

Increase Accuracy of Visual Estimation of Blood Loss from Education Programme

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Objective: To study the increase accuracy of visual estimation of blood loss after an education program.

Material and Method: Seven simulated scenarios with known measured amount of blood were created by using expired packed red cell from blood bank and common surgical materials. Ninety nurses were randomized into two groups. The experimental group attended blood loss estimation course while the control group did not. The percentage of errors in blood loss estimation were calculated and compared between both groups. The main outcome of this study was percentage of nurses who had accurate estimation. We assumed that if the estimated blood volume is within twenty percentage of actual volume it is accurate.

Results: There were no difference in age group ($p = 0.08$), clinical experiences ($p = 0.95$) and type of work ($p = 0.47$) between both groups. Educational program significantly increase accuracy in blood loss estimation ($p < 0.05$) in all seven scenarios.

Conclusion: Educational program increased the accuracy of visual estimation of blood loss.

Keywords: Visual estimation of blood loss, Education programme

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Blood loss is one of the threatening fatal problems. It is found that if the body loses 20-30% of the total blood in the circulatory system, it shall not be able to adjust itself to such condition and the blood loss will consequently causes the failure in multiorgan functions. If the patient is not treated in time, this may lead to irreversible functions losses⁽¹⁾.

Therefore, the medical personnel have to estimate accurately the blood loss. The underestimation of blood loss may result in delayed blood transfusion and the overestimation of blood loss causes excessive unnecessary blood transfusion⁽²⁾.

The purpose of this study was to assess blood absorption characteristics of commonly used surgical materials, create a brief didactic presentation to educate clinicians about estimating blood loss, and

investigate the effectiveness of didactic session to improve the estimation of blood loss in mock clinical settings.

Material and Method

The protocol mimicked the Louisiana State University Health Science Center Institutional Review Board⁽³⁾. Nurses in Department of Obstetrics and Gynecology were invited to participate in this study. All participation in the study was voluntary and followed the inclusion and exclusion criteria. The Regional blood bank provided Packed red cell (PRC) for this study. We applied measured volumes of blood in increasing increments to the following surgical materials: abdominal swabs, rolled gauzes, surgical sponges and half-sheet. All materials were photographed and weighed before and after blood application. Wet abdominal swabs and rolled gauzes were saturated with normal saline and hand wrung.

We created a 15-minute Power Point presen-

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tation as the didactic tool to teach visually the estimated blood loss. The slides illustrated the following three teaching tools for visually assessing blood volume.

First, mathematical formulas to calculate the volume of simple objects were described. The volume of box (rectangular parallelepiped) is calculated as length x width x height. For a box with dimensions of 10x20x4 cm the volume is 800 ml.

Second, the volumes of familiar objects were demonstrated to the audience. The metric volume of a standard 1-L intravenous fluid bag is of course 1,000 ml. The metric volume of 0.1 L intravenous fluid bag is 100ml.

Third, we presented some simple rules of thumb regarding visual estimation of blood volume contained in common surgical materials. A standard dry 30 cm x 30 cm abdominal swab (Topline®) Containing 25 ml, 50 ml, 75 ml and 100 ml of blood will appear 50% saturated, 75% saturated, 100% saturated and 100% saturated with excess blood dripping respectively (Fig. 1). A dry 45 cm x 10 cm rolled gauze (Topline®) containing 20ml and 40 ml of blood will appear 50%

saturated and 100% saturated respectively (Fig. 2). A dry 4 inch x 4 inch surgical sponge (Medigauz®) containing 10 ml of blood will appear completely saturated (Fig. 3). For example, five completely soaked surgical 4x4 sponges will contain approximately 50 ml of blood.

