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Implementation of Quantitative Blood Loss Measurement in Cesarean Section Births

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A Dissertation Submitted to The Graduate School at the University of Missouri-St. Louis
in partial fulfillment of the requirements for the degree
Doctor of Nursing Practice with an emphasis in Women's Health Nurse Practitioner

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Implementation of Quantitative Blood Loss Measurement in Cesarean Section Births

Postpartum hemorrhage is a major complication following birth. Although some bleeding after birth is normal, birth parents may experience excess blood loss causing complications such as blood transfusion, admission to the intensive care unit (ICU), emergency hysterectomy, and potential death. According to The American College of Obstetrics and Gynecology's (ACOG) practice bulletin no. 183, postpartum hemorrhage can be defined as blood loss that is greater than or equal to 1,000 mL or blood loss that is accompanied by signs and symptoms of hypovolemia within 24 hours following birth (Shields et al., 2017). Postpartum hemorrhage is responsible for approximately 11% of maternal deaths in the United States and is a leading cause of death occurring on the same day as birth (ACOG, 2019). Lastly, 54-93% of deaths occurring from postpartum hemorrhage are preventable (ACOG, 2019).

Postpartum blood loss includes blood lost during labor/birth, immediately postpartum, and the subsequent 24 hours following birth. There are two main methods for determining blood loss. There are two methods to determining blood loss: Visual estimated blood loss (EBL) and quantitative blood loss (QBL). Estimated blood loss is determined by the provider at birth, and is a subjective measure based on provider estimation. The provider estimates the volume of blood on pads and fluid collector bags for vaginal births, and estimates the amount on pads, fluid pockets, laps, and suction canisters for cesarean sections. EBL has been found to decrease accuracy in appropriately identifying postpartum hemorrhage

(ACOG, 2019). Quantitative blood loss is performed by utilizing scales to weigh blood soaked items and assessing suction canister volumes to determine a more accurate volume lost (ACOG, 2019).

EBL may underestimate total blood loss, leading to delayed treatment (ACOG ,2019). It may also lead to overestimation, resulting in unnecessary use of interventions and supplies or medications (Hire et al., 2020). An ACOG committee opinion No. 794, ACOG (2019) states that skills in visual estimation of blood does not improve with health care provider specialty, age, or clinical experience. Blood loss may be determined using QBL for both vaginal and cesarean section births. Blood soaked lap sponges, bottom drapes, fluid pockets/collectors, and suction canisters are weighed/measured and blood loss is determined after subtracting out dry weights, amniotic fluid, and any other fluids (such as saline or urine) (ACOG, 2019).

The purpose of this quality improvement (QI) project is to implement QBL measurement in cesarean section births at a large, midwestern, suburban hospital in order to increase accuracy of identification of postpartum hemorrhage and decrease maternal morbidity/mortality. The identified unit currently uses EBL methods for cesarean section births rather than QBL. The aim of this QI project is to establish a baseline postpartum hemorrhage rate in cesarean section births following implementation of QBL. The primary outcome measure for this project will be rate of maternal blood transfusions during hospitalization following cesarean birth. The secondary outcome measure will be the rate of uterotonics usage including Methergine, Hemabate, Cytotec, and tranexamic acid (TXA), within the first 24 hours. The IHI Model for Change framework will be used as a framework to guide this QI project. The question for this study is:

In pregnant women ages 18-49 who have a cesarean section birth on an inpatient labor/delivery hospital unit:

1. What is the rate of blood transfusions following implementation of QBL?
2. What is the rate of uterotonic use?

Review of Literature

A search of the literature was conducted using CINHAL, pubmed, MEDLINE, and google scholar. Key search terms and phrases included quantitative blood loss, cesarean section, postpartum hemorrhage, estimated blood loss, obstetric hemorrhage, postpartum hemorrhage identification, and childbirth. Boolean operators used included AND and OR. After all search terms and phrases were used, a total of 50,000 publications were generated. Inclusion criteria included articles from 2017-2023 and women who underwent cesarean section for birth. Exclusion criteria were articles older than 2017. Following inclusion and exclusion criteria, 25,080 publications were generated, furthermore, full-article access narrowed results down to under 5,000 and 10 articles were selected for the literature review.

Postpartum hemorrhage is the loss of greater than or equal to 1,000 milliliters (mL) of blood within 24 hours following delivery and/or signs and symptoms of hypovolemia within the first 24 hours following delivery (Shields et al., 2017). When postpartum hemorrhage is suspected, accurate blood loss measurement is critical to prepare for necessary interventions. Poor outcomes not only result from the hemorrhage itself, but also due to delayed recognition secondary to provider underestimation of hemorrhage (Doctorvaladan et al., 2017). Maternal vital signs and laboratory values can help identify excessive blood loss; however, these significant changes often present too late. Therefore, effective and objective measurement of ongoing blood loss is crucial (Doctorvaladan et al., 2017). Visual EBL has been known to be imprecise and can underestimate maternal blood loss by 33-50% for women with high blood loss (Blosser et al., 2021).

