PERIOPERATIVE BLOOD LOSS ASSESSMENT- HOW ACCURATE?

Dr. Naveen Eipe¹ Dr. Manickam Ponniah²

SUMMARY

In the perioperative period, the anaesthesiologist’s clinical estimation of the blood loss is often alone used to determine the need for transfusion of Red Blood Cells (RBCs). The aim of this study was to assess the accuracy of perioperative blood loss estimation. Fifty patients undergoing major surgeries were enrolled in this study. Normovolemia was maintained and no RBCs were transfused. At any point in time perioperatively, the attending anaesthesiologist estimated the blood loss upto then, the clinically Estimated Blood Loss (EBL). Simultaneously a blood sample was sent to the laboratory and the hematocrit was tested. The Gross formula was used to calculate the Actual Blood Loss (ABL). In 64% of the cases the blood loss was underestimated. The Bland and Altman plot suggests that clinical estimation is more inaccurate as the average blood loss increases (p< 0.05). The 95% confidence intervals for the differences (between ABL and EBL) were –719.93ml to + 1265.61ml. Interclass Correlation Coefficient for the data was 34% further confirming poor correlation between the EBL and the ABL. We conclude that in the perioperative period clinical estimation of blood loss is inaccurate and alone should not be used to determine the need for red blood cell transfusions.

Keywords : Blood loss, Clinical estimation and Red blood cell transfusion.

Introduction

According to one survey, anaesthesiologists administer over 50% of all blood given to patients.¹

In healthy individuals undergoing surgery with significant blood loss, under transfusion has been associated with risks of increased perioperative morbidity and delayed recovery in the postoperative period. In patients with respiratory disease and those with compromised cerebral and/or coronary circulations, the risks of acute perioperative anemia are significant.²

Anaesthesiologists often rely on clinical estimation of blood loss alone to guide the transfusion of Red Blood Cells (RBCs) in the perioperative period because other methods of estimations either may not be practical or available at all the times. The aim of this study was to assess the accuracy of the clinically estimated blood loss.

Methods

Following approval of the institutional research and ethics committee and informed consent from the patients, 50 patients were selected randomly from the OR list who met the following criteria:

Inclusion criteria: (1) Major elective general surgical, orthopedic, neurosurgical, gynecological and ENT procedures for which blood was cross-matched.

Exclusion criteria : (1) Cardiac surgery and other surgeries where clinical estimation of blood loss is not routinely performed (because of extracorporeal circulation or large fluid shifts). (2) Patients whose BMI>25 (obesity makes blood volume estimation from body weight inaccurate). (3) Patients with severe anemia (patients with hematocrit <21% would not normally be allowed to lose blood prior to transfusion). (4) Patients with sudden and / or massive blood loss (as they require RBC transfusion in an emergent situation often before blood loss could be estimated or hematocrit could be sent).

The consultant anaesthesiologist was informed about the study and a proforma was made available to him. Age, sex, body weight, preoperative hematocrit, diagnosis and surgery were entered in the proforma. Assuming normovolemia was maintained throughout, fasting and maintenance fluids were replaced with appropriate crystalloids and any blood loss was replaced with colloids (eg. 6% hydroxy ethyl starch). At any point in time perioperatively, the attending anaesthesiologist clinically estimated the blood loss up to then. Simultaneously, a blood sample was sent to the laboratory and the hematocrit was tested. No RBCs were transfused till the sample was drawn. The clinically Estimated Blood Loss (EBL) and time were noted; also the fluid therapy up to the time of estimation was recorded. Using a standard automated analyzer the hematocrit was tested and the result was conveyed to the anaesthesiologist within 5 minutes.

In this study, the anaesthesiologists were free to use any clinical method of estimation of blood loss. Clinical methods of blood loss assessment used included counting the blood soaked mops and gauze pieces (and multiplying them by the estimated volume of blood they carried), measuring
blood lost to suction bottles and estimating that, which was in and around the operative field. The time from the induction of Anesthesia to the time of blood loss estimation was noted and also the volume and types of intravenous fluid given before and after the estimation was recorded. The total blood loss, RBCs (if) transfused and the total duration of surgery were mentioned in the proforma. The Post Op hematocrit was also followed up.

