Using Blood Loss Pictogram for Visual Blood Loss Estimation in Cesarean Section

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Objective: *To determine whether using pictogram can improve visual estimation of blood loss in a mock cesarean setting and whether profession and clinical experience influence the accuracy of blood loss estimation.*
Material and Method: *Photographs of measured blood volume absorbed in different percentage of surface area of common surgical materials were taken and arranged in the table of pictogram. Pictures of seven cesarean scenarios were set with known blood volumes (20, 35, 60, 100, 350, 400, and 1200 ml) in different surgical materials. Forty-nine participants from four professions had to view all seven pictures and quantitatively estimate blood volume pre-post using the pictogram. Percent error of estimated blood loss was analyzed.*
Results: *Before using the pictogram, tendency of underestimation, overestimation and accurate assessment in lower and higher blood loss volumes were 43.4%, 25.7%, and 30.9% respectively. There was a trend in overestimating blood loss at the lower volumes and underestimating or accurate estimating blood loss at higher volumes. Profession affected the accuracy in estimation of some small blood loss volumes but clinical experience had no influence. After using the pictogram, accurate estimation increased significantly from 30.9% to 61.8%. No difference in ability to determine blood loss in all professions and clinical experience.*
Conclusion: *Estimated blood loss pictogram is a simple tool, easy to use for initial evaluation of blood loss in cesareans and can improve the accuracy of visual blood loss assessment significantly.*

Keywords: *Blood loss pictogram, Visual assessment, Cesarean section, Blood loss estimation*

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Obstetric hemorrhage remains a leading cause of maternal mortality in developing regions as shown in systematic analysis of maternal death's causes by WHO published in March 2006[1]. Inaccurate assessment of blood loss after delivery or in the surgical area can have considerable adverse events. Underestimation results in delayed treatment and overestimation in unnecessary and costly procedures[2]. Accuracy in recognition of postpartum hemorrhage (PPH) is necessary for prompt appropriate intervention and improving outcomes[3].

Visual assessment is a quantitative method, simply used for routine measurement of blood loss in the low-resource setting[2] by both of anesthetists and obstetricians. However, visual estimation of blood loss is insensitive to detect postpartum hemorrhage and trends to be grossly underestimated[4]. Patel et al showed that visual assessment underestimated postpartum blood loss by 33% compared with the drape assessment[5].

The team found that using a teaching tool with limited instruction such as combination of simple geometric formulas, known volumes of common objects, and known absorption characteristics of surgical materials, was a significant success method to rectify error of blood loss estimation in the operating room. Error in visual blood loss estimation after applying the instruction studied by Dildy GA et al was 10 to 13%[6]. A written and pictorial guideline was developed to help all labor unit staffs do an early assessment and prompt treatment of PPH[7].

The purpose of the present study was to investigate the effectiveness in usage of a known blood loss pictogram to reduce the error of blood loss

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estimation in mock caesarean settings. The authors also evaluated the influence of profession and clinical experience on the accuracy of blood loss assessment before and after using the pictogram.

Material and Method

A prospective descriptive study was conducted in April 2011 at the Department of Anesthesiology, Charoenkrung Pracharak Hospital, Bangkok, Thailand. It was approved by the Ethics Committee for Researches Involving Human Subjects, the Bangkok Metropolitan Administration with registered number 021.54. All 49 participants from four professional groups were voluntary to join in this study. The sample size was calculated by the formula, $N = Z^2_{\alpha/2} P(1-P)/d^2$ when P was the percentage deviation of visual estimated blood loss after didactic session in participants from four professional groups, studied by Dildy GA et al, which was 13%[6]. The present study did under detecting a statistically significant difference, at a 90% confidence level.