A small correlational study designed to determine the accuracy of EBL from nursing leaders showed a significant underestimation of blood loss (Pennington & Washington, 2020). Out of 260, only five estimations of blood loss were correct, with 50% underestimated and 48% overestimated (Pennington & Washington, 2020). Specifically, one blood soaked item alone warranted a postpartum hemorrhage diagnosis and 49% of participants underestimated its amount at less than 500 mL (Pennington & Washington, 2020). In a study by Blosser et al. (2021), it was found that in cesarean births, there was a higher percentage of postpartum hemorrhage in the QBL group compared to the EBL group. This may be due to the increased accuracy of blood loss quantification and in turn increasing recognition of hemorrhage.

Additionally, EBL has been found to overestimate blood loss. Pennington & Washington (2020) found that 48% of staff had overestimated blood loss when using EBL solely. Hire et al. (2020) conducted a study to determine differences between QBL and EBL in cesarean deliveries. The median EBL was 1,275 mL and the median QBL was 948 mL, Thus, twenty-four (57%) of postpartum hemorrhages by EBL would not have been classified as such by QBL (Hire et al., 2019).

Hospitals have initiated the change to QBL in vaginal and cesarean deliveries as supported by ACOG (2019). In a retrospective study, EBL and QBL following deliveries were compared to see if there was a difference in number of blood transfusions, time to transfusion, readmission rates, postpartum hemoglobin, and mortality. Ayala et al. (2023) only found a significant difference in length of stay, where women who had QBL had a lower mean length of stay compared to EBL, 2.6 days versus 3.2 days ($p < .001$). This finding was despite women in the QBL group having a higher incidence of uterine atony and higher use of augmentation (Ayala et al., 2023). Wolfe et al. (2022) showed a decrease in transfers to ICU after implementation of QBL, however, the study was limited in that it was difficult to determine reasons birth parents were transferred to the ICU. To determine need for a blood transfusion, providers rely on the patient's hemoglobin and hematocrit levels. Among cesarean deliveries, Blosser et al. (2021) found QBL outperformed EBL in predicting both a need for blood transfusion and a greater than or equal to 10 point drop in hematocrit. QBL correlates with adjusted change in hemoglobin for birth parents with all volumes of blood loss (Powell et al., 2022).

Despite multiple advantages to QBL in deliveries, some limitations do exist. One study found that QBL was only moderately correlated to patient's blood loss when comparing to their "reference assay" (determining blood loss based off a patient's hemoglobin pre-operatively and post-operatively) (Thurer et al., 2022). QBL was overestimated for 88% of patients and was deviated from the reference assay by more than 250 mL. Altogether, a diagnosis of postpartum hemorrhage was assigned in 40 patients, or 80% and 20% of patients would have had an unnecessary/incorrect postpartum hemorrhage diagnosis and intervention (Thurer et al., 2022). Inaccuracy from QBL is likely due to the added weight from absorbed amniotic fluid and irrigation fluid (Doctorvaladan et al., 2017). Therefore, when implementing QBL in cesarean births, amniotic fluid and irrigation fluid must be accounted for and subtracted along with dry weights from the total blood loss. Despite having its limitations, QBL shows to overall benefit patients by providing improved insight to real-time blood loss and remains recommended by ACOG (2019).

Implementation of QBL in cesarean and vaginal births have shown feasibility when adopting the new policies. For example, Hendrixson et al. (2022) successfully adopted QBL in cesarean deliveries with a 97% compliance rate. Quantification of blood loss is a practical and low cost intervention that shows multiple benefits when determining maternal blood loss (Powell et al., 2022). In the United Kingdom (UK), a quality improvement initiative was implemented in order to increase QBL compliance for deliveries. The elective scheduled cesarean section rate in 2017 was 12.7% and the non-scheduled cesarean section rate was 13.4% (Bell et al., 2020). Prior to the QI initiative, QBL measurement was performed in 52.1% of deliveries and increased to 87.8% following the initiative ($p < .0001$) (Bell et al., 2020). The increase in QBL in turn decreased the number of birth parents who suffered from maternal morbidities caused by postpartum hemorrhage due to early detection of excessive blood loss. Bell et al. (2020) found an incidence of 8.6% (previously 5%) for blood loss >1,000 mL and 1.3% (previously 0.8%) for severe postpartum hemorrhage (>2,000 mL), which is an increase in identification when compared to rates before initiation of QBL (Bell et al., 2020).

