



A Comparison of Visual Estimate versus Calculated Estimate of Blood Loss at Vaginal Delivery

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Authors' contributions

This work was carried out in collaboration between all authors. Authors PJH, KP, DD and DVC designed the study, wrote the protocol and wrote the first draft of the manuscript. Authors ANA, MK and CG completed the initial chart reviews. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/BJMMR/2016/19239

Editor(s):

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- Complete Peer review History: <http://sciencedomain.org/review-history/11541>

Original Research Article

Received 30th May 2015
Accepted 11th September 2015
Published 27th September 2015

ABSTRACT

Aims: To compare blood loss following vaginal delivery by two different methods: visually estimated blood loss (vEBL) and calculated estimate of blood loss (cEBL).

Study Design: Postpartum blood loss was analyzed during 2 different time frames: 1. Traditional estimation (vEBL) of blood loss and 2. Following training, with the use of a systematic method (cEBL).

Place and Duration of Study: Department of Labor and Delivery at Maricopa Medical Center in

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Phoenix, Arizona. Charts were reviewed from September and October 2009 and from September 2010.

Methodology: This was a retrospective cohort study in which blood loss was compared using two different methods. Traditional physician estimate of blood loss at vaginal delivery, “vEBL” was compared to a more formal determination of blood loss “cEBL” - calculated blood loss.

Results: The cEBL subjects (mean age 28.0+/-6.6) were significantly older than the vEBL subjects (mean age 25.4+/-5.8). The two groups were otherwise similar. Mean blood loss was compared across the two methods using Analysis of Variance. Mean blood loss was 324 for the cEBL group, and 309 for the vEBL group ($F(1,192)=0.76$, $p=.385$). Although the difference in mean blood loss was not statistically significant, the variance of the cEBL method was significantly larger ($P<.0005$). 2/94 (2.1%) of patients in the vEBL group were noted to have blood loss ≥ 500 cc; 11/100 (11%) of patients in the cEBL group were noted to have blood loss ≥ 500 cc.

Conclusion: The variance for the cEBL method was significantly greater than in the vEBL group, suggesting that postpartum hemorrhage may be diagnosed sooner with this method. As calculation of blood loss postpartum is increasingly endorsed we recommend further study to determine the typical range for blood loss with measurement via this technique.

Keywords: Estimated blood loss; median blood loss; postpartum hemorrhage; quantitative blood loss; vaginal delivery.

ABBREVIATIONS

vEBL – Visualized Estimate of Blood Loss; cEBL – Calculated Blood Loss; CMQCC HTF – California Maternal Quality Care Collaborative’s Hemorrhage Task Force; EBL – Estimated Blood Loss; QBL – Quantified Blood Loss; PPH – Postpartum Hemorrhage.

1. INTRODUCTION

Postpartum hemorrhage is a frequent complication of pregnancy and is one of the most common causes of potentially preventable pregnancy related death in the United States [1,2]. Recent studies have shown an increase in the rate of postpartum hemorrhage which may be contributing to increasing rates of maternal mortality in the United States [3]. It has been proposed that accurate determination of blood loss at the time of delivery could lead to earlier opportunities for intervention and more effective treatment of postpartum hemorrhage, thus decreasing the risk of associated maternal morbidity [4,5,6].

Traditionally, the amount of blood lost during a vaginal delivery is determined by the physician’s visual estimate of blood on drapes, sponges, etc. which also contain urine and amniotic fluid. Studies have shown that this method of determining blood loss can underestimate the true value by as much as 33% - 50% [7]. Importantly, underestimation happens at higher blood volumes where adverse consequences of excessive blood loss are more likely [8]. One study by Stafford et al. [9] compared visual estimation (vEBL) to calculated blood loss (cEBL) showing median vEBL 350 mL and

median cEBL 632 mL, suggesting that alternative methods to gauge blood loss may require changes in the long-standing definitions of postpartum hemorrhage (≥ 500 cc at vaginal delivery and $\geq 1,000$ cc at Cesarean delivery) particularly if surpassing these thresholds at the delivery triggers interventions for treatment of postpartum hemorrhage.

An approach whereby postpartum blood loss is monitored closely and objectively has been endorsed by patient safety advocates [5,6] however the consequences of this approach are not well studied. At least one large study failed to demonstrate a reduction in patient deaths with implementation of a hemorrhage protocol which included quantification of blood loss [10].