Hospital's blood bank generously provided the unusable stocks of whole blood (hematocrit 37 to 42%) for the present study. The authors applied exactly incremental increase of measured blood volumes contained in different surface area (25%, 50%, 75%, 100%, and 100% with dripping, respectively) to each of surgical materials commonly used in caesarean cases of Charoenkrung Pracharak Hospital: under-buttock plastic drape (15-in. x 14-in.), medium size laparotomy sponge (6 ply 6-in. x 18-in.), large size laparotomy sponge (6 ply 18-in. x 18-in.), and dry gauze sponge (8ply 4-in. x 4-in.). The laparotomy sponges were prepared in dry and wet (hand wrung after being soaked with normal saline) sponges.

All materials were photographed with a digital camera (CANNON model W 8400) after blood application. The authors performed the blood loss pictogram to be a guideline for visual estimation of blood loss by setting pictures of each surgical material with different volume of absorbed blood in different surface areas as shown in Fig. 1. The pictogram was printed on A4 200 gram glossy photo paper (IA glossy Photolab).

Participants in the present study were informed a brief introduction to the research. They all

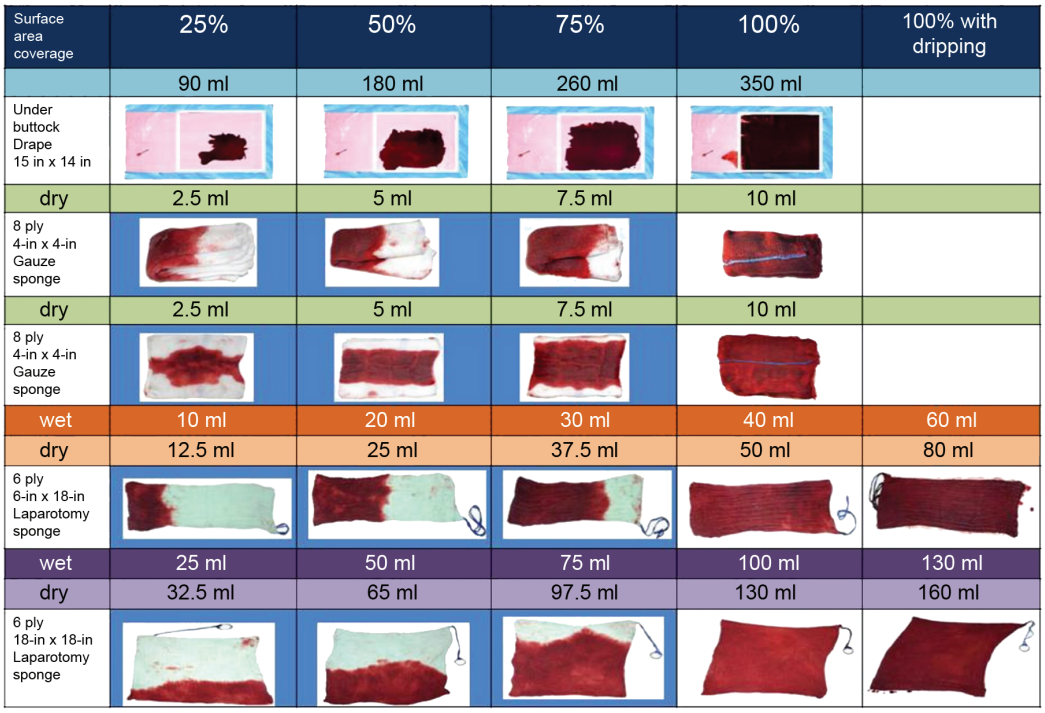

Fig. 1 Blood absorption characteristics and measured blood volume containing of an under-buttock plastic drape (15-in. x 14-in.), dry gauze sponge (8 ply 4-in. x 4-in.), dry-wet medium sized laparotomy sponge (6 ply 6-in. x 18-in.) and dry-wet large size laparotomy sponge (6 ply 18-in. x 18-in.) in 25%, 50%, 75%, 100% and 100% with dripping of the surface area

had to view the pictures (printed on paper the same as the pictogram) of seven simulated clinical scenarios of caesarean mock settings and quantitatively estimate the blood volume in milliliters:

