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BLOOD LOSS ESTIMATION BY MATERNITY NURSES

by

Victoria Cahill Bockman

A Thesis Submitted to the Faculty of the

COLLEGE OF NURSING

In Partial Fulfillment of the Requirements
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THE UNIVERSITY OF ARIZONA

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28 April 1986
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ABSTRACT

A descriptive design was used to study the abilities of maternity nurses to estimate blood loss. A convenience sample of 39 nurses estimated blood on 20 items which consisted of five different materials, each containing one of four measured amounts of blood. Each of the items was estimated as small, moderate or large postpartum loss and estimated in cubic centimeters.

Frequency distributions and mean scores suggested that nurses were most inaccurate estimating larger amounts of blood and blood contained in chux. The data also indicated that nurses were not consistent in how they evaluated small, moderate and heavy postpartum blood loss. A secondary, multivariate analysis revealed no statistically significant differences in estimations by amount or material. There were no significant relationships between educational achievement or years of experience in estimation. Limitations of the study design and multivariate approach to data analysis are acknowledged.

CHAPTER I

INTRODUCTION

> ...learning is a product of experience rather than information.
> Michel Odent, 1984, p. 58

Nurses are intimately involved in the care of women throughout the childbearing process. Monitoring blood loss before, during, and after birth is of particular concern to nurses as even the most healthy women may be vulnerable to a sudden and devastating hemorrhage at this time. Postpartum hemorrhage remains a leading cause of maternal mortality and therefore may be a life-threatening situation. Even a moderate blood loss can debilitate a new mother who already has so many psychological, emotional and physiological changes to cope with (Newton, 1966).

Nurses are taught measures to control postpartum bleeding. Nurses are also responsible for monitoring and recording blood loss. The accuracy with which nurses are able to assess blood loss is rarely tested; feedback is rarely, if ever, given. An underlying assumption in the traditional maternity unit seems to be that all health care providers have an innate ability to make accurate estimates of blood loss. This long-standing assumption has been challenged. Visual estimation is considered the most unreliable of any method of monitoring blood loss (Lucas, 1980). Yet visual estimation is often the only method of monitoring blood loss available.

Blood loss is recorded in cubic centimeters, which may have the misleading appearance of accuracy. Blood loss is also recorded using "ballpark" terms, such as, "average", "moderate" or "excessive". Rarely are such terms operationally defined. Furthermore, visual estimation is a complex process in which few practitioners are trained and tested.

Nursing texts are rife with vague, undefined terms used in conjunction with postpartum blood loss. The words "profuse", "excessive", and "large" give the impression that too much bleeding has occurred. On the other hand, the words "minimal", "slight", and "moderate" are more reassuring and normal (Butnarescu & Tillotson, 1983; Hawkins & Higgins, 1981; Reeder, Mastroianni & Martin, 1980; Ziegel & Cranley, 1984). But, what exactly do these words mean? How is one to know when "minimal" becomes "moderate" or "moderate" becomes "heavy"? Measuring blood loss with the greatest degree of accuracy possible is a worthy goal of nursing practice. Testing our ability to do so is the first step towards improving the practice of maternity nursing.

Statement of the Problem

Monitoring blood loss during the childbearing period is a primary nursing concern. Visual estimation may be the only means of quantifying blood loss available to nurses, yet nurses appear to receive little or no training in visual estimation (Higgins, 1980). Moreover, the literature available on nurses' abilities to estimate is extremely limited. The problem addressed by this study was to describe the abilities of maternity nurses in visual estimation of blood loss.

Purpose of the Study

The study was designed to replicate a previous investigation, "Measuring Nurses' Accuracy of Estimating Blood Loss" (Higgins, 1980). The purpose of this study is to determine the accuracy and consistency with which maternity nurses estimate blood loss. Higgins (1980) included in her sample nurses from different areas of specialization who estimated blood loss on a regular basis. Of the total sample (n=42), only 15 specialized in maternity care. One purpose of this study is to replicate that of Higgins' with a larger sample of maternity nurses. The study also seeks to answer the following research questions:

How accurate are maternity nurses at estimating blood loss?

Are maternity nurses more likely to over- or underestimate?

Do maternity nurses demonstrate consistency in the amounts of blood selected as slight, moderate or heavy?

Is there a relationship between the educational level of maternity nurses and accuracy in estimation?