The Actual Blood Loss (ABL) was calculated from a modification of the Gross formula given below.

\[
ABL = BV \left[ \frac{Hct (i) - Hct (f)}{Hct (m)} \right]
\]

Where BV was the blood volume calculated from the Body Weight

\[
(Blood \, Volume = \text{Body \, Weight in Kgs} \times 70 \, \text{mlkg}^{-1})
\]

Hct (i), Hct (f) and Hct (m) were the initial, final and mean (of the initial and final) Hematocrits respectively.

Therefore for each patient the clinically Estimated Blood Loss (EBL) and the calculated Actual Blood Loss (ABL) was used to calculate the Difference in Blood Loss (DIFF-BL) which was the numerical difference between the Actual and the Estimated Blood Loss.

The Average Blood Loss (AVG-BL) was calculated for each patient, which was the mean of the Actual and Estimated Blood Loss (Table - 1). This was plotted against the Difference in Blood Loss to obtain the Bland and Altman plot (fig. 1).

### Table - 1 : Average blood loss and difference in blood loss

<table>
<thead>
<tr>
<th>Average blood loss</th>
<th>&lt;0 ml</th>
<th>0-500 ml</th>
<th>&gt;500 ml</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;500 ml</td>
<td>6</td>
<td>6</td>
<td>0</td>
<td>12</td>
</tr>
<tr>
<td>500-1000 ml</td>
<td>9</td>
<td>9</td>
<td>5</td>
<td>23</td>
</tr>
<tr>
<td>&gt;1000 ml</td>
<td>1</td>
<td>3</td>
<td>11</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>16</td>
<td>18</td>
<td>16</td>
<td>16</td>
</tr>
</tbody>
</table>

P=0.0008

### Results

The 50 patients were divided between 35 Men and 15 Women. Their ages were between 18 and 91 years. The Body Weights ranged from 30 to 86 kgs (mean= 56.17 kgs and standard deviation of 12.557 kgs). The Preoperative Hematocrit ranged from 22 to 48% (mean= 37.096% and standard deviation of 6.442%). The Specialty represented were General Surgery, Orthopedics, Urology, Neurosurgery, ENT and Plastic Surgery with 26, 14, 5, 3, 1 and 1 patient respectively.

The clinically estimated blood loss was designated as the Estimated Blood Loss (EBL), which had a range of 100ml to 1750 ml. The blood loss calculated from the laboratory hematocrit was designated as the Actual Blood Loss (ABL) that was in this study between 180 ml and 2250 ml.

In 16 of the 50 cases the Estimated Blood Loss exceeded the Actual Blood Loss. In these cases the Anaesthesiologist had in his/her clinical judgment had estimated that the blood loss was more (than it actually was). These cases would have a negative difference in Blood Loss (or DIFF-BL<0). These can be grouped together as cases of overestimation and account for 32% of the study.

Of the remaining 34 cases (64% of the study), the Actual Blood Loss (ABL) exceeded the Estimated Blood Loss (EBL). Here the underestimation of blood loss is reflected by the Difference in Blood loss being positive (DIFF-BL>0).

The range of the Difference in Blood Loss was between – 800 ml (overestimation) and +1340 ml (underestimation). The mean of the differences was +272.84ml and the standard deviation was 496.38ml.

According to Bland and Altman's method of assessing agreement between two methods of clinical measurement, the difference between the measurements will reflect the accuracy of the measurement. For each patient the preoperative hematocrit, body weight, duration of blood loss, percentage of circulating blood volume lost was studied and compared to this difference in blood loss. The P value (p>0.05) for these suggests that the accuracy of clinically estimated blood loss does not appear to depend on the preoperative hematocrit, body weight, duration of blood loss or the percentage of blood volume lost.

The average blood loss was between 250 ml and 1925 ml with a mean of 821.42 ml and a standard deviation of 376.63 ml.
Agreement between clinical measurements can be assessed by the Bland and Altman plot between the difference between the two measurements (Difference in Blood Loss in this study) and the average of the measurements (Average Blood Loss in this study). The Average Blood Loss is used to group patients into groups with loss less than 500 ml (12 patients), 500 to 1000 ml (23 patients) and losses more than 1000 ml (15 patients). These are then compared to the Difference in Blood Loss.

In Table 1, we find that when average blood loss is low, the difference or inaccuracy is less. Similarly when the average loss exceeds 1000 ml, the difference in blood loss (or inaccuracy of estimation) increases significantly. This suggests that clinical estimation is inaccurate as the blood loss increases. The P value < 0.05 also confirms that there is a significant difference between the patients when the average blood loss is compared to the difference in blood loss.

