Accuracy of Visually Estimated Blood Loss in Surgical Sponges by Members of the Surgical Team

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It is important that operating room personnel monitor the correct amount of blood loss during surgery in order to properly replace lost volume. The aim of this study was to investigate the accuracy of operating room personnel in visually estimating blood loss in surgical sponges. We performed an observational study with comparative descriptive design at a university hospital including all members of the surgical team. In total, 163 observations were completed. The participants estimated the amount of blood in surgical sponges in 4 stations with varying amounts of blood and/or numbers of sponges. Data were analyzed using the Wilcoxon signed rank, Kruskal-Wallis, and Mann-Whitney tests. Both overestimations and underestimations occurred. Underestimations dominated and tended to increase with major amounts of blood. Operating room personnel miscalculated the amount of blood by a median value of 30% regardless of profession, years of experience, and self-assessed ability about visual estimation. This study highlights that assessments of patients' conditions can be partially based on methods often demonstrated to be inaccurate. Inaccurate visual estimation of blood loss might endanger patient safety.

Keywords: Blood loss, surgery, surgical sponges, visual estimation.

An accurate assessment of blood loss must be performed to be able to properly replace lost volume during surgery. Bleeding can pose a danger to the patient's recovery and sometimes also can be a threat to life, especially when associated with hemodynamic instability.[1,2] Guidelines exist on how to deal with a bleeding patient,[2] but structured manuals on how to perform visual assessment of bleeding have not been found.

A combination of clinical evaluation of the patient's vital signs, visual estimation of bleeding, and laboratory tests will guide the selection of appropriate fluid administration and blood transfusion.[2,3] Decisions about transfusion should be based on a set limit for hemoglobin (Hb) concentration. Depending on the patient and his or her underlying diseases, the normal range is between 6 and 10 g/dL (60-100 g/L).[3] An unnecessary blood transfusion exposes the patient to needless risks such as infections, allergic complications, and both hemolytic and nonhemolytic transfusion reactions.[2,4] Not giving a blood transfusion when needed may result in prolonged convalescence and therefore extended hospital stays.[3,5] Studies conducted in obstetric care, operating rooms, and emergency departments have shown that healthcare professionals routinely use visual assessment of blood loss.[6-8] In the operating room, bleeding from the surgical site is mainly collected in suction canisters, surgical sponges, and in the surgical field. Assessment of the amount of blood in suction canisters is facilitated by markings for the volume collected, but the amount present in the surgical field and sponges is difficult to assess. Studies comparing calculated blood loss with visually estimated amounts have been conducted in operating rooms.[5,7] Calculated blood loss was determined from the concentration of Hb from each solution during the surgery (via surgical sponges, suction canisters, and cell salvage devices)[7] and from the differences between preoperative and postoperative Hb levels.[5] In both studies, the estimated blood loss exceeded measured blood loss by about 40%.

The accuracy of estimated blood loss has also been investigated with the help of simulated bleeding.[9,10] In a prospective single-blinded observational study, anesthesia providers estimated the amount of moulage blood. The focus was on detecting differences in blood estimation based on provider training, gender, ethnicity, education, and years of experience. No such differences were found.[9] At an emergency department, physicians estimated the amount of moulage blood spread over sheets, in sponges, on a T-shirt, and added to a commode together with water.[10] The physicians did not estimate blood loss correctly, and greater clinical experience did not appear to improve the ability to estimate. The method was therefore considered to be a poor basis for determining the need for transfusion. Studies conducted on maternity wards show the same results.[6,8,11-13] Incorrect estimates consist of both overestimations and underestimations. Underestimation of the correct amount of blood tends to increase with large blood volumes, whereas small blood volumes often are overestimated.[10,12] Previous studies performed in surgical environments involve the anesthesia providers and often omit the rest of the operating room personnel, such as surgeons and operating room nurses.[5,7]

The aim of this study was to investigate operating room personnel's ability to visually estimate the amount of blood in surgical sponges and to determine whether the ability to visually estimate blood loss is influenced by profession, years of experience, gender, or self-assessed knowledge about visual estimation.