Framework

The evidence based practice framework for this quality improvement initiative is the IHI Model for Change framework. In this framework, the plan-do-study-act (PDSA) continuously cycles in order to effectively evaluate new policies/ideas (Kourtis & Burns, 2019), which works well with quality improvement projects. The first step (plan) is to develop a plan to test the change, then the change is carried out (Kourtis & Burns, 2019). The “study” and “act” steps allow the investigators to evaluate changes made and to determine if the change is effective. The PDSA cycle has become an essential part in “rapid cycle improvement” concepts (Kourtis & Burns, 2019) and will be instrumental in determining effectiveness of QBL in cesarean section births.

Methods

Design

This quality improvement (QI) project used a descriptive, observational design. A pre-post-test design from February 2024 through April 2024 was used to assess the rate of PPH, uterotonic use, and transfusions needed, amongst female patients undergoing cesarean section births. Demographic data was collected to determine potential trends in postpartum hemorrhages and their interventions. Demographic data collected included age, race, and gravida/parity.

Setting

The setting was a Midwestern, suburban hospital recognized by the American Nurses Credentialing Center (ANCC) as a Magnet hospital with 489 beds total, and an 18-bed labor and delivery unit. The labor and delivery unit performed 3,333 deliveries in 2023, 1,165 of them being cesarean sections, with a cesarean section rate of 35% for the 2023 year. The unit identified a 7-23% hemorrhage rate over the span of three months using EBL alone.

Sample

The sample was a convenience sample of women ages 18 to 49 years old undergoing cesarean birth at the hospital between February and April 2024. Inclusion criteria included women ages 18 to 49 years old, undergoing cesarean birth. Exclusion criteria included women under the age of 18 or over the age of 49, vaginal birth, and uterotonic use greater than 24 hours following birth.

Data Collection/Analysis

Data was collected from the hospital's EMR reporting system by the primary and secondary investigators. In addition, cesarean section births who had QBL documented will be collected, along with documented PPH, blood transfusion, and uterotonic use. Data was stored on a password-protected computer own by the primary investigator, and de-identified and coded as A1, A2, A3 etc. Descriptive statistics was used to describe the sample population and inferential statistics was utilized to 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 EBP/Research Council. The project was be approved by the hospital IRB. Additionally, the study gained approval from the university IRB. This project includes ethical consideration of a vulnerable population with risk of increased intervention related to PPH recognition.

Procedures

QBL Process

During cesarean section deliveries, a registered nurse is circulating the procedure and other personnel present in the room include anesthesiologist or certified registered nurse anesthetist (CRNA), scrub technician, registered nurse first assist (RNFA), the obstetrician, a neonatal intensive care nurse, and a pediatrician.

Three hanging scales were provided by the labor and delivery unit, making one scale available for each OR. Scales measured in grams, with one gram equating to one milliliter of blood. Nurses circulating cesarean section deliveries were to use the provided hanging scales to weigh blood soaked lap sponges, under buttock drapes, and peri pads. Operating rooms are provided with lap counter bags, holding 10 laps each. These were used to offer convenient counting and can easily be hung on scales.

To begin, blood was first measured using the suction canister. Anesthesia was to provide the measurement shown in the suction canister following birth of the newborn, before birth of the placenta, and again immediately preceding irrigation. Pre-placental measurement was to be subtracted from pre-irrigation measurement by the circulating nurse. Nurses then began to weigh lap sponges as each lap counter bag was filled. Lap counter bags are hung separately on the provided scale and each measurement is noted. Finally, if under buttocks drapes/pads are saturated, they were to be weighed as well. The initial postpartum fundal rub is done in the OR and blood is collected in a measuring cup held by the scrub technician; the volume will be included in documentation. Nurses found that weighed all blood soaked items and lap sponges at the end of the case in a zeroed out biohazard bag was easiest and most convenient. Once dry weights were subtracted out, this total was added to the suction canister total (pre-placental measurement from end of case measurement). This, along with initial fundal rub measurement, totaled to the cesarean section total blood loss.

QBL Documentation

The electronic health record (EHR) was utilized by the circulating nurse to enter total QBL under the "QBL calculator" flowsheets (Appendix A). QBL calculation worksheets (Appendix B) were developed using California Maternal Quality Care Collaborative (CMQCC) as a reference. Multiple calculation sheets were provided in each OR, next to current count sheets, for the circulating nurse to keep track of weights and measurements. Nurses were responsible for weighing lap counter bags as they fill with blood soaked laps and writing down weight in grams to calculate once all blood soaked lap sponges have been weighed.

