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A Comparison of Blood Loss Determination After Vaginal Delivery in El Salvador: Visual Estimation Versus Direct Measurement

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Abstract

Objective: This study aimed to compare the visual estimation and direct measurement methods for estimating blood loss in women following vaginal birth at a National Maternity Hospital in El Salvador. *Study design:* After delivery, attending physicians and nurses independently estimated the amount of postpartum blood loss by visual means and by direct measurement. *Results:* A total of 870 women underwent blood loss measurement. Visual estimation by physicians and nurses underestimated postpartum blood loss by 10.8% and 29.7%, respectively. When direct measurement of blood loss was regarded as the gold standard, visual estimation of blood loss by physicians had a sensitivity of 45.9% and a specificity of 91.1% for detecting postpartum hemorrhage (PPH). Visual estimation of blood loss by nurses had a sensitivity of 43.2% and a specificity of 94.4% for detecting PPH. *Conclusions:* In accordance with results from previous studies, healthcare providers tended to underestimate postpartum blood loss. The discrepancy between estimated and measured blood loss widened as blood loss volume increased. Given the low sensitivity of visual estimation in detecting PPH, this study revealed that more than half of PPH cases would not have been identified by visual estimation.

Keywords

Postpartum Hemorrhage, Visual Estimation, Direct Measurement, El Salvador

1. Introduction

Postpartum hemorrhage (PPH) is a leading cause of maternal complications accounting for approximately 25% of all maternal deaths [1], [2]. The severity of maternal complications due to blood loss is closely related to delayed identification of PPH [3], [4]. Although recognizing the inaccuracy, visual estimation has prevailed in developing countries as the most commonly used method for evaluating

postpartum blood loss [5], [6]. Previous studies have reported that visual estimation underestimated actual blood loss by as much as 30% to 90% [7]-[9].

PPH has been defined as blood loss of >500 mL, according to the traditional definition proposed by the World Health Organization in 1990 [10]. Alternative definitions for PPH have been proposed to improve diagnosis, such as a peripartum change in hematocrit level of >10% or a decrease in hemoglobin level of >4 g/dL [11], [12]. However, the adoption of these definitions may not be practical, because hematological test results do not reflect acute blood loss, and appropriately trained staff and laboratory equipment are not always available, especially in rural areas of low and middle income countries.

In El Salvador, located in Central American region, Ministry of Health (MoH) offers free medical services at all public health facilities, including medical services for childbirth. Currently, there is no methodology in place in El Salvador for the systematic identification of PPH. The amount of postpartum blood loss is generally based on visual estimation, and direct measurement using a scale or graduated cup is uncommon. Additionally, medical and nursing records do not include a designated field for recording the amount of blood loss. Although hemoglobin and hematocrit values are routinely analyzed on admission, these parameters are not evaluated as part of standard assessments during the postpartum period. Postpartum hematological tests are performed only when physicians expressly order the hematological status of women with suspected PPH.

The aim of this study was to compare the results of the visual estimation and direct measurement methods for estimating blood loss in women who gave birth vaginally.

2. Methods

This prospective study was conducted between April and June 2014 at the National Maternity Hospital, a top referral tertiary hospital in the field of obstetrics and gynecology in El Salvador. There are approximately 11,000 women who give birth annually at this hospital, and the vaginal delivery rate is 60%. The inclusion criterion was women who vaginally delivered infants with a gestational age of ≥35 weeks. Women with mild complications and multiple pregnancies were also included. The exclusion criteria were women who delivered by cesarean section or who experienced intrauterine fetal death, antenatal hemorrhage, hematological disorders, or severe complications. Prior to the start of this study, measuring method of blood loss was developed. Through a pilot study involving 77 consenting women, the use of equipment and the study procedure for measuring blood loss were evaluated.