Materials and Methods

• ***Data Source and Study Design.*** Using a consecutive sample, we conducted an observational study with a comparative descriptive design over 1 week in February 2015 at a surgical department of a university hospital in northern Sweden. The included participants were: operating room nurses, Certified Registered Nurse Anesthetists (CRNAs), anesthesiologists (specialists or in training), and surgeons (specialists or in training). All participants gave oral consent to participate. Students in their last term of nursing school were selected as a comparison group because of their nonexisting experience with visual estimation of blood loss.

• ***Procedure.*** Participants were told to visually estimate the amount of blood in surgical sponges at 4 stations. The participants received a questionnaire where they entered their sociodemographic data and the results from their estimations. The observations were performed in silence over 2 minutes under the supervision of 2 researchers. The participants were not allowed to touch the sponges or lift the swab counting bags (Swab-Bags, Purple Surgical International Ltd) where the sponges were held. These bags are used during surgery for the safe storage of contaminated swabs and because of the ability to see the sponges through the translucent plastic.

To make the study as authentic as possible, we used expired bank blood (red blood cells). To allow the bank blood to resemble and behave like whole blood, it was diluted with Ringer's acetate solution. The approximate hematocrit (Hct) value in humans is usually 33%. In this study, a lower Hct value was chosen because the blood was supposed to represent blood from a patient who has received a large infusion of fluid because of bleeding. After dilution, an Hct value of 24% was achieved. The surgical sponges were filled with the diluted bank blood following a previously determined plan inspired from previous studies.[8,9] In some cases, the sponges were first moistened with sodium chloride solution. This was supposed to symbolize the routine of sometimes moistening the surgical sponges before they are used in the surgical wound. The prepared surgical sponges were then placed in swab counting bags (a maximum of 5 in each) and were hung on portable swab racks. During the study, repeated inspections of the appearance of the stations were carried out by the 2 researchers to assess whether any changes had occurred that could affect the observations. Station 1 contained 150 mL of blood distributed over 2 surgical sponges (45 × 70 cm). Station 2 contained 100 mL of blood distributed over 5 surgical sponges (30 × 45 cm). Before the blood was added, these sponges were moistened with a previously determined amount of sodium chloride solution. Station 3 contained 100 mL of blood distributed over 5 surgical sponges (30 × 45 cm). Station 4 contained 1,100 mL of blood distributed over 20 surgical sponges (30 × 45 cm).

• ***Measures.*** The visual estimates of blood volume were stated in milliliters. The disparity between the correct amount and the estimated amount was then calculated. Before all analyses, these values were converted into percentage of deviation from the correct amount of blood. The correct amount of blood was given the value 0. Underestimates were designated with a minus sign and overestimates with a plus sign. For example, a 10-mL underestimation in a station consisting of 100 mL of blood was called −10%.

• ***Statistical Analyses.*** To assess whether the visual estimates statistically deviated from the correct amount of blood, we used the Wilcoxon signed rank test. A *P* value less than .05 was considered a statistically significant difference. Because this test could tell only whether the estimates differed from the correct value, not how they differed, frequency calculations were performed. The data were nonnormally distributed, and in an effort to minimize type II errors, we used median values (called the median percent) and quartile interval (interquartile range). To determine statistical differences among professions, we used the Kruskal-Wallis test, and in cases when only 2 variables were compared (eg, years of experience), the Mann-Whitney test was used.

• ***Ethical Consideration.*** The Declaration of Helsinki[14] formulates ethical principles that must be followed to protect participants in a study. These aspects were taken into account during the present study.