Is there a relationship between the length of experience in blood loss estimation and accuracy in estimation?

Is there a relationship between the amount of blood loss and accuracy in estimation, that is, are nurses able to estimate both large and small amounts of blood with the same degree of accuracy?

Is there a relationship between the type of material and its absorbency and the accuracy of estimation, that is, do nurses estimate more accurately when blood is contained in a thick perineal pad or a thinner chux pad?

Definition of Terms

For the purpose of this study the following terms were defined for ease of interpretation:

Estimation: The cognitive process involving the visual perception of blood loss, resulting in a subjective judgment of the volume present.

Blood Loss: The volume of blood discharged from the body at any given time during the childbearing process.

Nurses: Registered nurses who have graduated from a diploma, associate degree, or baccalaureate program and who directly care for childbearing women.

CHAPTER II

CONCEPTUAL FRAMEWORK AND LITERATURE REVIEW

The purpose of this section is to present a conceptual framework for the study of blood loss estimation by nurses. The content for this framework is taken from physiological and psychological literature on cognitive processes. Visual perception, perceptual learning, estimation and memory are conceptual processes involved in visual estimation of blood loss. These particular aspects of the cognitive process will be presented in relation to blood loss estimation. In addition to these concepts, the psychological study of selected individual modes of cognition, known as cognitive styles, will be addressed.

Neurophysiology of Cognition and Perception

The physiology of the brain and nervous system is defined by its anatomical organization. The functional unit of this system is a cell known as the neuron. The nervous system is composed of some billions of neurons, each separated by a minute space, the synapse. Signals are transmitted by an action potential along the body and axon of the neuron until the terminal point is reached. At this point, a neurotransmitter substance is released to diffuse across the synapse. Upon reaching the adjacent dendrites of other neurons the action potential is begun again, continuing the transmission of the signal. The neuro-transmitter substance may also be inhibitory, thus defining the pathway of neural excitation.

Because of the organization of the nervous system, any stimulus necessarily gives rise to excitation in aggregates of neurons. It is impossible to associate the excitation of any given cell to any particular stimulus or interaction within the system (Mantura, 1970). Research into functions of the two hemispheres does suggest that there may be neurons with specialized abilities in memory storage and perceptual function, although perception, per se, has never been localized (Livingston, 1978). The left hemisphere functions in analytic thought and deals with logic and mathematics. The right hemisphere performs synthetic and wholistic functions, interpreting forms and patterns. Although there are specialized functions of each hemisphere, both function at equally high levels and orchestration between the two results in efficient cognitive performance (Dumas & Morgan, 1975; Livingston, 1978).

Following an actual sensory experience, the sensation remains for a brief duration. This is called sensory memory and is the initial stage of the memory process. During the milliseconds that the sensory experience is retained in the sensory areas of the brain, large amounts of information remain available for scanning and sensory processing (Wingfield & Byrnes, 1981).

Short-term memory provides us with information which is usually encoded in verbal form. This primary memory is temporary, though longer lasting than sensory memory. It allows immediate access to information without the memory trace necessary to locate a long-term memory.

It is postulated that the physiological mechanism of long-term memory is due to actual physical, anatomical or chemical changes in either the synapses or postsynaptic neurons. These changes result in a permanent facilitation of the memory circuit. When one speaks of the physiology of perception, the specific sensory receptor must be considered in conjunction with the nervous system.

The sensory experience associated with the process of visual perception begins with the eye. Briefly described, when a nurse looks at a blood-soaked pad, light enters her eye and is focused on the retina, the light sensitive portion. Contained within the retina are specialized cells known as rods and cones. The cones function specifically in color vision. Light energy excites these cells, causing signals to be sent through successive layers of neurons in the retina. The signals are transmitted through the optic nerve and into the cerebral cortex. The fused image (from each eye) is transmitted into the primary visual cortex. This area of the brain detects spatial organization; that is, information concerning the form of the peripad, the outline of blood and its color are made available by this brain center. This information is transmitted, via neural signals, to the visual association area where the information becomes interpreted, and the nurse becomes aware of the degree of saturation of the pad.

In summary, the physiological process of visual perception is a complex process involving the interaction of external objects, light and specialized sensory receptors. The interpretation of the sensory experience is a process dependent on all involved areas of the brain. Memory is a part of this process.