Women were recruited to the study when they were admitted to the labor room. After agreement to participate was obtained, each woman was closely monitored and provided with standard care and obstetric services. Once full cervical dilatation was confirmed, the woman was taken to the delivery room and was directed to lie on the delivery bed. Two basins and two sterilized sheets were used in the collection procedure. The attending physician disinfected the genital area using sterilized water. A basin was placed under the delivery bed, and a sterilized sheet was placed under the woman's buttocks. After the infant was delivered and the umbilical cord was cut and clamped, the sheet and basin, which contained amniotic fluid, urine, feces, and blood from episiotomy and/or laceration were removed immediately. The soiled sheet and basin were replaced with a fresh sterilized sheet and basin, which were used for the sole purpose of measuring postpartum blood loss. The initial sheet and basin were not included in the measurement.

Postpartum blood loss was collected during the third stage of labor and the postpartum medical procedure. This phase included expulsion of the placenta, suturing to treat any genital tract trauma, and inspection of the genital area. During this period, each woman lay on the delivery bed, ranging from 10 minutes to more than 1 hour. When the postpartum medical procedure was completed, attending physicians and nurses independently estimated the amount of postpartum blood loss by visual means.

The procedure for direct measurement took up to 5 minutes to complete. Immediately after visual estimation, the amount of blood loss was calculated by weighing the gauze and sheet soaked with blood. In advance, a group of gauze and sheets was weighed to provide an average value of their dry weights. The average dry weights were subtracted from the total weight of the used materials. The blood collected from the basin and the placenta container was measured using a plastic graduated cup, and was converted from milliliters to grams. The weight of blood from the gauze and sheet was combined with the weight of blood from the basin and placenta container to provide the actual postpartum blood loss.

To verify the accuracy of the blood loss estimation, a graph was created based on a simple linear regression at a significance level of 5%. Tables and figures were prepared using Microsoft Excel (Microsoft Corp., Redmond, WA, USA). Statistical analyses were performed using SPSS version 17.0 (SPSS Corp., Chicago, IL, USA).

The Ethics Committee of the Graduate School of Medicine at the University of Tokyo, Japan, and the Ethics Committee for Health Research of the National Maternity Hospital, El Salvador, approved this study.

3. Results

There were 1,591 vaginal deliveries during the study period, and 1,333 women met the inclusion criterion. Out of 870 (65.3%) consenting women, blood loss from 727 (83.6%) and 672 (77.2%) individuals were visually estimated by physicians and nurses, respectively. A total of 650 (74.7%) women had three complete data sets: visual estimation by a physician, visual estimation by a nurse, and direct measurement. The data from these 650 women were used to compare results from visual estimation with those from direct measurement.

Table 1 shows that the mean visual estimation of blood loss by physicians was 290 g (SD ± 198.5), the mean visual estimation of blood loss by nurses was 282 g (SD ± 197.4), and the mean direct measurement of blood loss was 337 g (SD ± 262.9). The quantitative data on blood loss was categorized as <500 g, 500–999 g (PPH), or ≥1,000 g (severe PPH [SPPH]). When direct measurement of blood loss was regarded as the gold standard, prevalence of PPH and SPPH were 17.1% and 3.4%, respectively. Visual estimation by physicians was in agreement with results from direct measurement on the number of women (89 women) with blood loss of 500–999 g. However, visual estimation by physicians and nurses only identified one-half of the actual number of women with blood loss of ≥1,000 g (SPPH).

Tables 2 and Table 3 show that visual estimation by physicians and nurses underestimated postpartum blood loss by 10.8% and 29.7%, respectively, compared with results from direct measurement. In order to assess the predictive ability of visual estimation, the relations between visually estimated blood loss and measured blood loss were analyzed by calculating the sensitivity and specificity. Visual estimation of blood loss by physicians had a sensitivity of 45.9% and a specificity of 91.1% for detecting PPH. Once again, visual estimation of blood loss by nurses had a sensitivity of 43.2% and a specificity of 94.4% for detecting PPH.