The next step, participants were randomly divided into two groups, controlled group were then instructed to view seven simulated clinical scenarios and quantitatively estimate the blood volume in milliliters:

1. Station 1: Under-buttocks drape (half sheet) with 250 ml of blood.
2. Station 2: Seven dry 4x4 sponges with 35 ml of blood (5 cc of blood in each sponge).
3. Station 3: Three dry abdominal swabs with 150 ml of blood (25 cc, 50 cc and 75 cc of blood in each abdominal swab respectively).
4. Station 4: Four dry rolled gauzes with 80 ml of blood (20 cc of blood in each rolled gauze).
5. Station 5: Five wet abdominal swabs with 250 ml of blood (25 cc, 25 cc, 25 cc, 75 cc and 100 cc of blood in each abdominal swab respectively).
6. Station 6: Under-buttocks drape (half-sheet) with 100 ml of blood.



Fig. 1 Blood absorption characteristics of a dry 30 × 30 cm abdominal swab. For this particular type, 25 ml of blood saturates about 50% of the surface area, 50 ml of blood saturates about 75% of the surface area, 75 ml of blood saturates the entire surface, and 100 ml of blood will saturate and drip from the sponge

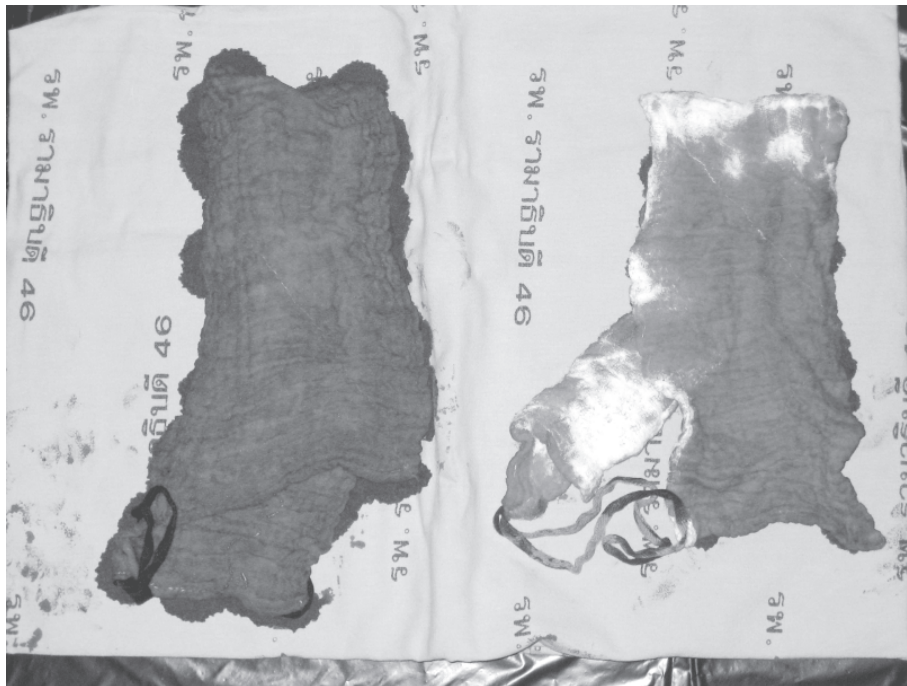


Fig. 2 Blood absorption characteristics of a dry 45 × 10 cm rolled gauze. For this particular type, 20 ml of blood saturates about 50% of the surface area, 40 ml of blood saturates the entire surface



Fig. 3 Blood absorption characteristics of a dry 4 inch × 4 inch surgical sponge, 10 ml of blood saturates the entire surface

7. Station 7: Three wet rolled gauzes with 85 ml of blood (15 cc, 30 cc and 40 cc of blood in each rolled gauze respectively).

The experimental groups were presented a 15-minutes didactic session. The participants evaluated the same seven stations after the briefing. The total time of introduction, didactic session and evaluation was approximately 40 minutes in the experiment groups and 25 minutes in the control groups.

Outcome measurement of this study is the proportion of the participants who could accurately estimate the blood loss. The accuracy in this study refers the estimation of blood loss compared to the measured blood loss. The acceptable difference is 20% ($\pm 20\%$). Summarized data are expressed as medians. All statistical tests were carried out in the computer program Stata. Demographic characteristics, ages were analyzed by using Chi-square calculated and presented in the form of frequency (percent). The clinical experience was analyzed by using Mann-Whitney U test because it was continuous data but not normally distributed. They were presented in median (range). The type of work was analyzed by using Chi-square calculated in frequency and percentage. The percentages of the accuracy between the control and the experimental group were then compared. The results were presented in the form of percent accuracy (%). The statistic method used to compare the percent accuracy between both groups is Chi-square or Fisher exact test and for significant correlation, the p value should be < 0.05 .

