Concordance Between Actual and Estimated Blood Loss: A Bleeding Calculation Simulation Exercise

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KEYWORDS

Bleeding estimation, simulation exercise, resident physicians and physicians assigned to Gynecology and Obstetrics

ABSTRACT

Introduction: Historically, visual estimation of blood loss during and after delivery has been the primary method for determining obstetric blood loss. This method is quick, easy, and cost-free, and it allows for the prompt identification of suspected postpartum hemorrhage. However, the majority of clinical studies concur that this method is imprecise and may underestimate the extent of bleeding produced during vaginal delivery. **Objectives:** The objective of this study was to compare the concordance between the estimated blood loss observed visually by physicians and residents of Gynecology and Obstetrics and the actual bleeding observed in a simulation exercise, with the aim of calculating the bleeding. **terial and methods:** A quasi-experimental study was conducted through the use of a simulation model at the General Hospital of Zone 20 of the IMSS in Puebla. A visual estimation was conducted between physicians and residents using surgical material (compresses and gauze) with a certain amount of blood. The evaluation of the estimate was carried out in three stations with different bleeding levels. The estimation of total bleeding was counted in milliliters using the visual method. A comparison of means was conducted using the ANOVA statistical test to evaluate the bleeding calculation. The relative error was calculated in order to determine the extent of agreement between the estimated and actual blood values for each station. **Results:** A total of 94 physicians, including residents in training in the specialty of Gynecology and Obstetrics, enrolled in the study. The discrepancy between the actual and estimated blood loss in a simulation exercise among affiliated obstetrician-gynecologists was 65.3%, while in the group of resident physicians it was 145.6%. It was determined that there was an 84% overestimation of bleeding. The relative error percentage for "Scenario A" was 141%, "Scenario C" yielded a result of 85%, and "Scenario B" produced a result of 74%. **Conclusion:** The agreement between the actual and estimated blood loss performed by obstetrician-gynecologists assigned to a bleeding calculation simulation exercise is slightly superior to that obtained by resident physicians. The lowest percentages of relative error were obtained by fourth- and third-year residents.

1. Introduction

Historically, visual estimation of blood loss during and after delivery has been the primary method for determining obstetric blood loss. This method is advantageous due to its expediency, simplicity, and cost-effectiveness in addressing suspected postpartum hemorrhage (1, 2, 3).

The visual method entails a visual count of compresses and gauze soaked with blood, which are then multiplied by the estimated volume of blood they carry. Additionally, the measurement of blood in suction bottles and the estimation of the amount present in and around the surgical field are conducted (4). Despite its widespread use due to its practicality, this method has been found to be inaccurate for estimating blood loss.

To ascertain the impact of calibrated drapes on blood loss estimation, P. Toledo and R.J. McCarthy devised a study in a simulated setting involving gynecologists and gynecology residents. This involved the establishment of a bleeding calculation utilizing collection bags with and without volume calibration at eight distinct stations. Calibrations commenced at 500 mL, with increments of 500 mL up to a total of 2500 mL. Each drape contained a known volume of blood, urine, and a specified number of surgical sponges. Each participant observed either the four calibrated stations or the four uncalibrated stations, after which they proceeded to the subsequent stations. The outcome variables were the accuracy of the estimated blood volume, and the effects based on the provider type, level of training, and years of experience. No differences were observed in the demographic variables of gender, level of training, or years of experience between the participants who began with the uncalibrated cloths and those who began with the calibrated cloths. However, it was

observed that the accuracy of estimated blood volume worsened with increasing blood volume in subjects who viewed the uncalibrated drapes first. The error ranged from 16% at 300 mL to 41% at 2000 mL, which was statistically significant ($P < 0.05$). The overall error in estimated blood volume was less than 15% across all volumes when uncalibrated drapes were observed first. The underestimation of estimated blood volume was reduced by 9% to 11% at the 2000 mL level when calibrated drapes were used, in comparison to 41% when uncalibrated drapes were used. In conclusion, the use of a calibrated gravimetric system provides greater accuracy in the estimation of transoperative bleeding.