The correlation between estimated and measured blood loss was compared by profession. The dataset of 727 (83.6%) women was used for the analysis of the physicians' performance, and the dataset of 672 (77.2%) women was used for analysis of the nurses' performance. The change of the correlation was observed over a period of 3 months. The association between visually estimated blood loss and measured blood loss is shown in Figure 1 and Figure 2. Simple linear regression analysis showed a gradual improvement in the correlation (R^2) between estimated blood loss by physicians and measured blood loss, from 0.394 in the first month to 0.593 in the third month (Figure 1). The overall correlation during the study period of 3 months was 0.478 ($p < 0.001$). The association between estimated blood loss by nurses and measured blood loss showed little change in correlation (R^2) between the first month (0.502) and the third month (0.520), with no correlation found in the second month (0.381) (Figure 2). The overall correlation during the study period of was 0.475 ($p < 0.001$).

Figure 3 shows that there was a moderate correlation (R^2 = 0.502) for the association between the difference in measured and estimated blood loss by physicians against measured blood loss. Figure 4 shows the association between the difference in measured and estimated blood loss by nurses against measured blood loss (R^2 = 0.450). Although there was a weak correlation, both figures describe a trend for underestimation of large amounts of blood loss.

Table 1. *Comparison of visual estimation and direct measurement of blood loss.*

Blood loss	Visual estimation by physicians		Visual estimation by nurses		Direct measurement	
	n	%	n	%	n	%
< 500 g	551	84.8	572	88.0	539	82.9
500 – 999 g	89	13.8	68	10.5	89	13.7
≥ 1,000 g	10	1.5	10	1.5	22	3.4
Total	650	100.0	650	100.0	650	100.0
(Mean±SD) [g]	(290±198.5)		(282±197.4)		(337±262.9)	
(Range) [g]	(10 – 2,000)		(0 – 1,700)		(0 – 2,170)	

Table 2. *Predictivity of visual estimation by physicians in identifying postpartum hemorrhage.*

Visually estimated postpartum hemorrhage by physicians	Postpartum hemorrhage by direct measurement		
	Blood loss ≥ 500g	Blood loss < 500g	Total
Blood loss ≥ 500g	51	48	99
Blood loss < 500g	60	491	551
Total	111	539	650

Sensitivity = 45.9% (51/111); Specificity = 91.1%; (491/539); Positive predictive value = 51.5% (51/99);
Negative predictive value = 89.1%; (491/551); Accuracy = 83.4% ([51+491]/650)

Table 3. *Predictivity of visual estimation by nurses in identifying postpartum hemorrhage.*

Visually estimated postpartum hemorrhage by nurses	Postpartum hemorrhage by direct measurement		
	Blood loss ≥ 500g	Blood loss < 500g	Total
Blood loss ≥ 500g	48	30	78
Blood loss < 500g	63	509	572
Total	111	539	650

Sensitivity = 43.2% (48/111); Specificity = 94.4% (509/539); Positive predictive value = 61.4% (48/78);
Negative predictive value = 89.0% (509/572); Accuracy = 85.7% ([48+509]/650)