Bland and Altman plot

When the Average Blood Loss is plotted on the X-axis against the Difference in Blood Loss on the Y-axis we observe the spread of data for all the 50 patients. Here we see that as the Average Blood Loss increases, the values scattered further away from the “0” point on the Y-axis. This signifies that there is an increase in the difference in or disagreement between the Actual and Estimated Blood Losses as the average blood loss increases.

The calculated 95% Confidence Intervals was –719.939 ml to +1265.619 ml.

To prove that the Estimated Blood Loss was not different from the Actual Blood Loss by chance alone the Interclass Correlation Coefficient was calculated and found to be 34%, which indicates poor correlation between the two methods.

Discussion

The aim of this study was to assess the accuracy of perioperative blood loss estimation.

Blood is a finite resource with a limited shelf life and is associated with considerable processing costs. Utilization of this resource needs critical review to identify areas of overuse and thus reduce risk to patient and hospital costs. Risks of homologous transfusion vary in type and severity. Morbidity and mortality may result from either an immunologically mediated reaction or a transmitted infection.

Perioperative transfusion triggers for RBCs include physiologic signs of inadequate oxygenation of the entire or a specific organ, hemoglobin concentration and logistic aspects such as experience of anesthesiologists and surgeons, predictability of blood loss and time required for a hemoglobin determination and RBC delivery. Defining transfusion triggers for red blood cell transfusions is important to avoid unnecessary RBC transfusions and equally to avoid under transfusion in situations where RBC transfusions may be beneficial. The American College of Physicians recommended that RBC transfusions should be done unit by unit and the patient should be evaluated between each transfusion. In their study of patients undergoing curative surgery for colo-rectal malignancies, Tartter and Barron concluded that excessive intraoperative transfusion and the practice of administering blood without reevaluating the hematocrit in between resulted in 90% of the unnecessary transfusions. They further recommended that the determination of the hematocrit immediately before administration of each unit would reduce blood consumption by 25%.

The minimal hemoglobin level tolerated without organ dysfunction is referred to as the Critical Hemoglobin. Anaesthesiologist should transfuse RBCs focusing on the postoperative Target Hemoglobin. In the early post-anesthetic period, patients are most vulnerable to adverse events due to perioperative anemia. Unfortunately akin to the “Transfusion Triggers”, this “Target Critical Hemoglobin” is ill defined and often controversial.

Anaesthesiologists often rely on clinical estimation of blood loss alone to guide the transfusion of Red Blood Cells (RBCs) in the perioperative period. But these estimations suffer from large interobserver variability and poor repeatability. The extent of blood loss and response to transfusion is reflected in the changes in the hematocrit. This change may be used to calculate the Actual Blood Loss using suitable formulae. The design of this study was based on a modification of the Gross formula that was originally derived to calculate the Allowable Blood Loss. According to Gross, the mean of the initial and final hematocrits is taken in the denominator rather than the initial hematocrit (derivation of Kallos which was based on simple proportions). This takes into account the ongoing hemodilution that occurs, assuming that normovolemia is maintained. In this study normovolemia was maintained throughout and no RBCs were transfused between the preoperative hematocrit and the clinical estimation.

This study has shown that using clinical estimation alone to guide transfusion is inadequate. The interclass correlation coefficient for the data was 34% further confirming poor agreement between the Actual Blood
Loss and the estimated blood loss. The 95% confidence intervals (-719.939 ml to +1265.619 ml) suggest that clinical estimation alone may result in unacceptable under or over transfusions.

Perioperative transfusion practices and its implications on morbidity and mortality have depended on the accuracy of clinical estimated blood loss. Though these clinical methods are simple to perform and can be performed repeatedly; at no additional cost or complication to the patient, they may largely depend on the Anaesthesiologist’s experience and expertise in estimating blood loss. Since the above constellation of factors are dynamic, evolving and in a sense “real time”, Anaesthesiologists should repeatedly estimate the blood loss. These clinical estimations and changes in the monitored hemodynamic variables should be interpreted by the Anaesthesiologist and used to determine the time of testing the hematocrit. RBC transfusions should be indicated only by the change in hematocrit. These tests can now be easily and economically be performed in the operating rooms itself and repeated as often as indicated; preferably before and after each transfusion of RBCs.

The practice of perioperative transfusion medicine is a balancing act between the adverse transfusion outcomes and potential clinical benefits where the Anaesthesiologist should rely on definite laboratory values or point of care estimations of Hematocrit and not on clinical estimation alone.

References