Calculation of "soft goods" included laps, lap counter bags, under bottom pad, blue towels, white towels, and a red biohazard bag. Dry weights of each item were provided on the calculation sheet. Once all soft good, blood soaked items had been weighed, the total was to be added to the suction canister total. Once initial fundal rub is performed, the nurse noted the amount and added to the soft goods weight and suction canister total. This total QBL was to be added into QBL calculator "total blood loss" (Appendix A) and will constitute total QBL. If needed, other items, including under buttock drape and peri pads may be weighed and added into the other items blood loss.

Staff Education

Staff, including registered nurses, anesthesiologists, and obstetricians were provided education about QBL in the operating room along with QBL calculation worksheets (Appendix B) for reference. Education involved handouts explaining steps in order for QBL and proper documentation (Appendix C) along with provided screen shots (Appendices B) to direct staff where QBL calculator. Announcements and reminders were made during staff huddles and during staff meetings. Emails were sent out half-way through implementation for reminders, advice, and resending the “QBL how-to” sheet (Appendix C). Labor and delivery’s Unit Nursing Shared Governance (UNSG) was briefed and educated on QBL and designated “QBL champions” in order to assist with the new roll out to the unit. QBL how-to sheets and screenshots were also be provided in OR, huddle rooms, bathrooms, and nurses station for quick reference guides. One month into implementation, an additional meeting with designated QBL champions from UNSG occurred to answer any questions and provide examples.

Results

The total number of cesarean sections pre-implementation was 283 (n = 283) and the total number of cesarean sections post-implementation was 330 (n = 330). Following the intervention, the hemorrhage rate was 18.79% (n = 62), see Appendix E. The most frequently observed category of race in the post-implementation group was Caucasian (n = 255, 77.27%). The most frequently observed category of Age in the post-implementation group was 33 (n = 39, 11.82%). The most frequently observed

Gravida in the post-implementation group was G-2 (n = 112, 33.94%). The most frequently observed category of Parity was P-2 (n = 142, 43.03%). There were 26 sets of twins in the post-implementation group (n = 26, 7.88%). See Appendix D.

The rate of blood transfusions prior to intervention was 3.89% (*n* = 11). Following intervention, the rate of transfusions was 3.94% (*n* = 13), indicating a 0.05% increase. See Appendix F. The rate of additional uterotonic following intervention was 42.12% (*n* = 139). This is was a 9.82% decrease from the pre-implementation group of 51.94% (*n* = 147). See Appendix G.

A Chi-square Test of Independence was conducted to examine whether blood transfusion administration pre-implementation and blood transfusion post-implementation were independent. The results of the Chi-square test were not significant based on an alpha value of .05, $\chi^2(1) = 0.51$, $p = .477$, suggesting that blood transfusion administration pre-implementation and blood transfusion administration post-implementation could be independent of one another. This implies that QBL did not have a direct impact on blood transfusion rates following birth. See Appendix H.

A Chi-square Test of Independence was conducted to examine whether additional uterotonic use pre-implementation and additional uterotonic use post-implementation were independent. The results of the Chi-square test were not significant based on an alpha value of .05, $\chi^2(1) = 0.08$, $p = .782$, suggesting that additional uterotonic use pre-implementation and additional uterotonic use post-implementation could be independent of one another. This implies that QBL did not have a direct impact of the rate of additional uterotonics used following births. See table 6 in Appendix I.

Discussion

The aim of this project was to decrease blood transfusion administration by 5% and to determine the rate of additional uterotonic use. Blood transfusions did not decrease by 5%, but rather increased. The increase in blood transfusion rates were not statistically significant. However, the pre-implementation group had 283 patients while the post-implementation group had 330 patients, which may have skewed results with the potential for more blood transfusions. Following intervention, there was an increase in identification of postpartum hemorrhage, which may have increased the rate of blood transfusions due to accuracy of identification.

Although not statistically significant, the decrease in additional uterotonic use despite the increase in postpartum hemorrhage rates suggests that QBL allowed for a more targeted approached to uterotonic use. With QBL, providers can confirm whether significant hemorrhage is occurring or not. If significant blood loss is measured, uterotonics can be administered promptly and appropriately to precent or manage hemorrhage effectively. Conversely, if blood loss is within expected ranged, there may be less inclination to administer uterotonics prophylactically, thus reducing their use.

This QI project's main strength was its sample size. The post implementation group included 330 patients. This sample included a wide variety of ages, gravida and parity, and races. Another strength was leadership support. The labor and delivery manager, assistant manager, charge nurses, and nurse educator were in strong support of implementing QBL for their unit. Support from unit leadership allowed for a smooth transition into implementation despite staff and provider push back. Limitations included staff and provider push back and difficulty with educating nurses. Copies of QBL "how to" sheets and where to find documentation were sent out via email to nurses. Many admitted to not reading their emails about QBL. Educational hand outs were also provided throughout the unit, in staff break rooms, and bathrooms, which helped with compliance in subsequent months. It is recommended that the labor and delivery unit continue with the PDSA cycle and continue with QBL to increase identification of PPH.