Martínez et al. conducted an observational clinical study to determine the concordance between the visual estimate of hemorrhage and actual blood volumes. The study involved 30 anesthesiologists and 18 resident physicians, who estimated the volume of blood impregnated in surgical material in milliliters. An overestimation of bleeding was observed in 59.8% of the estimates. The authors concluded that the visual estimation by anesthesiologists exhibited a poor degree of agreement with the actual amount of fresh total blood impregnated in various materials.

In our country, the clinical practice guideline on the diagnosis and treatment of hemorrhagic shock in obstetrics, as updated in 2017, states that the visual method underestimates blood loss by 33-50%. It also cites a prospective cohort study which reports a significant difference between blood loss determined by the gravimetric method and visual estimation, with the former being 30% higher (7).

The present research establishes the foundation for an initial diagnosis of the true precision and accuracy of gynecologists in estimating postpartum bleeding visually at HGZ20 Hospital.

2. Methodology

The research was submitted for evaluation and authorization by the Local Committee of Ethics and Health Research and was assigned the registration number R-2019-2106-042.

A prospective, comparative, and quasi-experimental study was designed at the General Hospital of Zone Number 20 in the city of Puebla, Mexico.

The study population consisted of gynecologists and obstetricians affiliated with HGZ 20 and medical practitioners enrolled in the gynecology and obstetrics specialization program at HGZ 20 between 2022 and 2023. The total number of participants enrolled during the study period, which spanned from April 2023 to June 2023, was 94.

The researchers devised a scenario to simulate postpartum bleeding, utilizing surgical materials (gauze and compresses) covered with varying quantities of constituted blood.

The constituted blood was prepared using erythrocyte concentrates stored in bags, provided by the blood bank of the HGZ 20 hospital, which had reached their expiration date. These were mixed with a 0.9% saline solution.

The surgical material was distributed in three scenarios of varying degrees of simulated postpartum bleeding: scenario A, representing minimal bleeding, contained 50ml of constituted blood; scenario B, representing moderate bleeding, contained 267.5ml; and scenario C, representing severe obstetric hemorrhage, contained 950ml.

The researchers requested the voluntary participation of all gynecologists-obstetricians and gynecology residents attached to HGZ 20, who were permitted to choose the date of their participation according to their convenience.

The participants were permitted five to ten minutes to make their estimation. At the conclusion of the exercise, they recorded the calculated bleeding at each station on the data collection sheet.

The variables subjected to analysis were as follows: The participants were divided into two categories: Resident Doctor and Attached Physician. For the resident doctors, we assessed the degree of residency, and for the attached doctors, we assessed the work shift, years of experience as a gynecologist, age, and gender.

The means were compared at the three stations using the ANOVA statistical test to assess the bleeding calculations of the study group. The accuracy of the estimates was calculated by determining the relative error. This was done by comparing the actual bleeding volume in milliliters with the values quantified by the gynecologists and gynecology

residents participating in the study. These values were expressed as percentages, with 0% indicating perfect agreement and no error in the estimates. An absolute error was calculated in order to determine the number of instances where the estimate was underestimated.

The financial resources were provided by the researchers and the Mexican Institute of Social Security.

The research was feasible due to the availability of sufficient material and human resources, as well as the necessary infrastructure in the research location

3. Results and Discussion

A total of 53 OB-GYNs and 41 GYN residents participated in the study from April 2023 to June 2023.

The distribution of the medical specialists analyzed is presented in Figure 1.

Figure 1. Flowchart of the classification of the participants in the study.

Demographic characteristics of each participating group:

Gender. In both groups of resident and affiliated physicians, there was a predominance of the female gender, but no differences p*=0.73 were shown.*

Age and Years of experience. Table 1 shows the differences in age and years of experience *p<0,000.*

Demographic characteristics of the participants.

Variable	Resident physicians	Enrolled physicians
Age	**29.2 ± 3.79**	**44.4 ± 7.9**
Years of experience	**1 ± 0.8**	**17.5 ± 7.4**
Gender	**Male: 14** **Female: 27**	**Male: 20** **Female: 33**

Table 1. The mean and standard deviation of age and years of experience of the study participants are shown.