1. Station 1: Under-buttocks plastic drape with 350 ml of blood.

2. Station 2: Two wet 6-ply 18 x 18 inches laparotomy sponges with 100 ml of blood.

3. Station 3: A wet 6-ply 6 x 18 inches laparotomy sponge with 20 ml of blood.

4. Station 4: Twelve wet 6-ply 18 x 18 inches laparotomy sponges with 1,200 ml of blood.

5. Station 5: Five dry 8-ply 4 x 4 inches sponges with 35 ml of blood.

6. Station 6: Six wet 6-ply 18 x 18 inches laparotomy sponges with 400 ml of blood.

7. Station 7: A wet 6-ply 6 x 18 inches laparotomy sponges with 60 ml of blood.

Then the pictogram was presented to the volunteers and demonstrated how to use it. All participants reassessed the same seven clinical stations. The present study was accomplished. Percent error of estimated blood loss was figured out as [(estimated blood loss - measured blood loss)/ measured blood loss]100 for each measurement. The authors prospectively classified percent error of estimated blood loss as overestimation (percent error more than +20%), accurate assessment (percent error between +20% and -20%), and underestimation (percent error less than -20%)[7].

Statistical analysis

Pre-post using of blood loss pictogram comparisons of percent error of estimated blood loss were performed with the Wilcoxon matched pairs signed rank test, the sign test, and Bowker's test of symmetry. The effect of profession and clinical experience on percent error estimated blood loss was evaluated with appropriating the Kruskal-Wallis, Friedman's and Mann Whitney U tests. The effect of actual blood volume on the tendency to overestimate or underestimate volume was obtained with Jonckheere-Terpstra test. A Bonferroni adjustment has been made into account to maintain overall significance level of 0.05, therefore, any test yielding a p-value smaller than 0.0071(= 0.05/7) was affirmed significant.

Results

Forty-nine nurses and physicians participated in the present study (Table 1). The median of clinical experience's years was not different among anesthesiologists, nurse anesthetists, obstetricians, and theatre nurses.

The present study significantly illustrated that before using the pictogram tendency of underestimation, overestimation and accurate assessment were 43.4%, 25.7% and 30.9% in lower blood loss volumes (20, 35, 100 ml) and higher blood loss volumes (350, 400, 1200 ml). The tendency was disappeared post using blood loss pictogram. All six stations were evaluated with significant accuracy when the pictogram was used. The accuracy increased from 30.9% to 61.8%. Error in estimation decreased from 69.1% to 38.2%.

Before using the pictogram, there was a trend (Jonckheere-Terpstra test) in overestimating blood loss at the lower volumes (20, 35, 100 ml) and underestimating or accurate estimating blood loss at higher volumes (350, 400, 1200 ml), but there was no trend after using the pictogram in all six different volumes.

There was a significant improvement in reduction of percent error of estimated blood loss in 3 out of 7 clinical stations (Table 2, Fig. 2). Under-buttocks drape containing 350 ml of measured blood loss (Station 1) was estimated to contain 250 ml before and 350 ml after using the pictogram. The difference

Table 1. Clinical experience was defined as the number of years since working in the field of profession at the time of study

Participants	Number	Years of clinical experience, [Median (range)]			
		1-4 yrs	5-15 yrs	≥ 16 yrs	All
Anesthesiologist	3	-	7.0 (6-7)	-	7.0 (6- 7)
Nurse anesthetist	20	2.5 (1-4)	6.0 (5-15)	22.0 (19-29)	9.0 (1-29)
Obstetricians	13	2.0 (1-3)	7.0 (6-8)	22.0 (16-27)	3.0 (1-27)
Theatre nurse	13	1.0 (1-3)	10.0 (5-13)	25.5 (22-29)	10.0 (1-29)
All participants	49	2.0 (1-4)	7.0 (5-15)	22.5 (16-29)	7.0 (1-29)