Cognition and Perception

We know from physiology that learning results in relatively permanent changes in the neural pathways. An early experimental psychologist (Tolman, 1948) proposed that a rat's ability to learn its way through a maze must be due to the formation of a "cognitive map". He extended this proposition to men as well. This view is now considered rather narrow due to its stimulus-response orientation.

Modern cognitive psychology encompasses the body of knowledge dealing with the way people acquire, store and use information. Wingfield & Byrnes describe cognition as a "dynamically organized system" which includes perception, memory and thinking (1981, p. 14). The interplay of these processes allows us to acquire knowledge of our environment through our senses.

Cognition may also be considered as a developmental process since any cognitive process inherently results in information built upon the processing of previous information (Meredith, 1970). Piaget considers the division of cognition into perception and thinking impossible because "action as a whole is both the point of departure for reason and a continuous source of organisation and reorganisation for perception" (Piaget, 1969, p. 361). According to Piaget, perception functions as the intermediary connection between objects and "operations" or actions.

As children and adults, we explore our world through our senses. Through our perceptions we are able to incorporate our world within us. Perceptual development in children has been the focus of Gibson's work. She views perceptual learning as the ability to perceive and distinguish what is already present in the world (Gibson, 1969; Miller, 1983). Experience is necessary for the increasing efficiency of perception, that is, one learns through practice to differentiate and pick out pertinent details of the perceived object.

Heil (1983) also considers that the ability to perceive and pick out information may be limited by cognitive as well as by physiological factors. For both Heil and Gibson, attentional factors come into play for efficiency in perceptual abilities. Through experience one learns to focus attention on the meaningful aspects of what is being perceived. According to Heil, a "belief-complex" is a necessary cognitive precondition for an individual to have an appreciation for what she is seeing.

The nurse who cares for the postpartum woman must, then, have an "appreciation" of the amount of blood on the peripad if she is to distinguish excessive blood loss from the expected or normal amount. This "appreciation" comes about with experience during which a belief about what constitutes excessive or normal blood loss is formed. However, the nurse must be able to do more than discriminate between normal and excessive bleeding. She is often called upon to qualify the amount of bleeding in terms of excessive, moderate or slight. Often, too, the amount must be quantified as a measure of cubic centimeters lost.

Estimation

The process of estimation is rarely addressed in the literature. Piaget is the only researcher who has considered the process of estimation in depth. In his studies of children, Piaget has found that pre-numerical children include both quantitative and qualitative relationships when judging volumes. A child who states that there is "more in one glass because it is higher", is expressing in simple quantitative terms a perceptual relationship of differences between qualities, i.e., heights, of objects (Piaget, 1961).

Piaget's report of research on perception and estimation in adults refers to the role of centration, or the tendency to overestimate an object or figure which is centered or fixed (Piaget, 1969). Simply stated, when a subject is presented with two objects, i.e., lines or rods, and is asked to judge which of the two, if either, is longer than the other, the tendency is to choose one as a standard by which to judge the other. Because of its privileged role in the comparison, the object chosen as the standard is systematically overestimated. Factors considered as having a part in the role of centration and the tendency to overestimate include differences between central and peripheral vision, length of exposure time and attention. Piaget has found that with practice these factors are compensated for and the illusionary effects of centration decrease. The role of centration in estimation appears to be well accepted by all investigators who have studied the concept (Piaget, 1969).

Experiments on size estimation have usually used tests of comparison or size matching of rods, cubes or common "every-day" objects.

Liam (1981) reports that when subjects of various studies were able to rely on their familiarity with the test objects, correlations between estimated and objective sizes were invariably very high.

Clearly, estimating the length of rods or the size of a cube is different from estimating the amount of blood absorbed by a pad. The point is that with increasing familiarity, estimations should become more accurate.

An additional point should be made here. Sensory processing and perception may be erroneous and, perhaps, are frequently so. An error may not become apparent as long as behavior remains within acceptable limits. Usually errors in perception and sensory processing are identified and corrected only if and when behavior is noticeably in error (Livingston, 1978).

Cognitive Styles

Psychological research which focuses on the individual's system of perceiving and responding to environmental stimuli has produced an array of differences known as cognitive styles. Because the following styles have been developed and studied by different researchers, there is an apparent lack of an unifying structure and many of these styles appear to "overlap".

