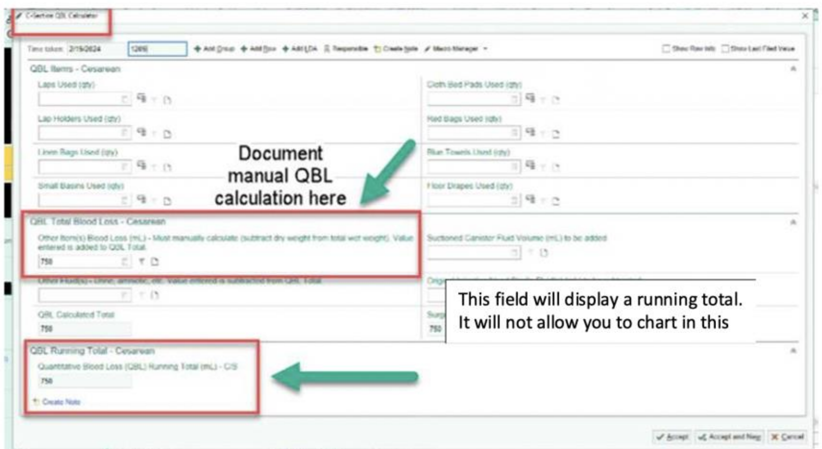
Zermeno, Y., Kram, J. J., Dickson, E., & Salvo, N. (2022). Accuracy of blood loss assessments during cesarean deliveries. *Obstetrics & Gynecology, 139,* 42S. https://doi.org/10.1097/01.AOG.0000825852.41825.0e

Appendices

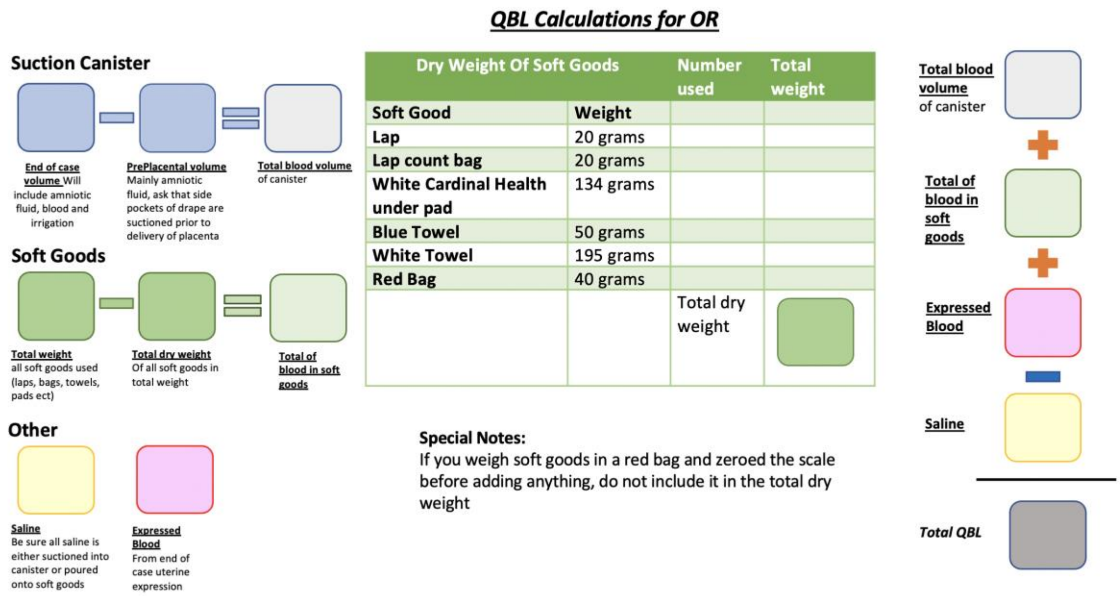
Appendix A

Access the QBL calc-C/S in your delivery summary

When this tab opens, chart the calculated QBL in the bottom of the screen in tab labeled "QBL total blood loss- Cesarean: Other items". This will create the total QBL for the case.



Appendix B



Dry Weight Of Soft Goods		Number used	Total weight
Soft Good	**Weight**		
Lap	20 grams		
Lap count bag	20 grams		
White Cardinal Health under pad	134 grams		
Blue Towel	50 grams		
White Towel	195 grams		
Red Bag	40 grams		
		Total dry weight	

Appendix C

QBL HOW TO:

Step 1:
Measure volume in suction canister following delivery of newborn BEFORE placenta delivery. Ensure all amniotic fluid is suctioned from pockets and field before recording volume

Step 2:
Weigh laps as bags fill. Record weights

Step 3:
Measure volume of suction canister at end of case. *ENSURE ALL SALINE IRRIGATION HAS BEEN SUCTIONED INTO CANISTER BY OB OR RNFA*

Step 4:
Weigh any laps left on field, even if unused.