Results

A total of 163 observations were included in the study. The sample from the operating rooms consisted of 136 observations. The distribution between genders in this sample was 46% men (n = 62) and 54% women (n = 74). The age range was 25 to 67 years; mean age (SD) was 46 (11) years. The present study sample from the operating rooms represents approximately 70% of the number of employees (operating room nurses, CRNAs, and anesthesiologists) during this period. Surgeons at this hospital are consultants in the operating rooms. Because several surgeons can collaborate on a single surgery or one surgeon can perform multiple operations in one day, the number of available surgeons for the study was difficult to calculate. Students in their last term of nursing school (n = 27) were selected as a comparison group because of their nonexisting experience of visual estimation of blood loss. The distribution between genders among students was 7% (n = 2) men and 93% (n = 25) women. The ages in this group ranged between 21 and 42 years; mean age (SD) was 25 (5) years. The size of the sample corresponded to the number of last-term nursing students who were at the university that day. The characteristics of the included sample are presented in Table 1.

When we analyzed the blood loss estimates performed by operating room personnel, the results showed that in 3 of 4 stations (stations 1, 2, and 4) there was a statistically significant deviation between the correct amount and the visually estimated amount of blood in surgical sponges ($P < .001$). Further analysis showed that the differences consisted of underestimations between 33% and 59% (Figure 1). The students overestimated the amount of blood in 3 of 4 stations (stations 1, 2, and 3; Table 2). Stations 2 and 3 consisted of the same amount of blood, but in station 2 sodium chloride had also been added to the surgical sponges. In station 2, the surgical team's estimates were significantly inaccurate ($P < .001$), with an underestimation of 40%. In station 3, the team's median estimate was the same as the correct value (see Table 2).

The estimates in stations 1 to 4 followed the same pattern regardless of occupation (except for the surgeons), years of experience, gender, or self-assessed knowledge about visual estimation of blood loss in surgical sponges (Tables 2-4). No statistically significant deviations were seen in any of the 4 stations when we compared estimates among the occupations in the surgical team and those with less than or more than 10 years' experience (data not shown).

A total of 91% of the CRNAs answered that they possess knowledge about visual estimation of blood loss in surgical sponges. More than half of them (58%) responded that they are confident in their knowledge. This indicated that the CRNA was the pro-

Characteristic	ORNs	CRNAs	Anesthesiologists	Surgeons	Surgical team[a]	Students[b]	Total group
No. (%)	41 (25)	47 (29)	22 (14)	26 (17)	136 (83)	27 (17)	163 (100)
Sex, No. (%)							
Male	10 (24)	18 (38)	14 (64)	20 (77)	62 (46)	2 (7)	64 (39)
Female	31 (76)	29 (62)	8 (36)	6 (23)	74 (54)	25 (93)	99 (61)
Age, mean (SD), y	44 (11)	47 (12)	48 (9)	47 (11)	46 (11)	25 (5)	42 (10)
Years of experience, mean (SD)	14 (13)[c]	17 (14)[c]	18 (11)	17 (10)	17 (12)[c]	0 (0)	13 (10)[c]
With self-assessed knowledge, No. (%)	11 (27)	43 (91)	10 (45)[d]	4 (15)	68 (50)[d]	0 (0)	68 (42)[d]
Confident in the knowledge[e]	3 (27)	25 (58)[f]	6 (60)[d]	2 (50)[f]	36 (53)[d,f]	0 (0)	36 (53)[d,f]
Uncertain of knowledge[g]	8 (73)	16 (37)[f]	4 (40)[d]	1 (25)[f]	29 (43)[d,f]	0 (0)	29 (43)[d,f]
Without self-assessed knowledge, No. (%)	30 (73)	4 (9)	11 (50)[d]	22 (85)	67 (49)[d]	27 (100)	94 (58)[d]

Table 1. Sample Characteristics and Knowledge About Visual Estimation of Blood Loss in Surgical Sponges