Feedback from registered nurses (RN) included simpler documentation using the QBL calculator. A unit specific calculator should be created for the EHR to include frequently used items in cesarean section births and unit specific weights. Continued education at nurse skills days and simulations to ensure nurse compliance and understanding. Hemorrhage rates, blood transfusion rates, and uterotonic use may be looked at six months post-implementation to determine success.

Conclusion

Prior to implementation, estimated blood loss was utilized to determine the amount of blood loss following a cesarean section birth. QBL was initiated to improve identification of blood loss, decrease blood transfusion rates, and determine additional uterotonic use. Following implementation, blood transfusions increased, while uterotonic use decreased. Overall, QBL increased identification of postpartum hemorrhages. Recommendations for further study include continuing with the PDSA cycle to determine the effect of QBL on hemorrhage rates, blood transfusion and additional uterotonic use rates, continuing staff education, and exploring more efficient documentation/calculation for RNs.

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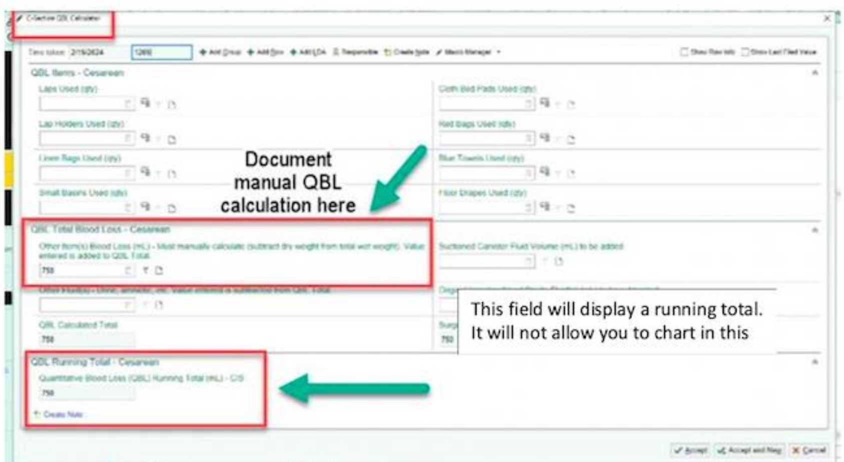
Appendices

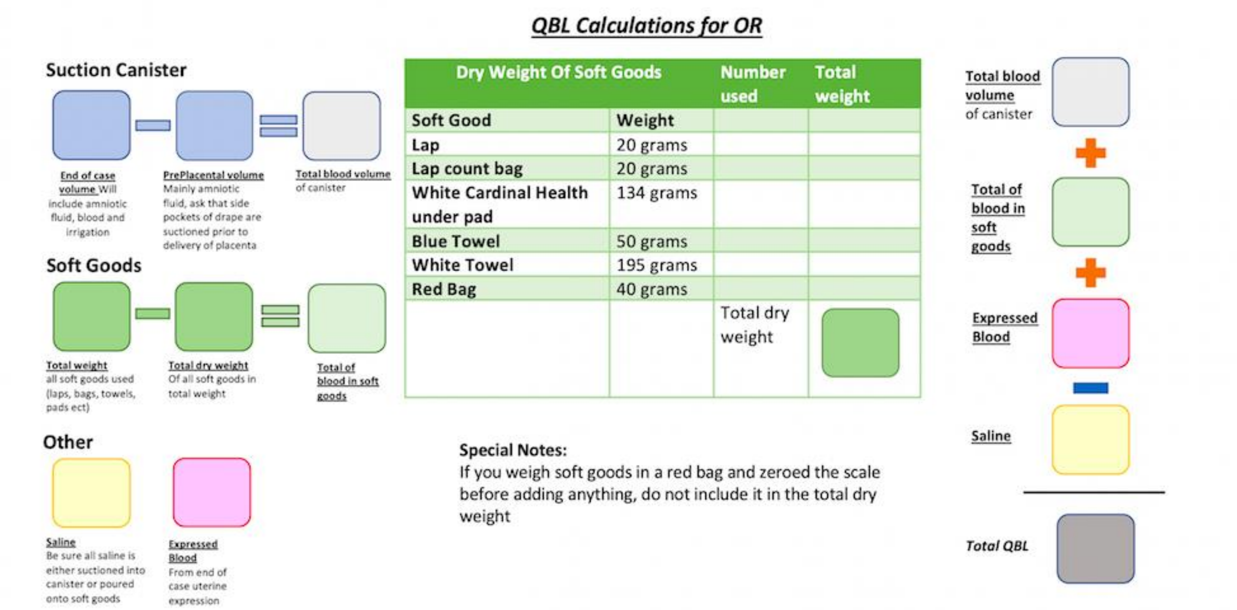
Appendix A

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

Table 4

Frequency Table for Nominal Variables

Variable	*n*	*%*
Race_		
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		
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		
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		
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		
twins	26	7.88