Table 2. Measured blood loss, estimated blood loss, percent error estimated blood loss, and difference in percent error estimated blood loss for each of the 7 clinical stations pre and post using blood loss pictogram

Station with measured blood loss (ml)	Pre				Post				Difference in percentage estimated blood loss		p-value
	Estimated blood loss (ml)		Percent error estimated blood loss		Estimated blood loss (ml)		Percent error estimated blood loss				
	Median	Range	Median	Range	Median	Range	Median	Range	Median	Range	
1. Under-buttocks drape (350)	250	50 to 2,000	-28.6	-85.7 to 471.4	350	300 to 350	0.0	-14.3 to 0.0	-28.6	-85.7 to 471.4	<0.001*,[b]
2. Two wet 6 ply 18-in x 18-in laparotomy sponges (100)	100	20 to 300	0.0	-80.0 to 200.0	125	50 to 162.5	25.0	-50.0 to 62.5	-25.0	-142.5 to 225.0	0.097[ns,a]
3. A wet 6 ply 6-in x 18-in laparotomy sponge (20)	50	10 to 200	100.0	-60.0 to 700.0	30	20 to 70	20.0	-20.0 to 180.0	80.0	-60.0 to 520.0	<0.001*,[a]
4. Twelve wet 6 ply 18-in x 18-in laparotomy sponges (1,200)	1,200	500 to 4,000	0.0	-58.3 to 233.3	1,350	800 to 2,000	12.5	-33.3 to 66.7	-13.3	-95.8 to 203.3	0.751[ns,a]
5. Five dry 8 ply 4-in x 4-in gauze sponges (35)	40	10 to 200	14.3	-71.4 to 471.4	35	30 to 140.0	0.0	-14.3 to 300.0	14.3	-342.9 to 471.4	0.199[ns,a]
6. Six wet 6 ply 18-in x18-in laparotomy sponges (400)	400	150 to 1,500	0.0	-62.5 to 275.0	455	260 to 700.0	13.8	-35.0 to 75.0	-18.1	-96.3 to 250.0	0.299[ns,a]
7. A wet 6 ply 6-in x 18-in laparotomy sponges (60)	150	20 to 1,000	87.5	-75.0 to 1,150.0	60	60 to 130.0	-25.0	-25.0 to 62.5	87.5	-75.0 to 1,175.0	<0.001*,[b]

p-values correspond to tests on the median difference in percentage estimated blood loss

[a] By Wilcoxon matched pairs signed rank test

[b] By sign test (due to positively skewed data)

* Significant

ns = non significant

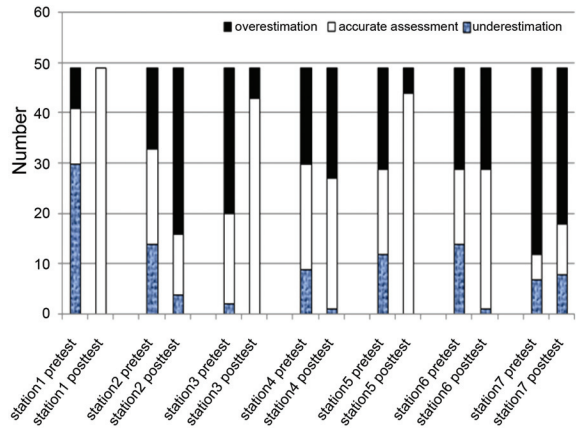

Fig. 2 Estimated blood loss before and after using blood loss pictogram for each of the 7 mock clinical stations. Dark bars represent overestimation (percent error +20% or more), white bars represent accurate assessment (percent error between +20% and -20%) and irregular texture bars represent underestimation (percent error -20% or less) of measured blood loss. Statistically significant ($p < 0.001$, Bowker's test of symmetry) improvements in estimated blood loss were observed in all Pre and Post using the pictogram pairs

was statistically significant ($p < 0.001$), improved of percent error in estimated blood loss from -28.6 to 0% after using the pictogram. A wet 6 ply 6-in x 18-in laparotomy sponge with measured blood loss of 20 ml, 60 ml (Station 3, 7) was estimated to fill with blood 50 ml, 150 ml before and 30 ml, 60 ml after using the pictogram, with a statistically significant ($p < 0.001$) improvement of percent error in estimated blood loss from 100 to 20% and from 87.5 to -25% in sequence after using the pictogram.