In Table 2, the academic degree of the gynecology residents and the shift distribution of the attached gynecologist-obstetricians are shown.

Degree of residency	Number of participants	Category: Affiliated Physicians	Number of participants
First Grade	12	**Substitute Physicians**	10
Second grade	20	**Morning shift**	18
Third Grade	6	**Evening round**	11
Fourth Grade	3	**Night shift and accumulated working day**	14
Total	41	**Total**	53

Table 2. Gynecology residents and their degree in residency and categories among obstetrician-gynecologists.

The following Figures (1, 2 and 3) show the estimates made by our study group in each scenario

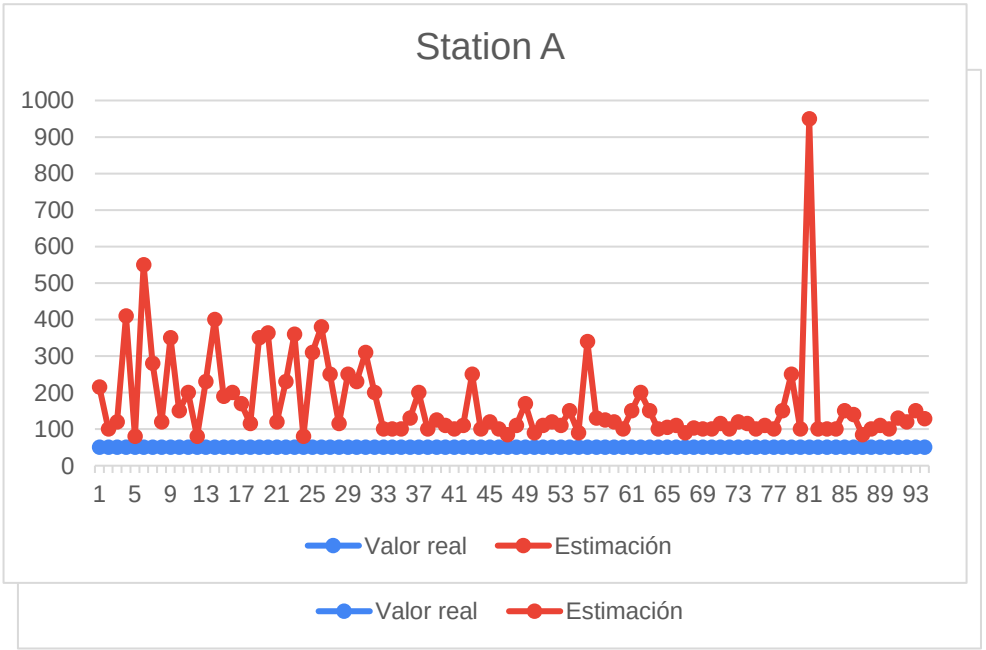

Figure 1. The amount of blood estimated by the participants in station A "low bleeding" is shown in red, in blue the actual value of blood.

Figure 2. The amount of blood estimated by the participants in station B "moderate bleeding" is shown in red, in blue the actual blood value.