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

Appendix E

Table 1

Frequency Table for Nominal Variables

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

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

Figure 1

PPH pre-implementation

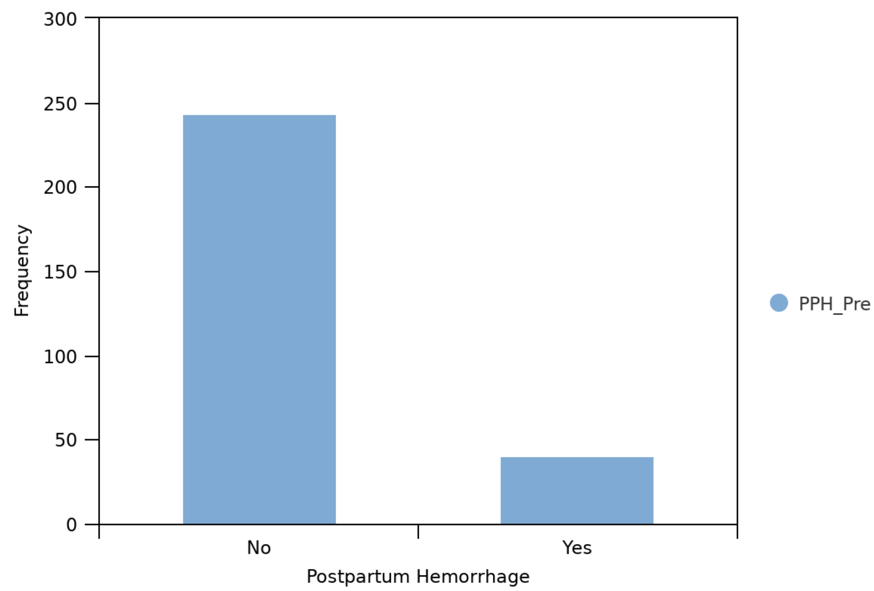
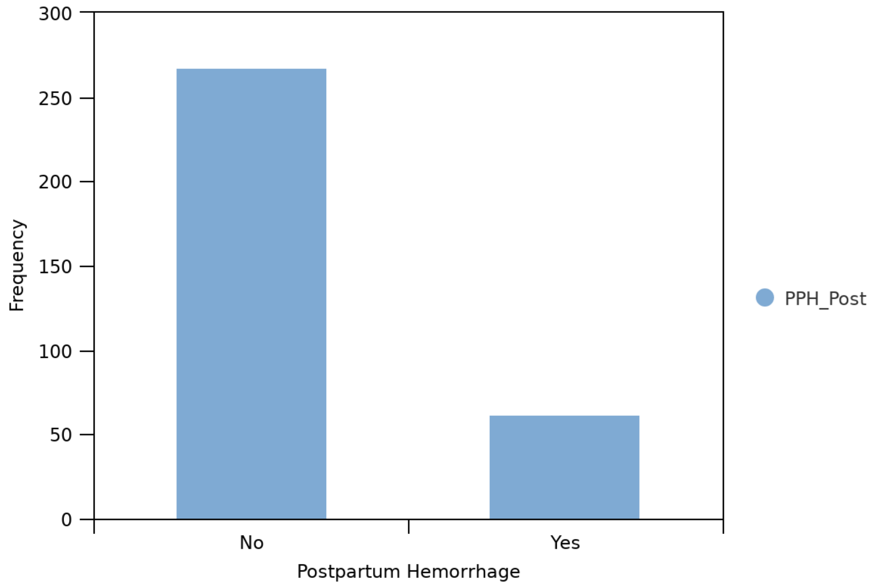


Figure 2

PPH Post-implementation



Appendix F

Table 2

Frequency Table for Nominal Variables

Variable	*n*	%
Blood Transfusion Pre-implementation		
No	272	96.11
Yes	11	3.89
Blood Transfusion Post-implementation		
No	317	96.06
Yes	13	3.94