Abbreviations: ORN, operating room nurse; CRNA, Certified Registered Nurse Anesthetist.
[a]ORNs, CRNAs, anesthesiologists, and surgeons.
[b]Students in their final year of nursing school.
[c]Five participants did not respond to the question of working experience: 2 ORNs and 3 CRNAs.
[d]One anesthesiologist did not answer the question about knowledge of visual estimation of blood loss in surgical sponges.
[e]Members of the surgical team who trust their knowledge in such a way that they could share it with others.
[f]Three participants did not answer whether they trust their knowledge in such a way that they could share it with others or not: 2 CRNAs and 1 surgeon.
[g]Members of the surgical team who do not trust their knowledge in such a way that they would share it with others.

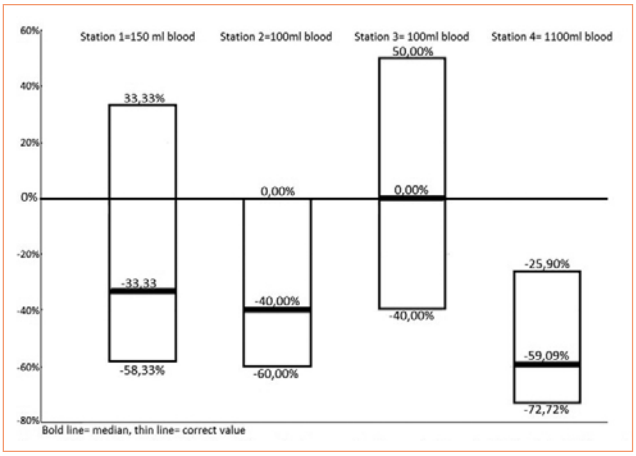

Figure 1. Estimation of Blood Volume in Surgical Sponges, by Surgical Team in Stations (Median Percent)

fessional who felt most confident in his or her ability for visual estimation. The conditions were close to the reverse among the surgeons, of whom 85% stated that they have no knowledge in the matter (Table 1). Estimates from CRNAs who trust their knowledge and from surgeons who expressed that they possess no knowledge were compared with each other. Both categories underestimated the blood volume in stations 1, 2, and 4. The CRNAs tended to underestimate more than surgeons did (Figure 2, Table 4), whose deviation from the correct amount of blood loss was larger in all but 1 station.

In a comparison between estimates performed by male and female personnel in the surgical department, a statistically significant difference was seen in station 1, where the men underestimated more than the women did (Figure 3).

A statistically significant difference was seen in 3 of the 4 stations when estimates from the surgical team were compared with estimates performed by students (data not shown).

Discussion

This study highlights that visual assessments of blood loss, performed by operating room personnel, might not be patient-safe because this method is often proved to be inaccurate. Similar results have also been shown in prior studies conducted in surgical departments.[15,16] Both overestimates and underestimates occurred in the present study. Underestimates dominated and tended to increase in the station symbolizing major bleeding. Regardless of profession, years of experience, and self-assessed knowledge about visual estimation of blood loss, the estimated amount differed from the correct amount by more than 30%. This result is similar to that of a study in which visual estimates of postpartum hemorrhage, performed by obstetricians and midwives, significantly differed from the correct amounts by 30%.[17]

Bleeding must be measured, and a great deal of this

Station[b]	ORNs (n = 41)	P value	CRNAs (n =47)	P value	Anesthesiologists (n = 22)	P value	Surgeons (n = 26)	P value	Surgical team (n = 136)	P value	Students (n = 27)	P value
1	−33 (−60 to 33)	.071	−33 (−67 to 0)	< .001	−33 (−60 to 0)	.037	0 (−45 to 42)	.807	−33 (−58 to 33)	< .001	33 (−47 to 167)	.021
2	−25 (−60 to 0)	.013	−50 (−60 to −25)	< .001	−40 (−53 to −8)	.038	−28 (−54 to 21)	.053	−40 (−60 to 0)	< .001	50 (−50 to 150)	.015
3	0 (−50 to 75)	.317	0 (−40 to 10)	.837	0 (−30 to 50)	.383	38 (−50 to 100)	.044	0 (−40 to 50)	.059	100 (−25 to 250)	.002
4	−64 (−73 to −11)	< .001	−63 (−73 to 45)	< .001	−36 (−69 to −9)	.003	−57 (−73 to 7)	< .001	−59 (−73 to −26)	< .001	−36 (−64 to 9)	.035