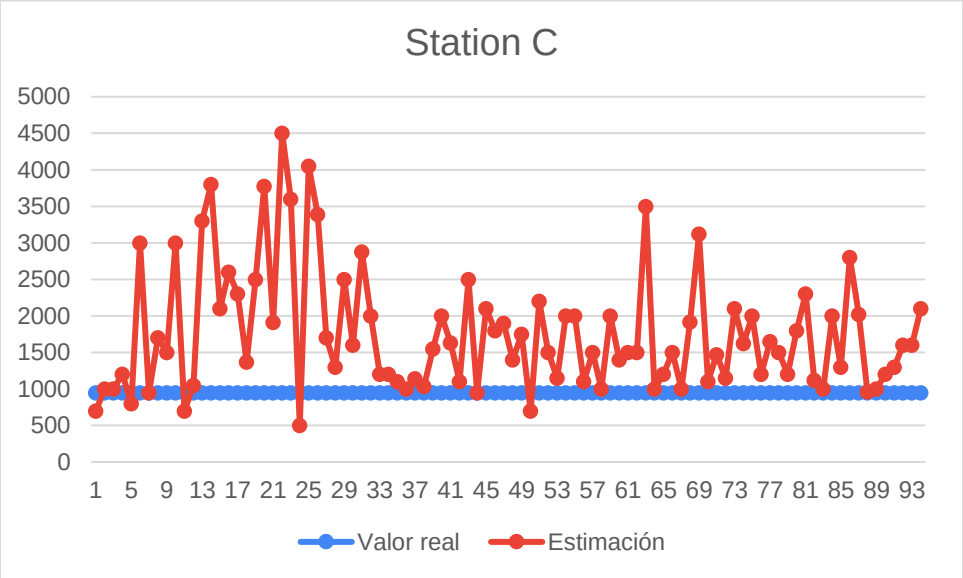

Figure 3. The amount of blood estimated by the participants in station C "obstetric hemorrhage" is shown in red, in blue the actual blood value.

The mean score at each station was different between the groups *p<0.05, at the different stations, at the first station F=2.392, p< 0.02, second station F=4.46, p* <0.00, third station F=5.13, *p<0.00.*

On the other hand, when analyzing the scores between obstetrician-gynecologists and residents, it can be seen that there were differences in agreement and station A - B, *p=0.007, in station C and concordance C, there were no differences.*

The relative error was calculated to determine if the estimates matched the actual blood value at each station. The relative error obtained at each station was graphed (Figure 4A) and compared the relative error between the affiliated physicians and the residents (Figure 4B).

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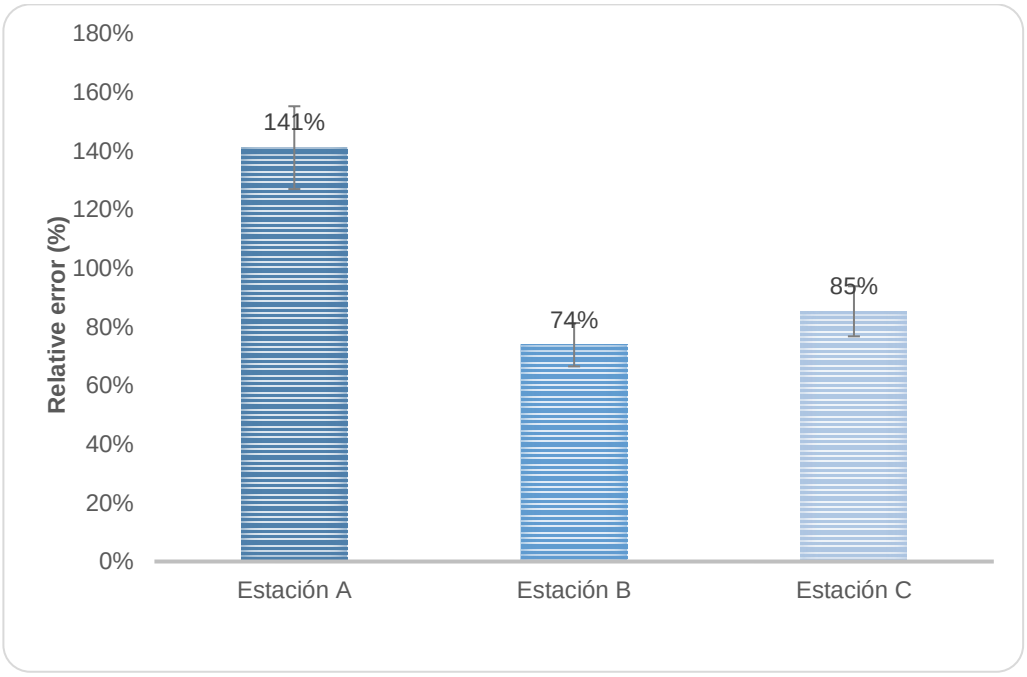