In late 2009 Maricopa Medical Center began participating in the California Maternal Quality Care Collaborative’s Hemorrhage Task Force (CMQCC’s HTF). Participation in this project involved implementing a number of measures aimed at improving recognition and response to obstetric hemorrhage [11]. One of these measures included using objective measures to quantify blood loss at every delivery (cEBL) as opposed to traditional use of visual estimation (vEBL) [12]. It is known that focused training in objective measurement of blood loss can

improve accuracy in calculation of blood lost during surgical procedures [13]. Determination of cEBL as a part of this quality improvement project required using one or more of three methods to calculate blood loss. The three methods used were: (1) weighing blood-saturated items of known dry weight to calculate blood loss (2) using graduated containers to measure blood loss and (3) utilizing objective methods to determine the amount of blood lost (such as comparing containers of known volume). This method is sometimes referred to as quantification of blood loss or QBL. Details of this method can be found at cmqcc.org. This method is endorsed by experts promoting quality improvement in the area of maternity care [11,12]. Because this method was implemented universally across our department we were able to compare the median value and standard deviation of visually estimated blood loss (vEBL) versus calculated or blood loss (cEBL) to determine if the average blood loss at the time of a low risk vaginal delivery differed significantly with use of this alternative method for calculation. A sub-analysis of patients who experienced postpartum hemorrhage was also undertaken.

2. MATERIALS AND METHODS

This was a retrospective cohort study performed at Maricopa Medical Center Labor and Delivery department in which we compared blood loss at delivery using two different methods. We looked at a specified time period before the CMQCC initiative was established to collect the vEBL data and compared it to the cEBL data collected from a similar time period after the CMQCC initiative was established. Specifically for this study, we compared September and October 2009 with September 2010. Our use of cEBL started in March of 2010 and we felt that by September of 2010 the practice was well-established among providers including interns who entered the program in July of 2010. Similar time periods were compared to control for potential seasonal differences. Inclusion criteria were: vaginal deliveries, 37 weeks gestational age and older. Exclusion criteria were: Less than 37 weeks gestational age, cesarean deliveries, use of forceps or vacuum, parity of five or greater, blood loss reported as "estimated blood loss" or vEBL during the cEBL time period, intrauterine fetal demise, multiple gestation. A similar, separate study was planned for patients delivering via cesarean section and for those at high risk of PPH. The outcome variable measured was blood loss in milliliters (mL) at time of delivery and the

predictor variable was method of calculation (vEBL or cEBL). Additional covariates that were collected included: gestational age on admission, length of time from admission to delivery, gravity, parity, history of postpartum hemorrhage, use of cervical ripening agents other than mechanical methods, use of oxytocin, infant birth weight, use of magnesium sulfate, diagnosis of chorioamnionitis or antibiotic administration prior to delivery, history of any prior cesarean deliveries. Charts of patients meeting study criteria were pulled from the electronic delivery log. Charts were analyzed primarily by three authors (MK, KG and AS) and study variables recorded. One author (PJH) reviewed selected charts for accuracy.

Aids to improve objective measurement of blood loss included use of graduated drapes at vaginal delivery as well as posting of dry weights of commonly used materials in the department as visual cues to determine percent saturation of items commonly used to collect blood. Additional aspects of participation in the CMQCC HTF included performing hemorrhage drills, debriefings following postpartum hemorrhage and evaluating available systems within the department to improve response to postpartum hemorrhage. Because all attending, midwife and resident providers at Maricopa Medical Center work within the same practice group, we were able to establish consistency.

All data were stored in a secure database and the data were accessed by the research team only. Each record was assigned a dummy code number. A key indicating the correspondence between the dummy code number and patient-identifying information was maintained in a separate, secure location. Institutional Review Board approval was granted through the IRB of Maricopa Integrated Health System via expedited review.

Statistical analysis was performed using SPSS version 20. Levene's test for equality of variances was performed. Correlation calculations were performed to determine if there were any significant relationships between covariates and blood loss. Distribution of blood loss values for vEBL and cEBL were plotted using the Epanechnikov kernel density estimation method. To determine sample size, a preliminary analysis was conducted after 32 cases in each group were enrolled. A t-test revealed that mean blood loss was somewhat higher for the vEBL method than the cEBL

method ($p = .061$). This comparison achieved a statistical power of .67. Following this analysis, it was decided to collect approximately 100 cases for each method to increase study power.