Results

All ninety participants were nurses. Clinical experience was defined as the number of years since graduation from nursing school. The demographic characteristics were age ranges (p-value = 0.077), experiences (p-value = 0.945), and type of work (p-value = 0.469), which were not significant difference between the two groups (Table 1). In all seven stations, there was a significant improvement between the two groups in accuracy in visually blood loss estimation (p-value < 0.05) (Table 2). However, in the fourth station, the accuracy of estimation in experiment group is lower than in the other stations (44.4%) because blood is not equally distributed in each swab. In the sixth station, the accuracy of estimation in experiment group is also low, about 40%, because the size of the half-sheet is large, making it difficult to estimate the amount of blood.

Discussion

As we know, blood loss is one of the three causes of the death in pregnant woman. The delayed diagnosis of blood loss and replacement of blood products can lead to many complications. To wait until the fatal symptom appears and the vital signs have changed to detect the blood loss may be too late^(1,4). Blood loss can be measured by a variety of methods. However, many of those methods are impractical in general practices such as colorimetric technique that requires the hemoglobin to be washed from surgical materials in a blender and measured in a colorimeter^(2,5).

Table 1. Demographic characteristics

Characteristics	Control (n = 45)	Experiment (n = 45)	p-value
* Age (years)			
21-30	17 (37.8)	22 (48.9)	
31-40	17 (37.8)	20 (44.4)	
41-50	6 (13.3)	3 (6.7)	
51-60	5 (11.1)	0 (0.0)	0.077
** Experience (years)	7 (2, 36)	8 (2, 20)	0.945
*** Type of work			
- LR	18 (40.0)	17 (37.8)	
- OR	14 (31.1)	19 (42.2)	
- Antenatal ward	13 (28.9)	9 (20.0)	0.469

* Data presented as frequency (percent)

** Data presented as median (range)

*** Data presented as frequency (percent)

LR = Labor room

OR = Operating room

Table 2. Measured blood loss, Estimated blood loss, Percent accuracy in estimated blood loss of the control and experiment groups, the 7 clinical stations

Station	Control group (n = 45)			Experiment group (n = 45)			p-value**
with measured Blood loss(ml)	EBL*ml		Percent Accuracy	EBL*ml		Percent Accuracy	
	Median	Range	N (%)	Median	Range	N (%)	
Half-sheet (250)	220	50-450	16 (35.6)	210	120-300	40 (88.9)	<0.001
Seven dry 4 x 4 sponges (35)	50	15-100	11 (24.4)	35	30-42	45 (100)	<0.001
Three dry abdominal swab (150)	150	20-600	10 (22.2)	160	110-265	35 (77.8)	<0.001
Four dry rolled gauze (80)	100	10-320	6 (13.3)	100	50-250	20 (44.4)	<0.001
Five wet abdominal swab (250)	320	50-900	15 (33.3)	275	180-350	39 (86.7)	<0.001
Half-sheet (100)	150	40-400	8 (17.8)	150	80-480	18 (40.0)	0.020
Three wet rolled gauze (85)	150	40-300	13 (28.9)	90	65-150	38 (84.4)	<0.001

* EBL = Estimated Blood Loss

** p-value compare the percent accuracy of visually of blood loss estimation between experiment and control groups

The gravimetric method requires weighing materials such as abdominal swabs on a scale and subtracting known weight of the surgical materials from blood⁽⁶⁾. Blood volume estimation using dye-dilution or radioisotope dilution techniques are more technically difficult, requiring special equipment and serial measurements.