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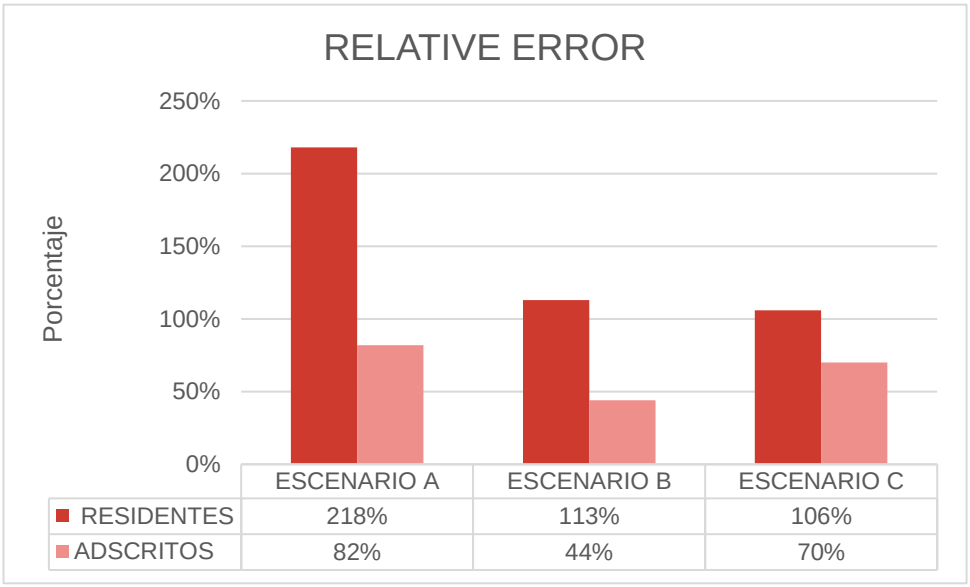
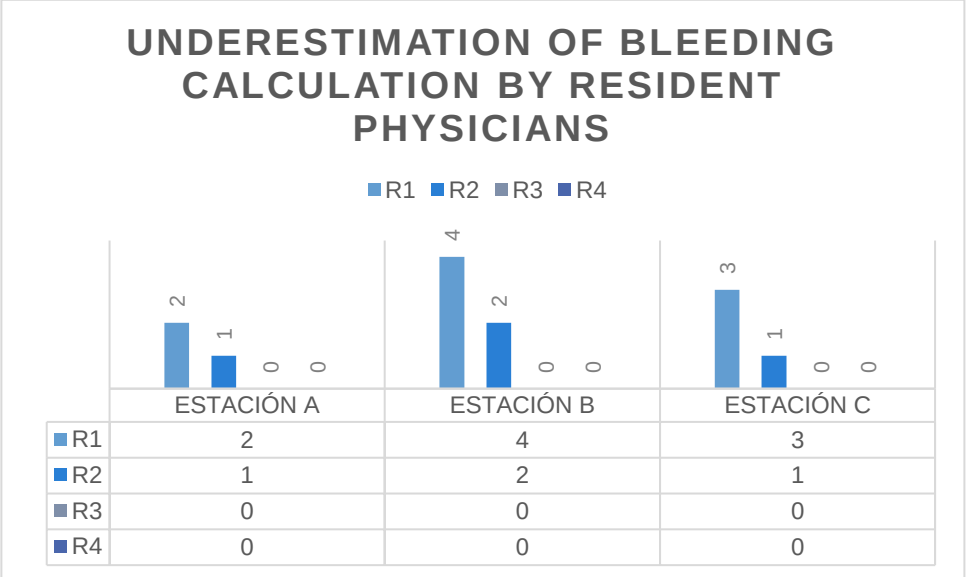


Figure 4. A. Relative error obtained in the different stations (scenario A: 50 ml, stage B: 267.5 ml and scenario C: 950 ml of blood). **B.** Comparison between resident and seconded physicians.