Step 5:
Subtract pre-placenta canister vol. from end of case total canister volume. This equals TOTAL CANISTER BLOOD VOLUME.

Step 6:
Add all lap weights and subtract out dry weights (see dry weight chart). (Ex: 25 laps x 20 grams = 500 g dry weight → one lap bag = 20 grams x # of bags used for weighing)

Step 7:
Take total bloody lap volume + total canister volume and subtract saline irrigation used for total QBL

Step 8:
Measure blood from initial fundal rub and weigh white cardinal under bottom pad if saturated by hanging a red biohazard bag on the scale and zeroing it out. The white pad and fundal rub blood may then be placed in the bag. (Dry weight for white pad on calculation sheet must be subtracted out).

Appendix D

Figure 1

PPH pre-implementation

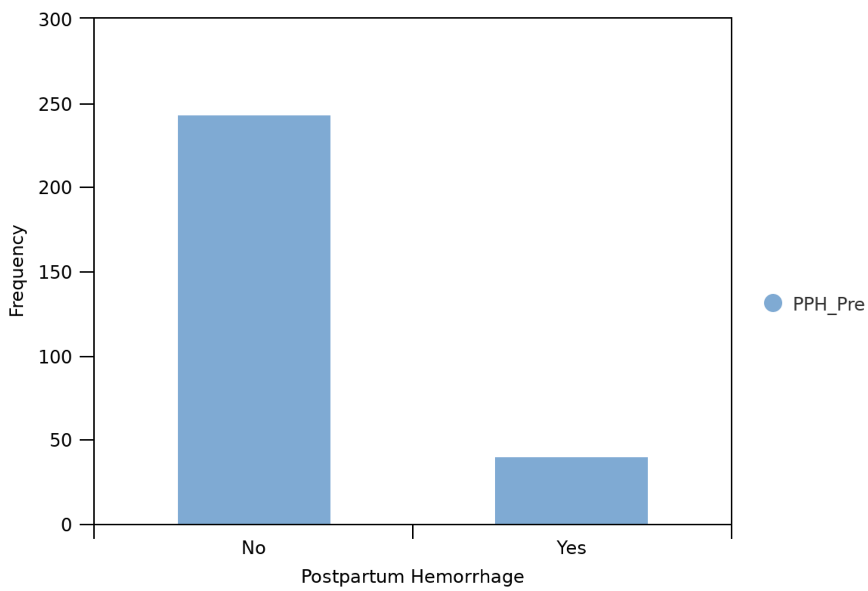
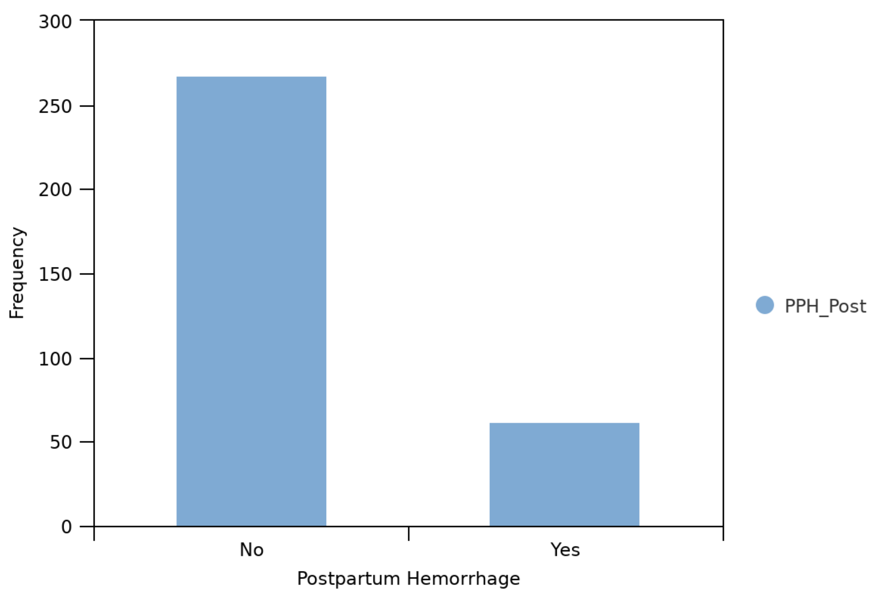