Table 2. Median Percent Deviation (Interquartile Range) from Correct Value in Estimated Blood Volume, by Occupation[a]

Abbreviations: ORN, operating room nurse; CRNA, Certified Registered Nurse Anesthetist.

[a]Interquartile range is the difference between the first and third quartiles. Negative values indicate underestimation; positive values, overestimation; 0, no deviation. Statistical significance was set at less than .05 with the Kruskal-Wallis test.

[b]Station 1, 150 mL blood, 2 sponges (45 × 70 cm); station 2, 100 mL blood, 5 sponges (30 × 45 cm); station 3, 100 mL blood, 5 sponges (30 × 45 cm); station 4, 1,100 mL blood, 20 sponges (30 × 45 cm).

Station[b]	Experience < 10 y (n = 51)	P value	Experience > 10 y (n = 80)	P value	No knowledge[c] (n = 67)	P value	Knowledge[d] (n = 68)	P value	Confident in knowledge[e] (n = 36)	P value	Uncertain of knowledge[f] (n = 29)	P value
1	−33 (−60 to 33)	.013	−33 (−53 to 33)	< .019	−33 (−53 to 33)	.045	−33 (−58 to 33)	.004	−33 (−48 to 25)	.005	−33 (−67 to 33)	.191
2	−30 (−60 to 0)	< .001	−50 (−60 to 0)	< .001	−40 (−60 to 0)	< .001	−48 (−58 to 0)	< .001	−35 (−60 to 0)	.018	−50 (−50 to 0)	< .001
3	0 (−50 to 50)	.709	0 (−30 to 71)	.034	0 (−40 to 50)	.319	0 (−38 to 50)	.084	0 (−24 to 69)	.051	0 (−40 to 75)	.492
4	−64 (−73 to −36)	< .001	−57 (−73 to −11)	< .001	−55 (−73 to 9)	< .001	−59 (−73 to −33)	< .001	−59 (−73 to −30)	< .001	−62 (−68 to −30)	< .001

Table 3. Deviation in Estimations of Surgical Team, by Knowledge[a]

[a]Median deviation (interquartile range, the difference between the first and third quartiles) from correct value of blood volume, in percent. Negative values indicate underestimation; positive values, overestimation; 0, no deviation. Statistical significance was set at less than .05 with the Mann-Whitney test.

[b]Station 1, 150 mL blood, 2 sponges (45 × 70 cm); station 2, 100 mL blood, 5 sponges (30 × 45 cm); station 3, 100 mL blood, 5 sponges (30 × 45 cm); station 4, 1,100 mL blood, 20 sponges (30 × 45 cm).

[c]No self-assessed knowledge about visual estimation of blood loss in surgical sponges.w

[d]Self-assessed knowledge about visual estimation of blood loss in surgical sponges.

[e]Trust their self-assessed knowledge and felt they could share it with others; 1 anesthetist did not answer the question.

fDo not trust their self-assessed knowledge in a way that they would share it with others.