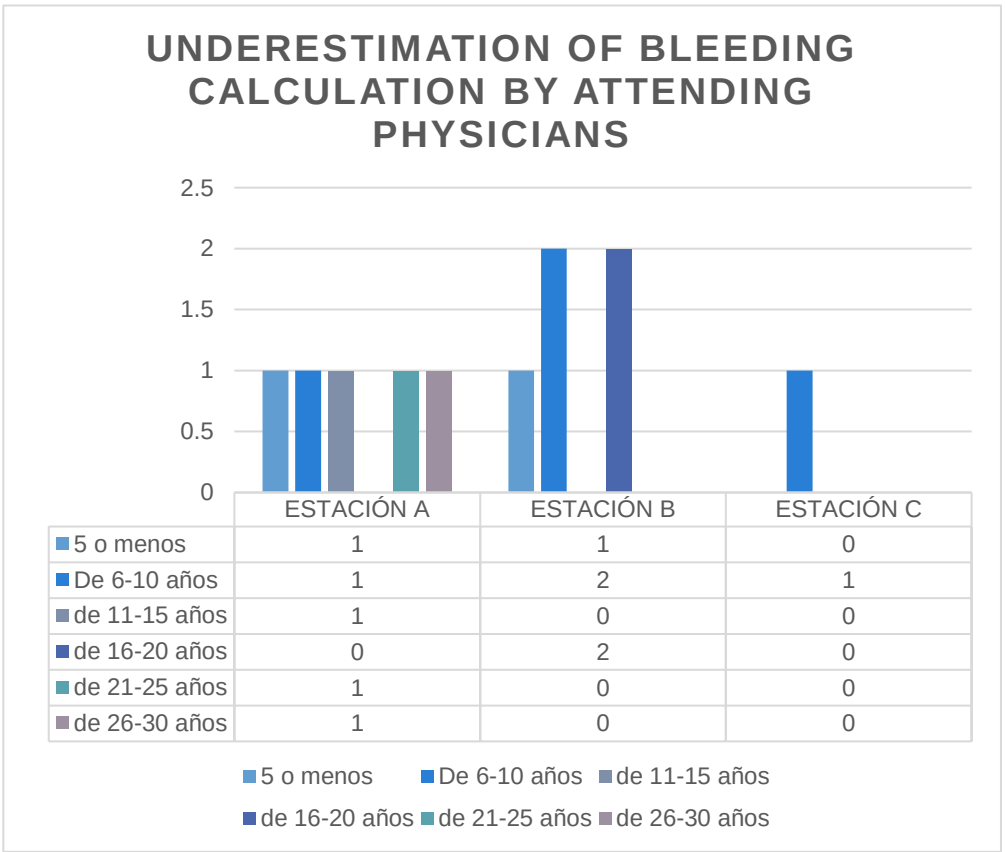
To obtain the underestimates made by gynecology residents, we determined those with a negative absolute error value (Figure 5).



	ESTACIÓN A	ESTACIÓN B	ESTACIÓN C
R1	2	4	3
R2	1	2	1
R3	0	0	0
R4	0	0	0

Figure 5: The degrees of residence of the participants and the number of underestimates obtained in the different stations are shown.

The absolute error was determined with a negative value of the visual estimates made by the attached gynecologist-obstetricians according to their years of experience (Figure 6).



	ESTACIÓN A	ESTACIÓN B	ESTACIÓN C
5 o menos	1	1	0
De 6-10 años	1	2	1
de 11-15 años	1	0	0
de 16-20 años	0	2	0
de 21-25 años	1	0	0
de 26-30 años	1	0	0

Figure 6: The number of underestimates at each station is shown according to the degree of experience of the obstetrician-gynecologists.

The measures of central tendency (mean and median) were applied tin the estimates made by the group of gynecology residents (Table 3).

GYNECOLOGY RESIDENT PHYSICIAN ESTIMATES

DEGREE	**STATION A**		**STATION B**		**STATION C**	
	Median	Min-Max	Median	Min-Max	Median	Min-Max
R1	125	(30-360)	360	(30-1500)	1025	(700-3000)
R2	180	(65-350)	822.5	(100-1250)	2500	(500-4500)
R3	50	(50-150)	327.5	(270-600)	1120	(1000-1200)
R4	61	(50-75)	460	(285-550)	1630	(1550-2000)

Table 3: The median, minimum and maximum of the estimates made at stations A, B and C by the group of gynecology residents of the General Hospital of Zone Number 20 are shown.