Figure 2

PPH Post-implementation



Appendix E

Table 1

Frequency Table for Nominal Variables

Variable	*n*	*%*
PPH_Pre-intervention		
No	243	85.87
Yes	40	14.13
PPH_Post-intervention		
No	268	81.21
Yes	62	18.79

Table 2

Frequency Table for Nominal Variables

Variable	*n*	*%*
QBL_compliance_Pre-intervention		
No	283	100
QBL_compliance_Post-intervention		
No	134	40.61
Yes	196	59.39

Table 3

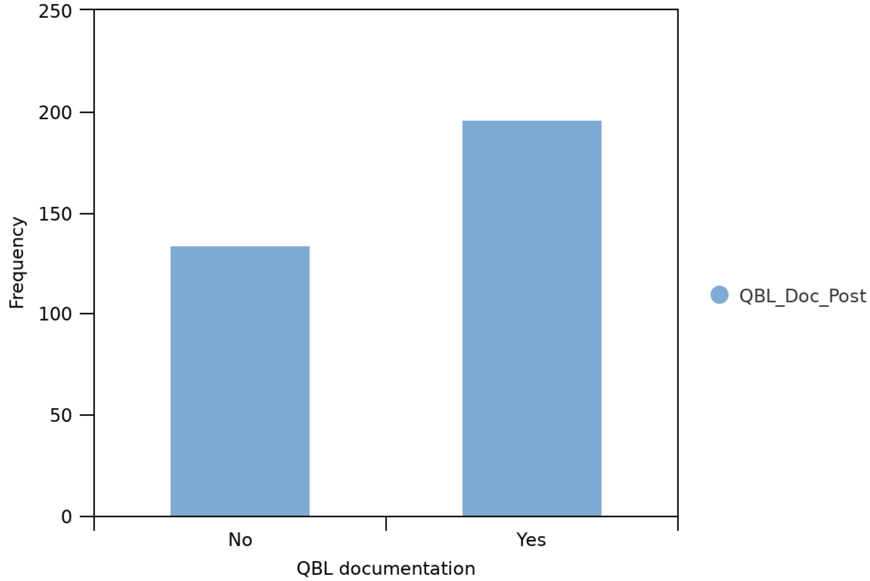
Observed and Expected Frequencies

	PPH_Post				
PPH_Pre	No	Yes	χ^2	*df*	*p*
No	198[199.21]	45[43.79]	0.29	1	.592
Yes	34[32.79]	6[7.21]			