Dildy et al⁽³⁾ studied 53 participants in Louisiana State University Health Sciences Center Institutional Review Board. Reconstituted whole blood was obtained from the blood bank, and simulated scenarios with known measured blood loss were created using common surgical materials. Visually estimated blood loss was performed by medical personnel before and after a 20-minute didactic session. They found significant reductions in error for all scenarios. In every day practice, blood loss is usually estimated by subjective visual quantization, which is generally based upon prior clinical experience⁽⁷⁾. This study has proved that short-term educational program on visual estimation of blood loss can improve the accuracy of the estimation. Before the lecture, there was a trend in overestimation of blood loss however, there was no trend after the lecture (Table 2). In general, the educational program produced a reduction in both, overestimation and underestimation of blood loss in all scenarios as seen in Table 2. Our method uses a combination of simple geometric formulas, known volumes of common objects and known absorption characteristics of surgical materials to estimate blood loss in the operating room. We found that this teaching tool could significantly

improve the accuracy of blood loss estimation. This reduction in underestimating heavy blood loss may have the potential to reduce hemorrhage-related morbidity and mortality.

Several limitations of our study deserve consideration, our scenarios may not mimic all blood loss circumstances. The blood absorption characteristics of various surgical materials need to be further defined, the appearance of blood stained wet versus dry laparotomy sponges, swabs may differ and the absorptive characteristics of one brand of laparotomy sponge may differ from another. Finally, using PRC may give different outcome from using whole blood, but we have the limitation of biological ethics.

Conclusion

In summary, we have established a simple educational method to improve accuracy in estimating blood loss in the operating room and delivery room. We believe that incorporation of this method into clinical training would be an effective way to improve estimated blood loss and recognize serious hemorrhage earlier.

Future research should determine whether this information could be retained over the long-term. We recommended that this type of educational program be periodically reinforced.

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การเพิ่มความแม่นยำในการประเมินการเสียเลือดด้วยตาโดยโปรแกรมการสอนการประเมินการเสียเลือด

มัณฑุพร สุขประเสริฐ, วิชาญ ไชยชนะศิริ, ณัฐพงศ์ อิศรางกูร ณ อยุธยา, ปัทมา พรหมสนธิ, ประทักษ์ โอประเสริฐสวัสดิ์

วัตถุประสงค์: เพื่อศึกษาการเพิ่มความแม่นยำในการประเมินการเสียเลือดด้วยตาโดยโปรแกรมการสอนการประเมินการเสียเลือด

วัสดุและวิธีการ: สถานีจำลอง 7 สถานี ซึ่งประกอบด้วยผ้าซับเลือดและเลือดหมดอายุ จากธนาคารเลือด ซึ่งถูกกำหนดปริมาณไว้แล้ว และอาสาสมัครพยาบาล 90 คน ถูกจัดแบ่งโดยการสุ่มออกเป็น 2 กลุ่ม กลุ่มทดลองได้รับการสอนด้วยโปรแกรมสอนการประเมินการเสียเลือดก่อนประเมินจริง ในขณะที่กลุ่มควบคุมไม่ได้รับการสอน. คำนวณและเปรียบเทียบความผิดพลาดในการประเมินการเสียเลือดระหว่าง 2 กลุ่ม ตัวชี้วัดหลักคือเปอร์เซ็นต์พยาบาลที่ประเมินการเสียเลือดได้อย่างถูกต้องโดยคลาดเคลื่อนไม่เกิน 20% ของปริมาตรจริง

ผลการศึกษา: ไม่พบความแตกต่างของประชากรทั้ง 2 กลุ่ม ในด้านอายุ ($p = 0.08$), ประสบการณ์การทำงาน ($p = 0.95$) และลักษณะของงาน ($p = 0.47$) แต่พบว่าโปรแกรมการสอนการประเมินการเสียเลือดด้วยตาเปล่า สามารถเพิ่มความแม่นยำในการประเมินการเสียเลือดในสถานีจำลองทั้ง 7 สถานีได้อย่างมีนัยสำคัญ ($p < 0.05$)

สรุป: โปรแกรมการสอนการประเมินการเสียเลือดด้วยตาเปล่า สามารถเพิ่มความแม่นยำในการประเมินการเสียเลือด