Note in Table 4, the measures of central tendency (mean and median) was applied in the estimates made by the group of gynecologist-obstetricians attached to it, taking into account the years of experience and according to their shift.

ESTIMATES OF THE ATTACHED OBSTETRICIAN-GYNECOLOGISTS

YEARS OF EXPERIENCE/ CATEGORY	STATION A		STATION B		STATION C	
	MEDIAN	Min-Max	MEDIAN	Min-Max	MEDIAN	Min-Max
5 or less	51.5	(40-70)	320	(250-550)	1650	(1000-3120)
From 6-10 years old	50	(40-60)	300	(220-350)	1100	(700-1400)
From 11-15 years old	60	(35-150)	350	(300-1000)	1500	(960-3500)
From 16-20 years old	65	(50-200)	320	(250-600)	1470	(1000-2500)
From 21-25 years old	80	(50-290)	320	(280-640)	1600	(1100-2800)
From 26-30 years old	70	(40-900)	430	(300-700)	2000	(1500-2300)
Morning	62.5	(35-290)	367.5	(250-600)	1562.5	(950-2500)
Evening	60	(40-150)	350	(220-1000	1500	(700-3500)

				)		
Substitute	57.5	(40-200)	335	(250-550)	1500	(1000 - 3120)
Day/Night	60	(35-900)	300	(250-700)	1600	(960-2800)

Table 4: The median, minimum and maximum estimates made at stations A, B and C by the group of gynaecologist-obstetricians attached to the General Hospital of Zone Number 20 according to their years of experience and according to their work shift are shown.

The average relative error of gynecology residents was compared according to their specialty grade (Table 5).

RELATIVE ERROR OF GYNECOLOGY RESIDENT PHYSICIAN ESTIMATES

DEGREE	**STATION A**	**STATION B**	**STATION C**	**AVERAGE**
R1	243%	77%	46%	122%
R2	286%	166%	172%	208%
R3	43%	36%	17%	32%
R4	23%	61%	82%	55%

Table 5: The degree of residence and the average of the relative error obtained in the different stations are shown. "R1". First-year resident, "R2" Second-year resident, "R3". Third-year resident, "R4". Fourth-year resident.

The average relative error of the gynecologist-obstetricians assigned was compared according to their years of experience and according to their category (Table 6).

ABSOLUTE ERROR IN THE ESTIMATES OF THE GYNAECOLOGIST-OBSTETRICIANS ATTACHED TO IT

YEARS OF EXPERIENCE	STATION A	STATION B	STATION C	AVERAGE
5 or less	12%	38%	79%	43%
From 6-10 years old	8%	17%	40%	23%
More than 10 years	216%	63%	78%	119%
Substitutes	52%	42%	72%	55.3%
Morning	75%	42%	68%	61.6%
Evening	45%	72%	69%	62%
Accumulated working hours and Night	155%	30%	74%	86.3%

Table 6: The years of experience of the attached obstetrician-gynecologists and the average of the relative error obtained in the different stations are shown.

DISCUSSION

The hypothesis posits that the group of affiliated gynecologists exhibited the lowest percentage of relative error in all scenarios, compared to the group of residents. This result is consistent with the findings of Martínez-Ramírez, who observed that anesthesiologists exhibited greater agreement than residents in their estimates.

A relative error percentage of 100% indicates a lack of agreement with the visual method for estimating bleeding, thereby supporting the hypothesis. However, this result is cause for concern, as it is considerably higher than that reported by the researchers. For example, Lerthbunnaphong's group indicates that the visual estimate was up to 31% less accurate than the objective measurement.

The existing literature indicates a tendency for observers to overestimate low volumes of transoperative bleeding and underestimate high volumes. In our study, however, of the 282 estimates obtained, only 23 instances (8.15%) involved underestimation of bleeding, while 84% involved overestimation. This figure is considerably higher than that reported by Martínez et al., who found that 59.8% of estimates were overestimates. This finding contrasts with those of the studies by Lerthbunnaphong et al. and Rubenstein's group, which indicate a higher rate of underestimation with the visual method.