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

Figure 3

Blood Transfusion - pre-implementation

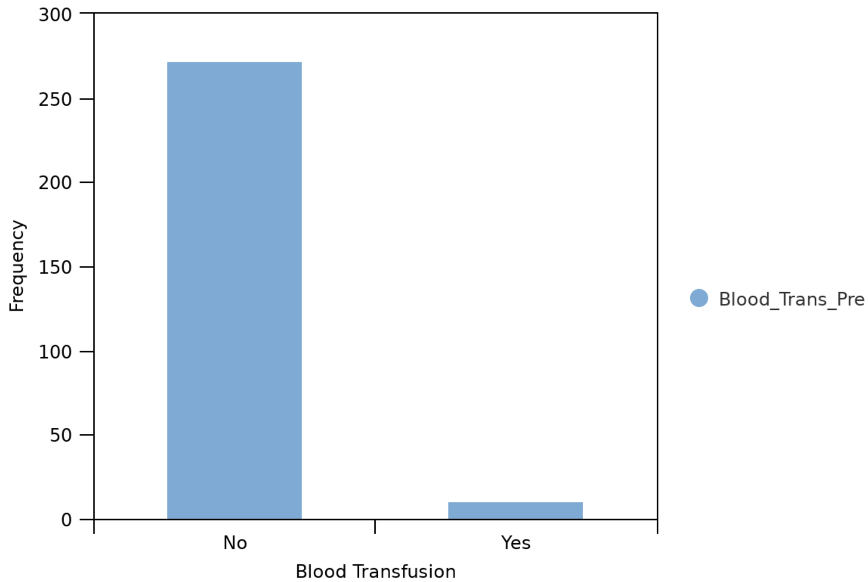
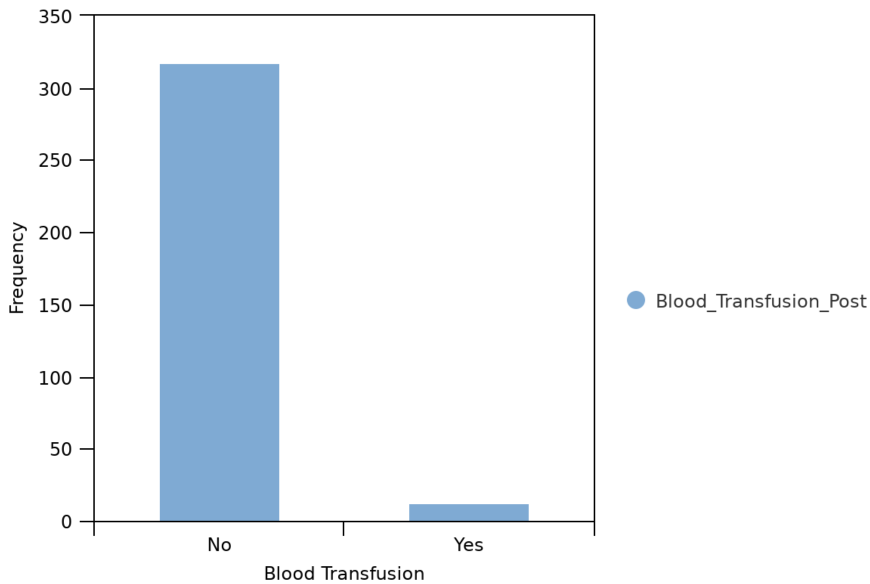


Figure 4

Blood Transfusion - Post-implementation



Appendix G

Table 3

Frequency Table for Nominal Variables

Variable	*n*	*%*
Add'l Uterotonic Use Pre-implementation		
No	136	48.06
Yes	147	51.94
Add'l Uterotonic Use Post-implementation		
No	191	57.88
Yes	139	42.12