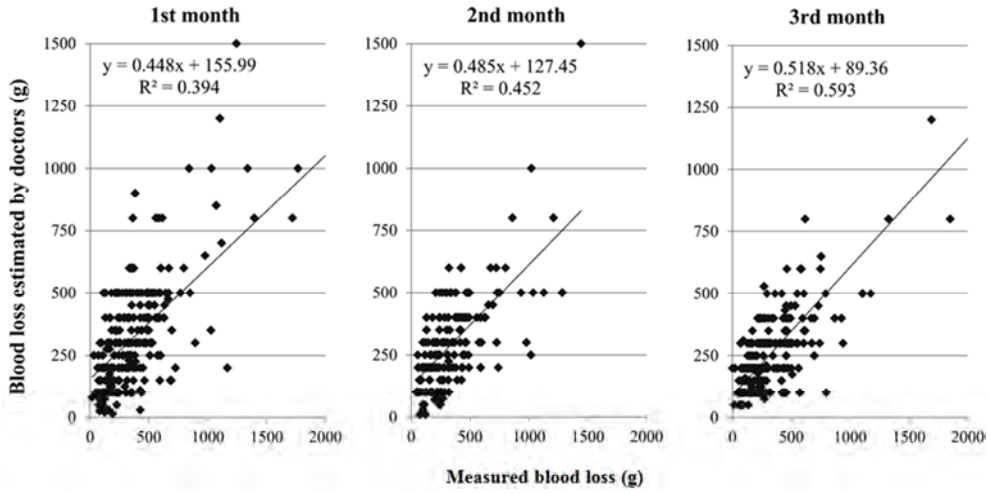

Figure 1. *Association between visually estimated blood loss by physicians and measured blood loss.*

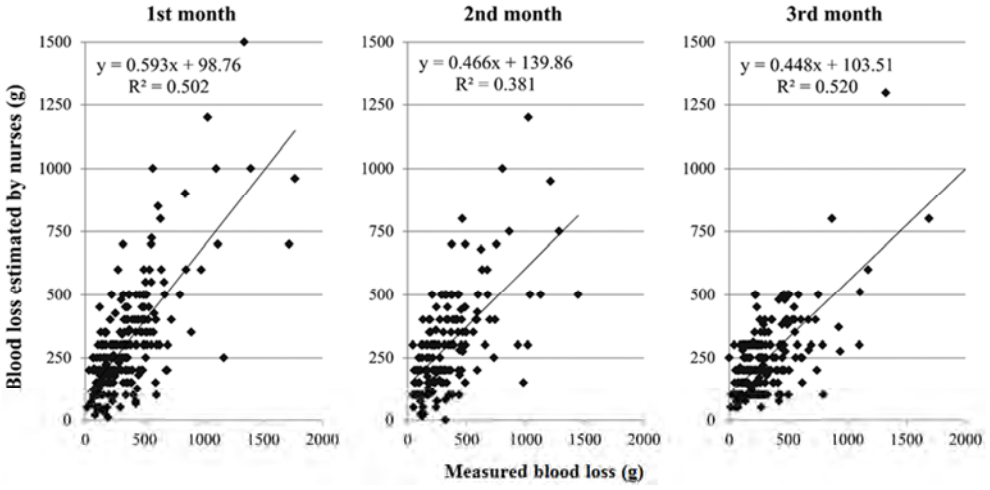

Figure 2. *Association between visually estimated blood loss by nurses and measured blood loss.*