Years of experience did not influence the ability to determine blood loss, either before or after using the pictogram by using the Kruskal-Wallis and Friedman's test. The Kruskal-Wallis and Mann Whitney U tests on percent error of estimated blood loss by profession informed that nurse anesthetists significant more accurately estimated in small volumes of blood loss (20, 35 ml) than obstetricians who assessed as overestimation before using the pictogram. Anesthesiologists more accurately estimated in small volume of blood loss (60 ml) than nurse anesthetists and obstetricians. Theatre nurses overestimated blood loss in small volumes (20, 35, 60 ml) but lesser than obstetricians.

Nevertheless, no difference in ability to determine blood loss in all professions and increasing in accuracy of estimation were found after using the pictogram. A reduction in overestimation and underestimation of blood loss by using the blood loss pictogram was presented in almost all scenarios (Fig. 2).

Discussion

The average rate of caesarean section cases in Thailand from SEA-ORCHID (South East Asia-Optimizing Reproductive and Child Health in Developing countries) project published in 2009 was 34.8%. The majority of women in this group were informed to have a less than 500 ml estimated blood loss. However, 33% of them were implied as postpartum hemorrhage cases (> 500 ml)[8]. In Asia, this clinical situation was the leading cause of maternal death (30.8%)[1]. Accuracy of blood loss estimation was necessary for early detection of PPH and immediate proper treatment can minimize its severity of outcomes[3].

Visual estimation is commonly used to be a standard method of observation in measuring blood loss volume though it is quite inaccurate[2,9,10]. Error in blood loss estimation of cesarean mock setting was found 69.1% in the present study.

In cesarean section, there was trend to overestimate blood loss in some studies[11] but the present result indicated that 43.4% of healthcare providers tended to underestimate the volume of postpartum blood loss. This is consistent with earlier researches of postpartum blood loss in entirely deliveries that underestimated around 30% to 50%[4,9,10].

The present study implied some ideas of previous studies that overestimation occurred at lower volumes. However, at higher volumes either accurate or underestimation was found. Post using the estimated blood loss pictogram, the tendency disappeared subsequently. It was significantly seen in 20, 35, 100, 350, 400 and 1200 ml of blood loss volumes, respectively.

By using Friedman's and Bowker's test, the present result informed using pictogram could improve the accuracy of estimation significantly in 20, 35, 60 and 350 ml of blood loss volumes. Although in assessing of 100, 400, and 1200 ml, the accuracy did not evidentially increase but none of any station was also significant underestimation or overestimation.

Some studies informed that improving the accuracy of visual estimate volume as close to actual

measured volume was succeeded by using clinical reconstructions or simulated clinical examples training[7,12]. The authors demonstrated using blood loss estimated pictogram was able to double increase percentage of accuracy in visual estimation (30.9% to 61.8%) and error in assessment also decreased (69.1% to 38.2%). Nevertheless, combination of different tools benefits for further decrease the percentage of error in estimation.

The background and clinical experience of the assessing healthcare professionals did not affect the accuracy of estimation[6,10,12]. The same results were found in the present study. Even though, before using the pictogram, nurse anesthetist evaluated more accurately than obstetricians and anesthesiologist could assess more accurately than nurse anesthetists in small volumes estimation. Ability in determination blood loss in each profession significantly increased in accuracy after using the pictogram.