Station[b]	CRNAs who trust their knowledge[c] (n = 25)	P value	Surgeons with no knowledge[d] (n = 22)	P value	Men (n = 62)	P value	Women (n = 74)	P value
1	−33 (−67 to 0)	.002	−10 (−51 to 33)	.778	−33 (−60 to 0)	< .001	−33 (−55 to 33)	.217
2	−50 (−65 to −10)	< .001	−28 (−54 to 26)	.116	−45 (−65 to 0)	< .001	−34 (−50 to 0)	< .001
3	0 (−33 to 50)	.445	38 (−43 to 100)	.057	−3 (−50 to 50)	.609	0 (−30 to 56)	.039
4	−59 (−73 to −41)	< .001	−53 (−73 to −7)	< .001	−59 (−73 to −27)	< .001	−59 (−73 to −13)	< .001

Table 4. Surgical Team's Deviations in Estimations, by Experience of Selected Provider and Gender[a]

[a]Median deviation (interquartile range, the difference between the first and third quartiles) from correct value of blood volume, in percent. Negative values indicate underestimation; positive values, overestimation; 0, no deviation. Statistical significance was set at less than .05 with the Mann-Whitney test.

[b]Station 1, 150 mL blood, 2 sponges (45 × 70 cm); station 2, 100 mL blood, 5 sponges (30 × 45 cm); station 3, 100 mL blood, 5 sponges (30 × 45 cm); station 4, 1,100 mL blood, 20 sponges (30 × 45 cm).

[c]Trust their self-assessed knowledge and felt they could share it with others.

[d]No self-assessed knowledge about visual estimation of blood loss in surgical sponges.

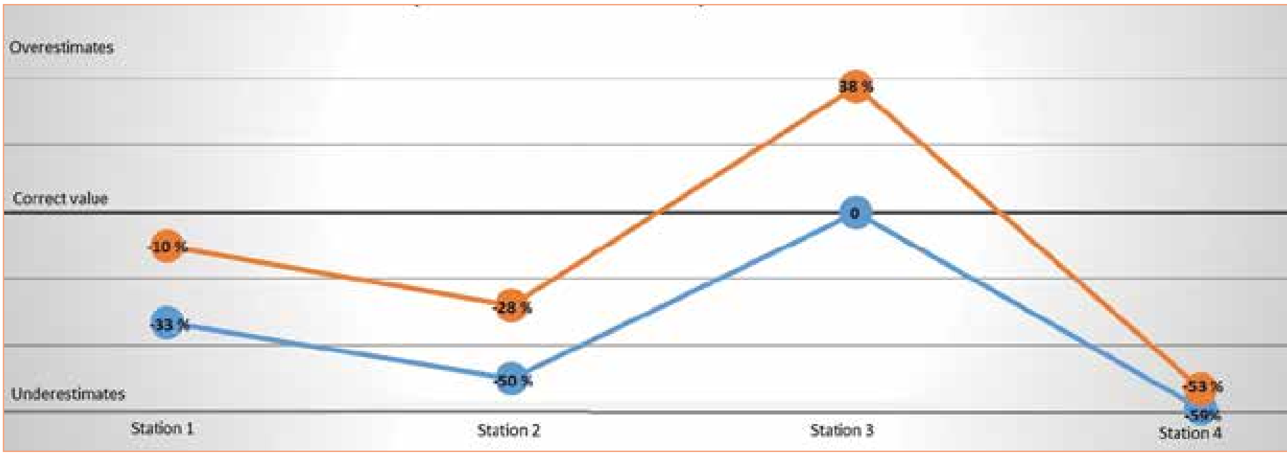

Figure 2. Estimation Median for Each Station, by CRNAs (Blue Line) and Surgeons (Orange Line)[a]
Abbreviation: CRNA, Certified Registered Nurse Anesthetist.
[a]Median value of the estimates of blood loss, in percent. These 25 CRNAs reported feeling that they could share their knowledge with others, whereas these 22 surgeons reported having no knowledge of visually assessing blood loss.