Appendix F

Figure 3

QBL Compliance



Appendix G

Figure 4

Pie Chart of Race in post-implementation group

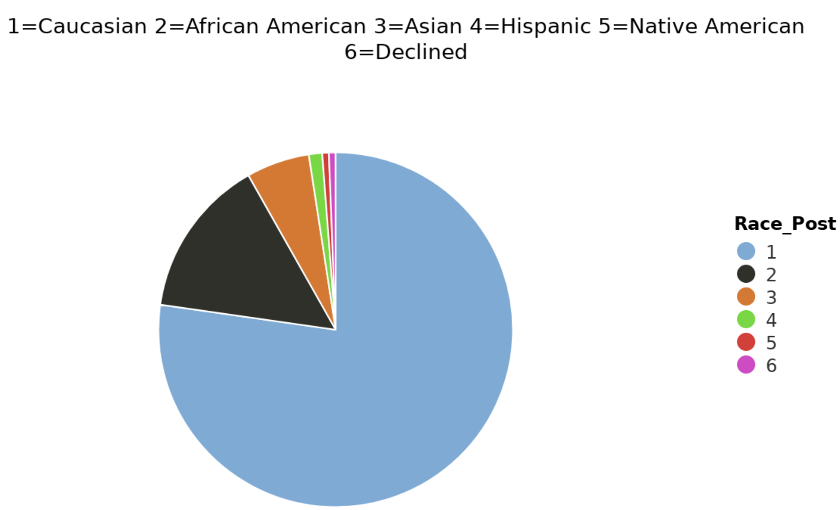


Figure 5

Barplot of Age in post-implementation group

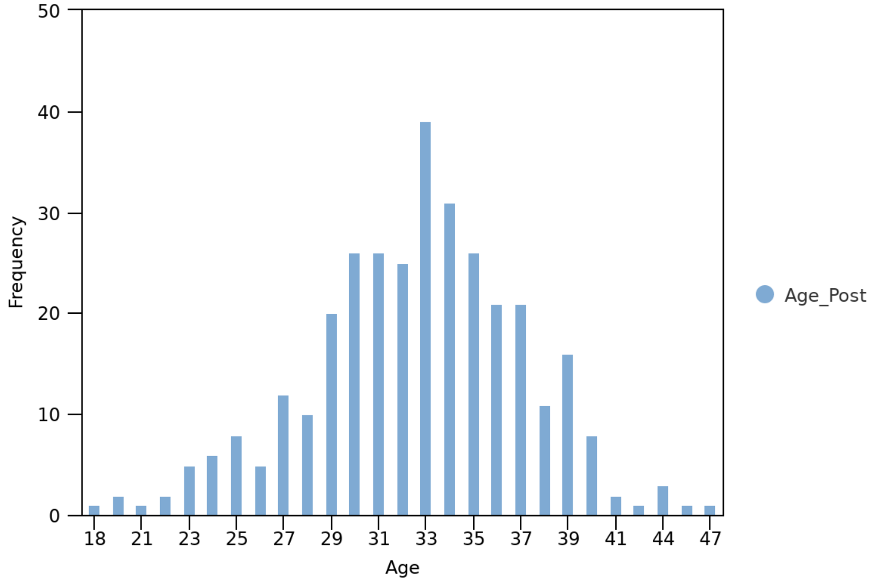
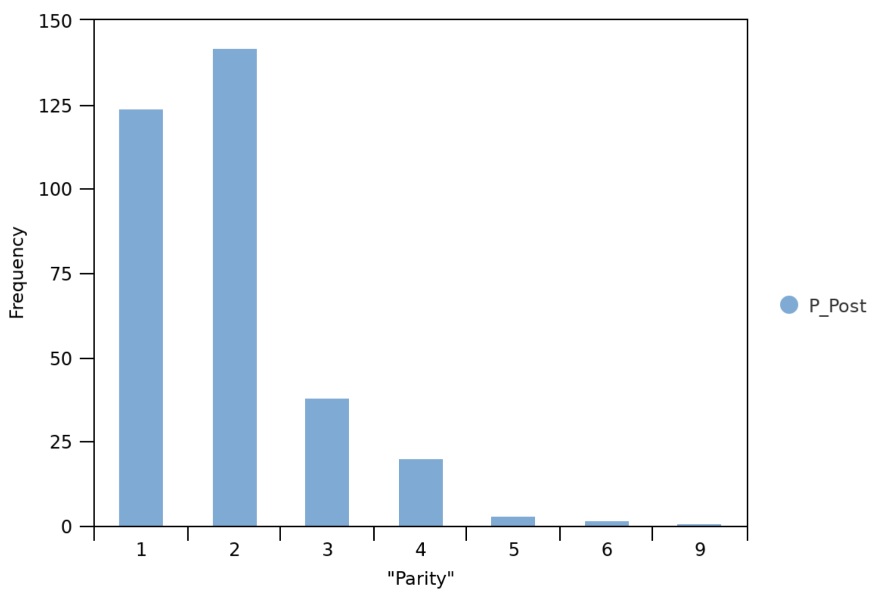


Figure 6

Barplot of Parity in post-implementation group



Appendix H

Table 4

Frequency Table for Nominal Variables

Variable	*n*	%
Race_Post		
Caucasian	255	77.27
African American	48	14.55
Asian	19	5.76
Hispanic	4	1.21
Native American	2	0.61
Declined	2	0.61
Age_Post		
18	1	0.30
20	2	0.61
21	1	0.30
22	2	0.61
23	5	1.52
24	6	1.82
25	8	2.42
26	5	1.52
27	12	3.64
28	10	3.03
29	20	6.06
30	26	7.88
31	26	7.88
32	25	7.58
33	39	11.82
34	31	9.39
35	26	7.88
36	21	6.36
37	21	6.36
38	11	3.33
39	16	4.85
40	8	2.42
41	2	0.61
42	1	0.30

44	3	0.91
46	1	0.30
47	1	0.30
Gravida_Post		
1	86	26.06
2	112	33.94
3	66	20.00
4	33	10.00
5	15	4.55
6	4	1.21
7	8	2.42
8	2	0.61
10	1	0.30
11	2	0.61
16	1	0.30
Parity_Post		
1	124	37.58
2	142	43.03
3	38	11.52
4	20	6.06
5	3	0.91
6	2	0.61
9	1	0.30
Multiples_Post		
twins	26	7.88

Note. Due to rounding errors, percentages may not equal 100%.