An additional chart review was performed on subjects with postpartum hemorrhage (blood loss of 500 mL or more) to determine if any of the following indicators of significant hemorrhage had occurred: Change in hemoglobin pre to post-delivery greater than 10%; vital sign changes (increase in heart rate from admission by 15% or more or blood pressure less than 84/45) or transfusion requirement. Two authors performed the chart review (DVC, PJH) with a re-reviewing completed to correct discrepancies.

3. RESULTS

A total of 94 charts in the vEBL group and 100 charts in the cEBL group were reviewed. Table 1 illustrates the characteristics of each group. The cEBL subjects (mean age 28.0+/-6.6) were significantly older than the vEBL subjects (mean age 25.4+/-5.8). The groups were similar in terms of parity and infant birth weight.

Mean blood loss was compared across the two methods using Analysis of Variance. Mean blood loss was 324 for the cEBL group, and 309 for the vEBL group ($F(1,192)=0.76$, $p=.385$). Although the difference in mean blood loss was not statistically significant, the variance of the cEBL method was significantly larger ($P<.0005$). Length of labor (measured as time from admission to delivery), birth weight, and use of oxytocin were not strongly related to blood loss, either singly or as a set of variables (adjusted $R^2 = .023$).

A detailed chart review of subjects who met criteria for postpartum hemorrhage (500 mL or greater) was undertaken. 2/94 (2.1%) of patients in the vEBL group were noted to have blood loss

≥ 500 cc; 11/100 (11%) of patients in the cEBL group were noted to have blood loss ≥ 500 cc. Of the 2 subjects in the vEBL group with PPH (blood loss of 500 mL and 850 mL) one was transfused (blood loss 500 mL), one had vital sign changes (blood loss 850 mL) and both had a significant change in hemoglobin ($>10\%$ decrease). In the 11 subjects with severe blood loss (range 500 mL to 1850 mL) in the cEBL group, 2 had vital sign changes (blood loss of 500 and 1850 mL) and the subject with 1850 mL of blood loss was the only subject in that group transfused. Postpartum hemoglobin was checked in 8 subjects of the cEBL group and 6 had a significant ($>10\%$) change. The range of blood loss in those with a significant change in hemoglobin was 600 mL to 1850 ml, the 2 subjects with no significant change in hemoglobin had a blood loss of 550 and 650 ml. Of the 3 with no hemoglobin checked, the calculated estimate of blood loss was 500 to 580 ml. Overall, both of the vEBL patients whose documented blood loss met the criteria for PPH all experienced sequela (transfusion or change in vital signs) while 9 out of 11 patients in the cEBL group showed no such signs of severe hemorrhage.

There was no significant difference in the mean value of blood loss at vaginal delivery when comparing measurement by the traditional technique of estimation (vEBL) versus the more objective technique of calculation (cEBL). More patients in the cEBL group experienced blood loss at or above the threshold of 500 cc, thus meeting the definition of postpartum hemorrhage however the rate of patients who experienced sequela concerning for significant blood loss was similar (2.1% for the vEBL group and 2% for the cEBL group). Similarly more patients in the cEBL group experienced a blood loss less than 200 cc. The variance of the cEBL method was significantly larger ($P<.0005$).

Table 1. Characteristics of the visual estimate of blood loss (vEBL) and calculated estimate of blood loss (cEBL) study groups

Characteristic	vEBL		cEBL		P-value
	N	%	N	%	
Parity					
0	24	26%	21	21%	.28 [†]
1	19	20%	30	30%	
2+	51	54%	49	49%	
Birth weight (gm)					
$\leq 2,500$	2	2%	4	4%	.73 [†]
>2500	92	98%	96	96%	

N and percent (mean \pm standard deviation). * t-test, [†] chi-square

4. DISCUSSION

The strengths of this study include the fact that the department of Labor and Delivery at our facility began using the calculated (cEBL) technique as a required standard beginning on a designated date. As part of our participation in this initiative, chart reviews were conducted to determine compliance with the cEBL method. We excluded patients whose charts did not clearly document use of cEBL at delivery therefore the two groups (vEBL vs. cEBL) should truly represent patients in whom the assigned method was used. We have a large number of vaginal deliveries and the ability to compare the two groups and have enough power to achieve statistical significance.