While Blosser et al. observed an underestimation in cases of bleeding greater than 1000 ml and a tendency towards overestimation in instances of bleeding less than 1000 ml, our study revealed a consistent pattern of overestimation across all scenarios.

The scenario with the highest incidence of underestimation was that of "moderate bleeding," while in the scenario of "obstetric hemorrhage," the rate of underestimations was the lowest. This finding contrasts with those of authors such as Withanathantrige and Coviello, who observed greater underestimation when the bleeding was greater than 300 ml of blood.

In the obstetric hemorrhage scenario, the mean estimate obtained via the visual method was 1760.69 ml, with an average overestimation of 810 ml. This figure is considerably higher than that reported in the research conducted at the Prentice Women's Hospital, which indicated an overestimation of 300ml for every 1000ml of bleeding.

These findings appear to align with those of Ponteiro's group, exhibiting a proclivity for overestimation of medium and high blood volumes.

A review of the data revealed that fourth- and third-year residents exhibited the lowest rates of relative error. In contrast, second-year residents exhibited the highest average relative error across all scenarios, reaching 208%.

Although it can be assumed that more experienced physicians have higher accuracy compared to novice physicians, the results of our study indicate that the group of affiliated OB-GYNs with 6-10 years of experience obtained the lowest relative error percentage compared to the group with more than 10 years of experience. Ponteiro et al. (2020) also observed a similar trend, with the group with the lowest error having more than 10 years of experience, followed by the group with more than 10 years of experience. In contrast, the findings indicated that the group with less than 5 years of experience demonstrated better agreement than the group with more than 10 years of experience.

The results of the analysis of the obstetrician-gynecologists assigned according to their work shift revealed that the "substitute doctors" exhibited the lowest relative error rates, while the night shift and cumulative shift doctors demonstrated the highest error rates.

The results of the study suggest that gynecologist-obstetricians with 6-10 years of experience and "substitute physicians" demonstrate greater agreement in their estimates. This may be attributed to their heightened involvement in obstetric care.

The secondary hypothesis is that the obstetric hemorrhage scenario will have the highest error rate. This is based on the findings of researchers such as P. Toledo and Mc Cathy, who found that the accuracy of the blood calculation worsened with the increase in volume. The results of our research indicate that the scenario with "little bleeding" exhibited the highest percentage of relative error.

While Pranal et al. found greater agreement for very low and high volumes, with the scenario with moderate bleeding being the one with the lowest agreement, the results of our study instead align with those of Ponteiro, who found that the relative error value for scenarios of low bleeding was

higher than for those with medium and moderate bleeding. The latter group exhibited the lowest relative error.

In contrast to the methodologies employed by other authors, our study utilized blood samples from actual patients at our hospital. The compresses and gauze materials were procured from the CEyE units of HGZ 20, with the objective of replicating the conditions under which gynecological staff perform bleeding calculations. This approach is a notable strength of the study.

Nevertheless, it should be acknowledged that the study is not without limitations. It is possible that the time difference between participants performing the simulation exercise may have influenced the visual assessment of bleeding. On the first day, there was a difference of up to four hours between the first and last participants, which may have allowed the blood impregnated in the surgical material to dry completely.

4. Conclusion and future scope

There is a discrepancy between the agreement between visual estimates and real blood loss in simulated scenarios among affiliated gynecologists and gynecology residents. It was found that visual estimates of blood loss exhibited a high degree of error in all scenarios, with relative errors exceeding 100% in some cases. It was observed that the groups with more experience in the study (third- and fourth-year residents and affiliated physicians) demonstrated a reduced tendency to underestimate bleeding in obstetric hemorrhage scenarios.

The high rate of overestimation observed indicates that there may be an excessive utilization of blood products for the management of obstetric hemorrhage in our hospital. This indicates the necessity for enhancements to be made to the training and techniques utilized for the assessment of blood loss in clinical settings, with the aim of ensuring the delivery of safe and accurate patient care. Furthermore, the findings underscore the necessity for continuous training and experience to enhance the precision of these estimates.

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Conflicts of interest: The authors of this manuscript declare that they do not existence of conflicts of interest in the development of this research.

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