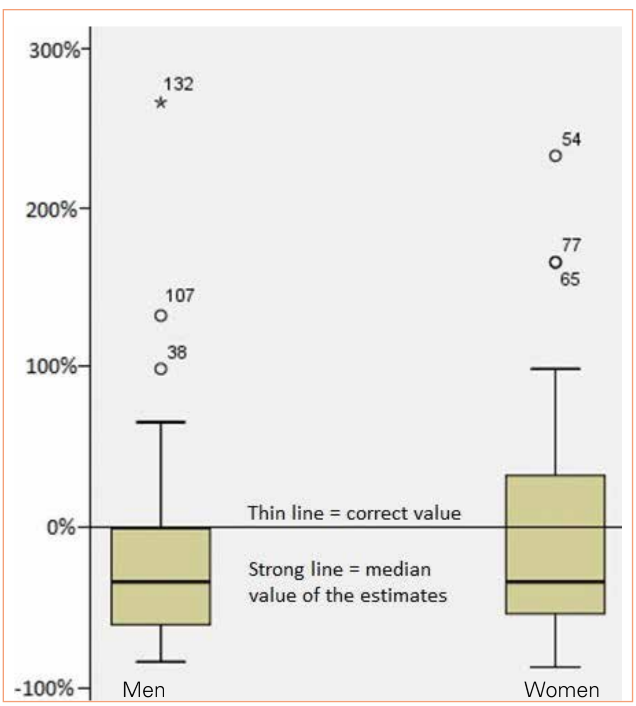

Figure 3. Median Deviation (Percent) From Correct Value in Station 1, by Men and Women on Surgical Team[a]
[a]Asterisk indicates; circles, number of observations.

assessment is done visually without training for the task or written guidelines on how to do it. Bleeding that is incorrectly assessed may pose an increased risk to the patient. Overestimates and underestimates can both lead to complications, because either incorrect replacement of volume or nonreplacement can lead to negative consequences for the patient.[5] An *error* in healthcare is defined as a planned action not completed as intended or the use of a wrong method.[18] Individuals are not to be accused for their incorrect estimates. Individual mistakes are founded in poor systems, not in imperfect humans.[19] A patient-safe culture is found in an organization in which healthcare professionals provide education and training in a supportive environment.[20] Studies in maternity care, where staff visually estimated the amount of blood in simulated blood loss stations, highlight the importance of education in this area. Interventions were carried out where training was provided. The results show improved estimates after the interventions.[12,21] Toledo et al[21] showed an improvement of about 30%, but the study also showed that training needed to be repeated.

In our study, the various professions' estimates of blood loss showed differences. The surgeons tended to overestimate small amounts of blood rather than underestimate them. Estimates by operating room nurses were closer to the correct amount than were the other professional categories when the surgical sponges had first been moistened with sodium chloride before blood was added. In Sweden, CRNAs are responsible for assessing and reporting blood loss, and the anesthetists are responsible for volume replacement during surgery. Operating room nurses and surgeons do not calculate bleeding during surgery but are highly involved in the surgical area and may have another visual dimension of the bleeding compared with the anesthesia staff. The result of a collaboration, where different experiences are linked, often reaches beyond each individual's performance. According to Leape,[19] medical care ought to be patient-centered and carried out with interprofessional teamwork to be patient-safe. It would be interesting to further investigate whether a collaboration between the different professions improve visual estimation.

Years of experience do not appear to be a significant factor for accuracy when estimating blood loss,[9,10,17] as the results from this study also indicate. When we compared estimates made by men and women in the operating rooms, the men underestimated more than the women did in station 1. In the 3 other stations, no differences in the estimates could be seen. It is therefore not possible to draw further conclusions from this result. Adkins et al[9] were also not able to demonstrate any difference in estimates based on the gender of the person estimating.

Self-assessed knowledge about visual estimation of blood loss in surgical sponges seems not to be an indication for correctness in the estimates. At the hospital in this study the CRNAs are responsible for determining the blood loss during surgery. Therefore, it is not surprising that they were the profession who expressed best confidence in this task. In this study, CRNAs who trusted their knowledge in such a way that they felt they could share it with others tended to underestimate the most. On the other hand, those who claimed that they had no knowledge of how to estimate were the closest to the correct amount. The definition of knowledge about visual estimation was made individually by all participants, as no description was presented in the form, nor were tests performed to determine the participants' knowledge. A previous study has shown that education improves visual estimations but that the skills decline over time.[12] This indicates that education about visual estimation must be repetitive to be useful.