Estimated blood loss pictogram is a simple tool for increasing the accuracy of blood loss assessment in a mock cesarean setting and may be useful for low-resource setting hospitals that cannot provide any complicated instruments for accurate estimation purpose. It is quite save and easy for any healthcare provider to implement. There is no need to remember how much of blood volume in different absorbed area of common surgical materials using in operative field. Furthermore, this simple tool can be applied for evaluation blood loss in other surgical situations.

Conclusion

Estimated blood loss pictogram is a simple tool, easy to use for initial evaluation of blood loss in cesareans and can significantly improve the accuracy of visual blood loss assessment.

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Potential conflicts of interest

None.

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การใช้แผนภาพประเมินการสูญเสียเลือดจากการผ่าตัดคลอด

พัชร์จิรา เจียรณิชานันท์, ปัทมา พูลน้อย

วัตถุประสงค์: *เพื่อศึกษาผลการใช้แผนภาพประเมินการสูญเสียเลือด ในการประเมินปริมาณเลือดที่สูญเสียจากสถานการณ์จำลองการผ่าตัดคลอดทางหน้าท้อง และผลของกลุ่มอาชีพและประสบการณ์ในการทำงานที่มีต่อความแม่นยำในการประเมิน*

วัสดุและวิธีการ: *ทำการบันทึกภาพของปริมาณเลือดที่ถูกดูดซับบนพื้นที่ขนาดต่าง ๆ กัน ของวัสดุซับเลือดชนิดต่าง ๆ ที่ใช้บ่อยในการผ่าตัดคลอด จัดเรียงในตารางเป็นแผนภาพสำหรับช่วยประเมินการสูญเสียเลือด จัดทำภาพ 7 สถานการณ์จำลองการสูญเสียเลือดที่ทราบปริมาณเลือด ในขนาด 20, 35, 60, 100, 350, 400 และ 1200 มิลลิลิตร บนวัสดุซับเลือดต่างชนิด อาสาสมัครจำนวน 49 รายที่เข้าร่วมในการศึกษาจากต่างกลุ่มอาชีพ จะต้องทำการประเมินปริมาณเลือดทั้ง 7 สถานการณ์ทั้งก่อนและหลังการใช้แผนภาพ ร้อยละของความคลาดเคลื่อนในการประเมินค่าการสูญเสียเลือดจะได้รับการวิเคราะห์*

ผลการศึกษา: *ก่อนการใช้แผนภาพประเมินการสูญเสียเลือด พบว่า แนวโน้มของการประมาณค่า ต่ำกว่าค่าจริง สูงกว่าค่าจริง และถูกต้อง คิดเป็นร้อยละ 43.4, 25.7, และ 30.9 ตามลำดับ โดยมีแนวโน้มที่จะประเมินสูงกว่าค่าจริงเมื่อมีการสูญเสียเลือดในปริมาณน้อย และจะประเมินต่ำกว่าค่าจริง หรือ ถูกต้อง เมื่อมีการสูญเสียเลือดในปริมาณมาก กลุ่มอาชีพมีผลต่อความถูกต้องของการประเมินเมื่อมีการสูญเสียเลือดปริมาณน้อย แต่ประสบการณ์การทำงานไม่มีผลต่อการประเมิน หลังการใช้แผนภาพ พบว่าการประเมินการสูญเสียเลือดมีความแม่นยำเพิ่มขึ้นอย่างมีนัยสำคัญทางสถิติ จากร้อยละ 30.9 เป็น 61.8 กลุ่มอาชีพและประสบการณ์การทำงานไม่มีผลทำให้เกิดความแตกต่างกันในผลการประเมินค่าการสูญเสียเลือด*

สรุป: *แผนภาพประเมินการสูญเสียเลือดเป็นเครื่องมือที่ไม่ซับซ้อนและง่ายต่อการใช้ช่วยประเมินปริมาณเลือดที่สูญเสียในการผ่าตัดคลอด และสามารถเพิ่มความแม่นยำในการประเมินได้อย่างมีนัยสำคัญทางสถิติ*