Field-independence and field-dependence are bipolar dimensions which developed out of research into perceptions of the upright in space. Witkin (1978) and his associates noted that when visual and bodily standards were separated, differences in locating the upright became apparent in individuals. Separation of the standards was accomplished by two, now classic, tests. In the first, the subject sits in a dark room and is asked to adjust a tilted luminous rod within a tilted luminous frame to the upright.

The second test requires the subject, seated in a tilted room, to adjust his body to the upright. The differences in the ability to locate the upright depend on whether the subject uses his own bodily sensations as the standard or visual cues, hence the term field-dependent. Field-independent people, or those who rely on their own internal cues, have also proven themselves as more adept in locating simple figures embedded within more complex figures than field-independent people.

The basic difference between these two styles is that field-independent people demonstrate a more analytic way of perceiving the environment, being less influenced by environmental distractors. Conversely, field-dependent people look more to other people as information sources and are more likely to take into account the views of others when forming their own. As a result, field-dependent people have much better interpersonal skills than field-independent people. Socialization appears to be a major factor in style development.

Inpulsivity-Reflectiveness is defined by Kagan as "the tendency to reflect over alternate solution possibilities, in contrast with the tendency to make an impulsive selection of a solution, in problems with a high degree of response uncertainty" (1965, p. 609).

This dimension grew out of research on children's reading abilities by Jerome Kagan. It is measured by the Identical Pictures Test in which the subject is shown a picture of an object. The subject is then asked to identify the object from a series of identical pictures containing similar objects, only one being identical to the first. The test measures the tendency to quickly identify the first seemingly correct answer as opposed to careful reflection over the alternatives. When the subjects are pressured to respond, it becomes difficult for the impulsive individual to take a more cautious approach. The reflective person may experience difficulty ind choosing any answer (Partridge, 1983).

Impulsive people are able to respond quickly to an event or dilemma. However, they do tend to make more errors than reflective people.

The Preceptive/Receptive-Systematic/Intuitive model of cognitive style was developed with a focus on problem-solving (McKenney & Keen, 1974). Information gathering (preceptive/receptive) and information evaluation (systematic/intuitive) are the approaches assessed by the various tasks: Identical Pictures, Paper Folding and Scrambled Words (Partridge, 1983).

The preceptive thinker tends to focus on relationships between items and test the found relationships against previous concepts or precepts. This individual uses his own concepts as a base from which to look for cues and may overlook relevant data.

Receptive thinkers tend to avoid preconceptions and completely examine all details before reaching any conclusions. This style of thinking runs the risk of failing to bring the details together into a coherent whole, through the tendency to disregard relationships.

Systematic individuals evaluate information according to a structured, orderly method. Their conclusions are defended in terms of the method used.

Intuitive thinkers tend to avoid committing themselves to any structure. They explore and abandon alternatives quickly, using a trial and error approach (McKenney & Keen, 1974).

Scanning and focusing are styles of information evaluation. Scanners tend to review information meticulously and uniformly. Focusers, on the other hand, tend to fix their attention on details which may or may not be relevant. This style presents a problem only when important data is not immediately perceptible (Partridge, 1983; Rice, 1979).

Masculine versus feminine differences in style are a matter of degree. Generally, researchers have found that women have better verbal ability than men and tend to focus attention on one particular task. Men have better spatial ability and are better than women at tasks requiring the use of different cognitive skills simultaneously. These differences may be slight, though they do tend to increase with maturity into adulthood. Socialization probably plays a role in the development of these differences, as may brain hemisphere dominance (Rice, 1979).

In summary, cognitive styles have been developed in response to modes of thinking and problem-solving demonstrated by individuals. These styles extend beyond "pure" cognition, even into personality types and relationships with others. It is also likely that cognitive style may influence the ability to estimate blood loss.

Conclusions

We know that the physiology of the brain is defined by its anatomical structure and organization. Our perceptions, however, cannot be defined by our sensory experiences only. Our perceptions encompass our past, present and even our future, for our belief systems are part of our perceptions. Our perceptions, as such, color how we see our environment and direct our actions within it.

There is speculation that frequently our sensory processing and perceptions may be in error, undiscovered, unless betrayed by some intolerable behavior. If this is so, and if visual estimations of blood loss are also frequently erroneous, then these misperceptions need to be sought out. However, it is improbable that a nurse would allow her patient to hemorrhage and only then discover her inaccuracies in estimation.