One possible weakness of the study is that changes made during the course of the project may have influenced the response to postpartum bleeding and thus altered the degree of blood lost at delivery. However, the other aspects of the project included interventions such as increased education regarding response to PPH and more ready availability of materials used to treat PPH. It would be expected that these interventions would serve to generally decrease the amount of blood lost at delivery. Thus, if the other arms of this QI project affected our results it is actually more likely that the differences seen for calculation of blood lost with vEBL vs. cEBL are actually greater than shown in our study.

The analysis of patients who experienced PPH demonstrates that there were many patients in the cEBL group who showed no clinical signs of significant hemorrhage despite having a blood loss documented at ≥ 500 cc. The absolute numbers of patients who experienced PPH are too small to draw scientific conclusions, but suggest that PPH may be identified sooner with the calculated estimate of blood loss. While PPH may be identified sooner with the cEBL method, more patients will meet the definition for PPH while not experiencing clinical complications of PPH. No patients in our study experienced significant sequelae of postpartum hemorrhage such as massive transfusion, hysterectomy or ICU admission.

Our study differs from others in that the mean value of blood loss did not differ significantly between the vEBL and cEBL groups. Again, this may be due in part to differences between our clinical method and laboratory methods described elsewhere. In the previously noted

study by Stafford et al. [9] a pre and post-delivery hematocrit was required for inclusion. It is possible that patients who clearly had a very small volume of blood lost at delivery did not have a post-delivery hematocrit obtained and were therefore excluded from the study, thus exaggerating the difference between visually estimated and calculated estimate of blood loss.

The inaccuracy of visual estimate of blood loss at delivery has been documented in several previous studies [7,8,14-16]. Many of these studies compared visual estimation with laboratory techniques such as colorimetric evaluation of blood-saturated materials or photospectrometric evaluation of collected fluids or tagged red blood cells. Results of such laboratory techniques may be affected by fluid status of the patient, are not immediately available, and are not routinely feasible. In particular laboratory methods are not available in low resource settings where early recognition of postpartum hemorrhage is of utmost importance. The method of calculation as described in this study requires availability of only a scale and graduated drapes. It has been noted that similar graduated drapes may be especially useful in low resource settings and developing countries [17].

Review of cases of maternal mortality due to postpartum hemorrhage indicate that delay in recognition of PPH may be a contributing factor in maternal death [5] thus emphasizing the importance of early recognition. Given this, organizations have included rapid identification and treatment of postpartum hemorrhage as a means to reduce maternal morbidity and mortality. Suggested protocols include calculation or quantification of blood loss as a cornerstone of early identification. Although there is little risk to patients and inherent logic in this approach, there are limited studies which assess the feasibility, effectiveness and consequences of such protocols. One large study failed to demonstrate a reduction in patient deaths with implementation of a standard protocol which included quantification of blood loss in the postpartum period. Of note, the same study did show reduction in maternal deaths with use of protocols for prevention of post-cesarean pulmonary embolism and hypertension-related intracranial hemorrhage [10].

There is limited information regarding use of quantified blood loss in the postpartum period and the implications of altering the standard means of postpartum assessment of blood loss

are not known. Our findings suggest that the cEBL technique may lead to a higher threshold for identification of postpartum hemorrhage when compared to traditional definitions. This is supported by our finding that the variance for the cEBL method was significantly greater than the vEBL group. In our review of charts of patients with blood loss greater than 500 cc few patients experienced clinical sequelae with only one patient requiring transfusion following a delivery-related blood loss of 1850 ml. In one classic study using accurate laboratory methods to determine postpartum blood loss 21.5% of patients had a blood loss of greater than 500 cc [18], also suggesting that the commonly endorsed definition for postpartum hemorrhage should be reexamined.

5. CONCLUSION

This study evaluates implementation of a relatively simple method to improve determination of blood loss at vaginal delivery. Our findings indicate that in using a different method to calculate blood loss at delivery new norms for typical blood loss at delivery may be suggested. Given increasing rates of postpartum hemorrhage and associated maternal morbidity and mortality, studies which serve to investigate methods to better identify and respond to this relatively common delivery complication are needed. A larger study including use of the method at a variety of practice locations and resource settings and including less restrictive exclusion criteria may provide further insight into this aspect of maternal care.

CONSENT

Due to the nature of the study, individual patient consent was not required.

ETHICAL APPROVAL

Institutional Review Board approval was granted through the IRB of Maricopa Integrated Health System via expedited review.

ACKNOWLEDGEMENT

This project was funded by a grant from the Maricopa Medical Foundation.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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