A RAPID METHOD FOR EVALUATING THE SUCTION BOTTLE COMPONENT OF BLOOD LOSS AT SURGERY * †

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There is no known convenient, accurate method for the calculation of total blood loss at surgery. The blood staining of the surgical field and the surrounding area, at best, can be estimated only crudely. This is done by utilization of well-known gravimetric techniques on the linens and the sponges in addition to a gross estimate of blood loss in the suction bottle (2). The latter has been obtained by subtracting a known volume of the saline irrigant from the total suction

![Specific Gravity of Blood Graph](image)

Fig. 1. Showing the relationship of the specific gravity of blood to grams of hemoglobin. Zero Gm. of hemoglobin corresponds to a specific gravity of 1.027 (plasma). A specific gravity of 1.060 corresponds to 15.6 Gm. of hemoglobin. The variation of specific gravity of blood with changes in temperature and plasma-protein concentration is well within the error of the method.

bottle volume of blood-saline mix. The increment is considered to be blood loss.

Often, because of uncontrolled spillage and sponge absorption, the volume of saline irrigant approaches or exceeds the volume of blood-saline mix in the suction bottle; then the above-mentioned scheme

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is no longer feasible. However, the plan proposed herein circumvents this pitfall and presents an accurate, rapidly performed method of calculating the suction bottle component of surgical blood loss.

Method. The blood saline mix is heparinized or oxalated to avoid clots and the sample drawn out by a syringe to obviate foaming. The specific gravity of the mix is measured by the hydrometer. Then, with the knowledge of the preoperative hemoglobin, the percentage of

![Specific Gravity of Blood-Saline Mix](image)

Fig. 2. Showing the relationship of specific gravity (as measured by a common laboratory urinometer†) of the blood-saline mix in the suction bottle to percentage of blood present. This also is a straight line function. The specific gravity of whole blood at the various hemoglobin concentrations can be obtained from figure 1, 1.010 representing the specific gravity of normal saline. If sterile water is used, the straight line function passes through the specific gravity 1.000 (as indicated by the interrupted line).

the blood present in the suction bottle can be calculated by the use of figure 2.

Similarly, one easily may calculate the amount of blood present in any blood-diluent mix by the use of the following formula:

\[ X = \frac{\% \text{ blood} \times (\text{sp. gr. of blood-diluent mix} - \text{sp. gr. of diluent})}{\text{sp. gr. of 100% blood at any given Hb conc.}} \times \frac{100}{\text{sp. gr. of diluent}}. \]

† The common laboratory urinometer should first be tested in distilled water and a suitable correction made if the specific gravity reading is not 1.000.

‡ The specific gravities may be measured by the use of the hydrometer; the value \( X \) represents the percentage of blood present in any blood-diluent mix. The derivation of this equation is:

\[ y = (m)x + (b'). \]

This is the equation of a straight line where \( m \) is the slope of the line and \( b' \) is the \( y \)-intercept (i.e., when \( x = 0, y = b' \)). On referring to figure 2, the \( y \)-intercept is 1.010 which is the specific gravity of the diluent (saline).
A crude estimate of the total blood loss may be obtained by the use of the following formula:

\[
(a) = \frac{(b) \times (c)}{(d)} \quad \text{(all values in cubic centimeters)},
\]

\[a = \text{total blood loss},\]
\[b = \text{blood content in blood-saline mix},\]
\[c = \text{total saline irrigant used},\]
\[d = \text{saline content in blood-saline mix (suction bottle), obtained by subtracting b from the total volume of the blood-saline suction-bottle mix}.\]

This crude extrapolation is based on the premise that the specific gravity of the blood-saline mix in the suction bottle is equivalent to the composite specific gravity of the entire blood loss and saline used. In practice, this is most applicable in surgical procedures where blood spillage and staining of the surgical field are minimized.

As an example, let us say that surgery is performed on a patient with a preoperative hemoglobin of 13 Gm., that 1,500 cc. of irrigating saline is used, and that the measured volume of blood-saline mix is 1,000 cc. with a specific gravity of 1.030 (measured by a hydrometer). Utilizing figure 2, we see that the straight-line function corresponding to 13 Gm. of hemoglobin intersects the specific gravity ordinant of 1.030 at around the 48 per cent projection of the abscissa. This means that there is about 480 cc. of blood in the blood-saline mix. This answer also can be derived by substitution in the above-mentioned formula:

\[
X = \% \text{ blood} = \frac{\text{(sp. gr. of blood-diluent mix - sp. gr. of diluent)} (100)}{\text{(sp. gr. of 100\% blood at any given Hb conc. - sp. gr. of diluent)}},
\]

\[
X = \frac{(1.030 - 1.010) (100)}{(1.052 - 1.010)} = 48\% = \text{therefore 480 cc. blood loss.}
\]

An approximate of total blood loss may then be calculated by using the formula

\[
(a) = \frac{(b) \times (c)}{(d)} = \frac{(480) (1,500)}{(520)} = 1,385 \text{ cc. = total blood loss.}
\]

(b) Let \( y = 1.060 \); then \( x = 100 \) (refer to figure 2 . . . 15.6 Gm. preoperative Hb).

Therefore: \( m = \frac{y - b'}{x} = \text{slope} = \frac{1.060 - 1.010}{100} \).

Then \( m = \frac{\text{(sp. gr. of 100\% blood at any Hb conc.) - (sp. gr. of diluent)}}{100} \).

Substituting the above in the equation \( x = \frac{y - b}{m} \).

\[
X = \% \text{ blood} = \frac{\text{(sp. gr. of blood-diluent mix - sp. gr. of diluent)} (100)}{\text{(sp. gr. of 100\% blood at any Hb conc. - sp. gr. of diluent)}},
\]
The specific gravity method for evaluation of the suction bottle component of blood loss, as outlined above, gains particular significance in neurosurgical procedures where suction and irrigants are used, and where blood loss is great \( 1, 3 \). The method has proved extremely accurate on analysis of known samples and currently is employed by the neurosurgical service of the Los Angeles County Hospital.

**CONCLUSION**

1. A convenient, accurate method for evaluating suction-bottle blood loss at surgery has been described.
2. The method is particularly applicable to neurosurgical procedures where blood loss is great and saline irrigation is commonly used.

**REFERENCES**


\[ \text{White, using gravimetric techniques, studied blood loss in 37 neurosurgical operations. The average blood loss for extensive intracranial procedures was 1,200 cc. Craniotomies averaged 800 cc, laminectomies about 600 cc. This was corroborated by Bonica in his review of 40 cases.} \]

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**WEDNESDAY, NOVEMBER 2, 1955**

**MORNING:**

**HISTORICAL SESSION:**

*The Jubilee Year of Organized Anesthesia*—Albert M. Betcher, M.D., Benjamin J. Ciliberti, M.D., Paul M. Wood, M.D., and Lewis H. Wright, M.D.

*The Origins of Spinal Analgesia and Anesthesia*—F. A. D. Alexander, M.D.

**AFTERNOON:**

**PANEL SYMPOSIA:**

*What are the Causes of Death Relative to Anesthesia and Surgery?*—Emmanuel M. Papper, M.D., Henry K. Beecher, M.D., Meyer Saklad, M.D., Charles Burstein, M.D., Robert D. Dripps, M.D., and George Humphreys, III, M.D.

*What Influence Does the Anesthetic Agent Have Upon the Mortality Rate?*—Speakers as in Panel Symposia above.