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

Figure 5

Additional Uterotonic Use - pre-implementation

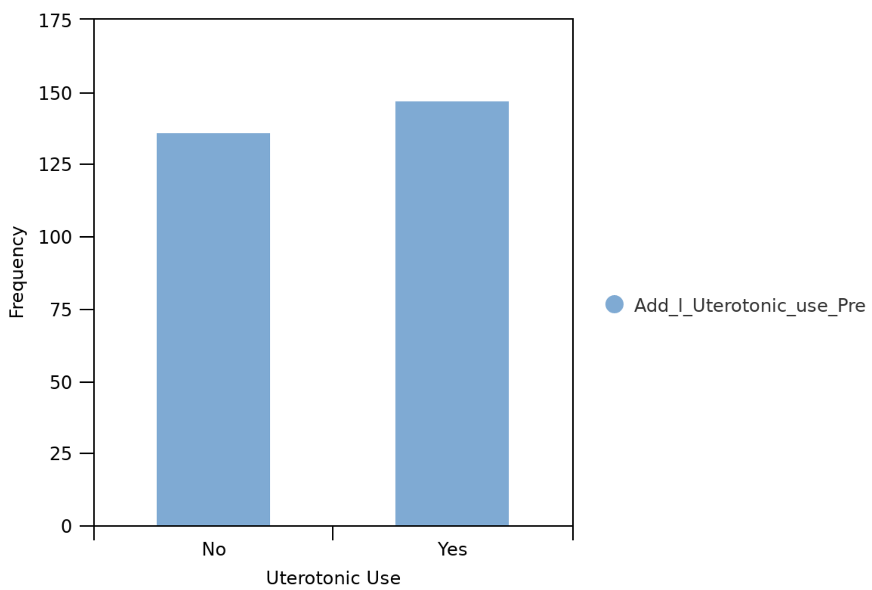
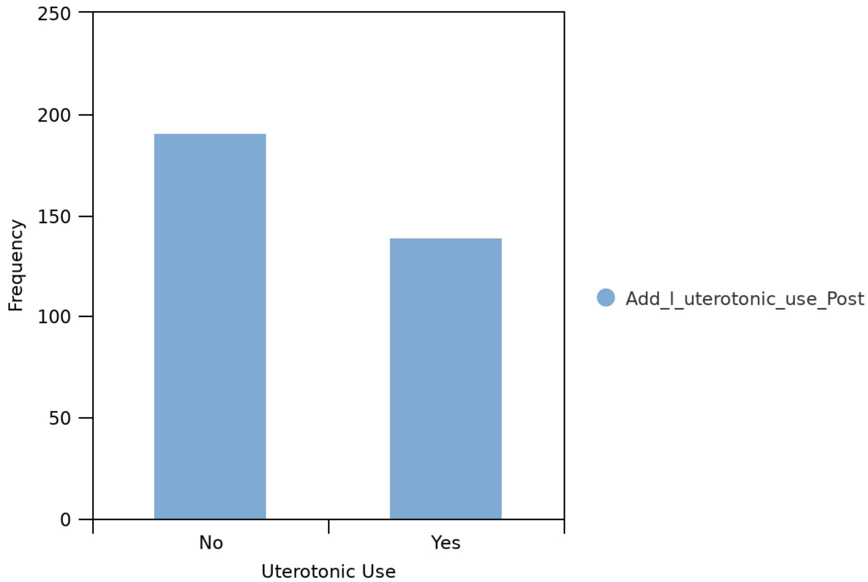


Figure 6

Additional Uterotonic Use - Post-implementation



Appendix H

Table 5

Observed and Expected Frequencies

	Blood Transfusion Administration post-implementation				
Blood_Transfusion administration pre-implementation	No	Yes	χ^2	*df*	*p*
No	260[260.47]	12[11.53]	0.51	1	.477
Yes	11[10.53]	0[0.47]			

Note. Values formatted as Observed[Expected].

Appendix I

Table 6

Observed and Expected Frequencies

	Add'l Uterotonic Use Post-implementation				
Add'l Uterotonic Use Pre-implementation	No	Yes	χ^2	*df*	*p*
No	79[77.85]	57[58.15]	0.08	1	.782
Yes	83[84.15]	64[62.85]			

Note. Values formatted as Observed[Expected].

Appendix K

Figure 3

Additional Uterotonic Use - pre-implementation

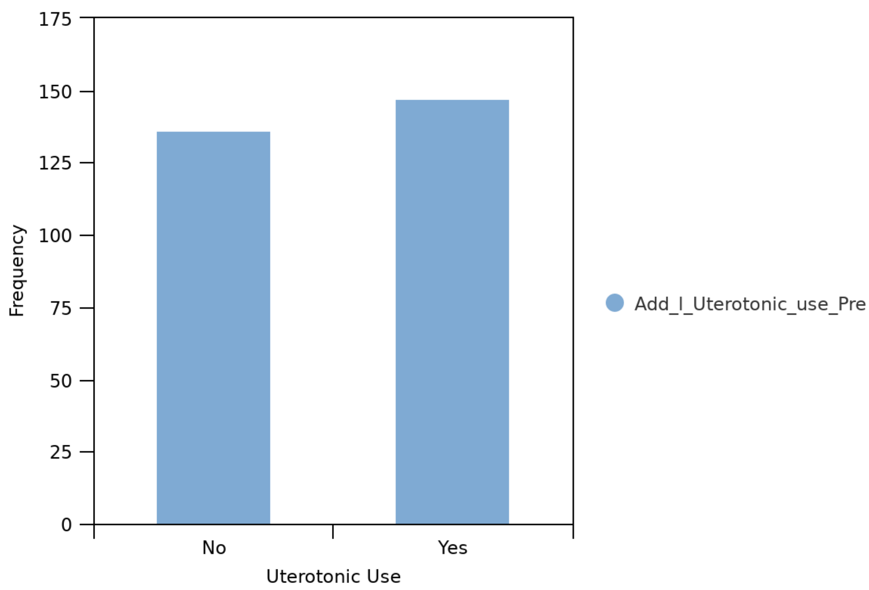


Figure 4

Additional Uterotonic Use - Post-implementation