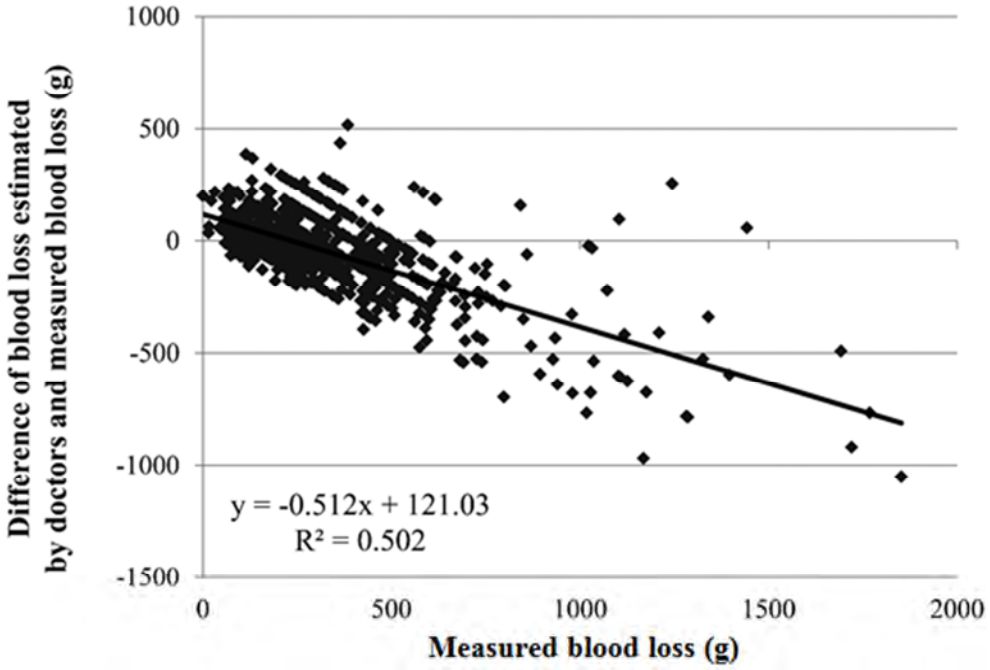

Figure 3. *Difference between measured and estimated blood loss by physicians against measured blood loss.*

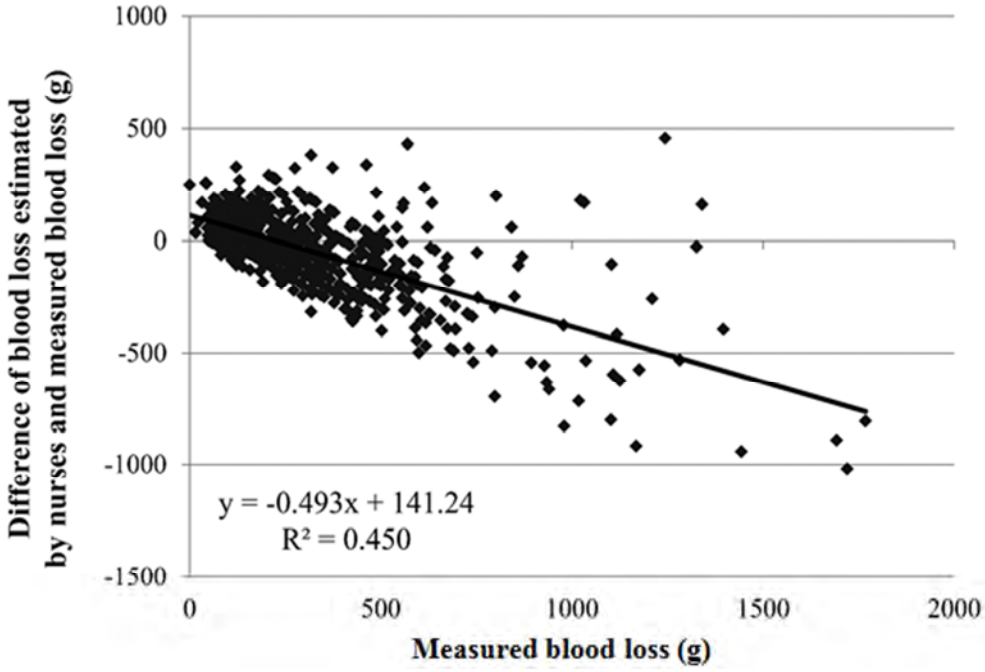

Figure 4. *Difference between measured and estimated blood loss by nurses against measured blood loss.*

4. Discussion

Visual estimation is the most commonly used method of determining blood loss throughout the world. Our results support those reported from previous studies in relation to the inaccuracy of visual estimation when compared with direct measurement of blood loss, which is regarded as the gold standard [7]-[9]. Visual estimates of blood loss by physicians and nurses were 10.8% and 29.7% lower than actual blood loss, respectively. The observed rate of underestimation was lower than those reported in previous studies [7]-[9]. Given that the official prevalence of PPH obtained from the health information system of National Maternity Hospital was 1.7% in 2013, the estimates of 15.2% by physicians and 12.0% by nurses demonstrated that their skill to identify women with PPH was improved. Moreover, 123 women were identified with PPH during the 12 months of 2013 compared with the results from visual estimation by physicians and nurses, who identified 99 women and 78 women as PPH cases, respectively, during the 3-month period of this study. The increased number of identified PPH cases may be related to the increased awareness of blood loss evaluation among healthcare personnel through training and the introduction of a designated field in the medical and nursing records to record the amount of blood loss.