The results of this study showed that persons with no prior experience of seeing blood presented in these amounts overestimated small amounts of blood, whereas the surgical team with experience almost exclusively underestimated the bleeding. Other studies share similar results.[22,23]

Studies have shown that objective methods, such as scanners, scales, or complex analysis of the patient's blood, better estimate blood loss during surgery, compared with subjective methods.[5,24-26] These methods, however, are expensive and often too time-consuming for practical use.[27] The objective method of assessing blood amount by weight is not particularly advanced or costly.[17] However, a scale does not give an absolute answer to the correct amount of blood because it cannot determine whether the blood is mixed with other liquids. This is highlighted in the study conducted by Holmes et al,[28] in which the gravimetric method demonstrated an overestimation because of the presence of contaminants other than blood. In this study, 2 stations contained the same number of surgical sponges with the same amount of blood. Had a scale been used, the amount of blood would have been overestimated in one of the stations; this because of the weight from the sodium chloride solution that had also been added. On the other hand, the visual assessments from that station showed underestimates, probably because the blood had a paler appearance and was therefore perceived as a smaller amount. This highlights the weaknesses of both methods and also the difficulty when combining them. A combination of a scale and visual estimates that are based on education and training should increase the chances for a correct assessment. As described by the Institute of Medicine (now the National Academy of Medicine)[18] in 2000, standardized guidelines are recommended as a part of patient-safe work, where the standards become part of the care of the patient. The introduction of a standardized way for operating room nurses to communicate what they see in the surgical field, how heavy the surgical swabs are, and if they are filled with liquids other than blood would offer further improvements to ensure a correct assessment.

• ***Study Limitations.*** Four stations consisting of different amounts of surgical sponges with different amounts of blood were created. The fabrication of the stations was limited by the amount of blood available from the blood bank. Previous studies with the same structure as this study have pointed out the unnatural appearance of moulage blood as a weakness.[9,11] Therefore, with the aim to make the study as authentic as possible, we decided that it was better to use a limited amount of real blood instead of moulage blood. To make this study even more authentic, however, Hct in the moulage blood should have been higher in stations 1 to 3 than in station 4, which represented a larger amount of blood. Finally, the small sample might be a confounding factor of the study.

• ***Implications and Recommendations.*** To ensure adequate care of the patient during surgery, correct competence for every task must be guaranteed, competence must be maintained, and the right techniques must be used. The competence to visually estimate blood loss during surgery is maintained and improved by education. Regardless of how the training is designed, for example, web-based education or scenario training, it seems to be of importance that the training is repetitive. For further improvement of this task, we suggest that training be performed collectively in the surgical team. In cooperation with the surgeons, operating room nurses should assess, using a standardized template, whether the blood in the surgical sponges is blended with other solutions during the operation. The visual estimates should also be combined with weighing the sponges. Guidelines should be formulated describing, in text and by pictures, the appearance of sponges containing different amounts of blood.

The importance of this study is that it pays attention to the lack of routines considering visual estimation of blood loss in surgical sponges during surgery. It is suggested that further research in this area be concerned with designing standardized guidelines and training the surgical team in visual estimation of blood loss. The findings suggest that studies are needed that review patients' postoperative conditions related to correct vs incorrect management of blood loss. Incorrect blood replacement might cause some of the postoperative complications that our patients experience.

Conclusion

The results of this study demonstrate that visual estimation of operative blood loss is unreliable and therefore not a patient-safe method. The ability to visually estimate the correct amount of blood in surgical sponges was not related to profession, years of experience, or knowledge of visual estimation.

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