However, the low sensitivity of visual estimation of blood loss (less than 50%) remains a major concern. As previous studies suggested, our results showed that the larger the blood loss, the larger the discrepancy was between estimated and measured blood loss [13]. For example, the blood loss from one patient was visually estimated as 800 g by an attending physician, compared with the actual blood loss of 1,852 g. Therefore, the physician underestimated the blood loss by 1,052 g, which is a significant disparity. However, it is worth noting that the diagnostic performance of attending physicians gradually improved month by month, but this improvement over time was not observed in nurses. This difference may be explained because attending physicians were able to observe the entire duration of bleeding from the beginning of the second stage of labor until the completion of the postpartum medical procedure. Nurses were not able to experience this observational period because they were responsible for three to five parturient women simultaneously either in labor or in the postpartum period. A previous study reported that the implementation of training using a simulation improved the diagnostic performance of healthcare personnel [14]. Given the improvement of the correlation (R^2) over time between estimated blood loss by physicians and measured blood loss, this study demonstrated that on-the-job training using existing materials and equipment was also useful in improving the diagnostic accuracy of PPH, particularly if healthcare personnel were able to monitor patients' bleeding status continuously.

The study had several limitations. First, this study was lack of novelty, because multiple studies have been published since the 1960s to evaluate the accuracy of visual estimation [15]. However, only a few studies about PPH were performed in Latin American countries. One systematic review has analyzed 120 datasets related to PPH, including 2 datasets from Latin American region [16]. In addition, previous study which analyzed medical records at four public hospitals in El Salvador indicated the prevalence of PPH was 0.15% [17]. Given the fact that our result showed the prevalence of PPH was 17.0%, we believe that present study has a clinical significance to understand the actual competency of Salvadoran health providers to estimate PPH in a visual manner.

Second, the level of detail in relation to the roles of

healthcare personnel and their years of experience was not taken into account. For example, obstetricians, residents in obstetrics and gynecology, and interns were categorized as physicians. Similarly, registered nurses and assistant nurses were categorized as nurses (Midwifery license is not exist in this country). As residents and interns attended deliveries under the supervision of obstetricians and they worked together as a team, classification of the profession was difficult. However, such information could help to shape the general profile or characteristics of visual estimation by a particular profession.

Thirdly, it was difficult to divide patients into distinct groups based on the presence or absence of PPH, as false PPH-negative cases are difficult to exclude because the total amount of bleeding is a continuous variable. Additionally, the direct measurement method inherently underestimates blood loss; for example, blood that spilled onto the floor or that was absorbed into the protective gown was not included in the measurement. Moreover, it was not feasible to begin the collection of blood immediately after childbirth in cases where infants were born with low Apgar scores (i.e., cases requiring neonatal resuscitation).

Despite these limitations, the procedure for measuring blood loss that was employed in this study was low-cost and only used materials and equipment available in the hospital. Although the diagnostic performance of visual estimation by physicians improved over time, given the low sensitivity of visual estimation in detecting PPH, the results of this study suggest that attending physicians and nurses should continue to use direct measurement for postpartum blood loss.

5. Conclusion

The healthcare providers in El Salvador could not identified more than half of PPH cases through visual estimation of blood loss. However, the diagnostic performance of attending physicians gradually improved. This study demonstrated that on-the-job training was useful in improving the diagnostic accuracy of PPH as far as healthcare providers were able to monitor participants' bleeding status continuously. It is recommended that attending physicians and nurses continue direct measurement of blood loss in order to identify the more women who are suffering from PPH, and provide appropriate treatment for PPH immediately after its detection.

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