The literature also tells us that we are capable of increasing our perceptual efficiency and improving our accuracy in visual estimation. This is perceptual learning. Before learning can occur, the literature states, we also need to know where to focus our attention. Nurses must be made aware of their accuracy or inaccuracy in blood loss estimation before they can be expected to improve. The empirical testing of nurses' accuracy in estimating blood loss is, then, the first step towards improving that ability.

Literature Review

Hemorrhage remains a leading cause of maternal mortality despite the many technological advances in maternity care and the increased availability of blood products (Collea, 1978; Kryc, 1982; Watson, 1980). Excessive bleeding may occur suddenly or discretely over a period of time. Monitoring blood loss during the childbearing period is an acute concern in nursing practice.

Visual estimation is still the primary means of monitoring blood loss during intrapartum and postpartum care of women. Visual estimation is efficient in terms of cost and time. It seems likely that the efficiency and ease of this method is the paramount reason for maintaining the widespread use of this subjective system within the technologically oriented discipline of obstetrics.

The literature was reviewed for previous investigations into blood loss estimation. Related aspects of the problem of blood loss estimation reviewed in this chapter include methods of measuring blood loss other than visual estimation. The issue of what constitutes excessive postpartum blood loss is also addressed.

Estimation of Blood Loss

Buchman (1953) noted that estimations of blood loss during gynecological surgeries were often 400 to 500 milliliters less than measured blood loss. He also declared that much disagreement on the amount of blood loss occurred among the various attendents during surgery.

Blood volume changes in women during pregnancy and the early puerperium were studied by Pritchard and his associates, who concluded that estimated blood losses for vaginal and cesarean deliveries had been routinely underestimated at their institution (Pritchard, Baldwin, Dickey & Wiggins, 1962). Radioactive chromium was used to label red blood cells in 150 women at term to quantify blood loss at delivery. The average measured losses of 505 milliliters for vaginal delivery and 930 milliliters for cesarean delivery were compared with the "routine" recorded losses of 100 to 150 milliliters and 300 to 400 milliliters, respectively.

Newton (1966) compared estimated blood loss with the measured loss using a colorimetric method. All materials containing blood were collected in a solution which converted hemoglobin to acid hematin. A colorimeter was used to read the hemoglobin concentrations of the diluted sample of the acid hematin solution and a venous sample of the patient's blood. This allowed calculation of blood loss by a simple formula. Testing of the method demonstrated a recovery of 88.5 to 97.9% of the blood used.

After measuring blood loss from 100 vaginal deliveries, Newton reported a 46% mean error of estimation. Newton also noted that estimations tended to be lower as blood loss increased. When blood loss measured between 400 and 499 milliliters, estimations were 20% low; for a measured loss of 500 milliliters or more, blood loss was underestimated by 34%. The mean blood loss during delivery and the first postpartum hour in this study was 577 milliliters.

A similar colorimetric method was used by Brant (1967) to measure blood loss at vaginal deliveries. Blood and blood-stained fabrics were agitated by washing machine to release hemoglobin. The hemoglobin concentrations of the agitated solution and of the patient's venous blood were used to calculate blood loss with a reported error of less than 2%. Comparisons of estimated blood loss with the measured loss (n=57) indicated that the amount of underestimation increased as the amount of blood loss increased.

The hemoglobin extraction-dilution method utilized by Wallace (1967) involved the use of the Perdometer, a washing machine with a built-in colorimeter. The reported error of this technique was reported at 1/2%. Comparisons of measured blood loss with the estimated loss given by the surgeon or nurse showed a "statistically significant under-estimation" during vaginal deliveries with episiotomy and forceps deliveries, that is when blood loss exceeded 200 to 300 milliliters (Wallace, 1967, p. 65).

Moir & Wallace (1967) used the Perdometer to determine blood loss at 113 forceps deliveries. The average error in estimated blood loss is listed as 28%. The investigators also noted that error in visual estimation increased as the measured blood loss increased. Estimates by "junior nurses" were said to be "even more inaccurate" (p. 427).

A more recent study (Sheridan, 1981) tested the ability of members of an anesthesia department to accurately estimate blood loss intraoperatively. Measurement of blood loss was accomplished by a gravimetric method, i.e., by weighing surgical sponges. No statistical significance was found between estimated and weighed loss on four-inch by eight-inch sponges. On the larger "lap" sponges, blood loss was underestimated by a mean of 23 grams for every grouping of five sponges. Surgical cases used in the study were randomly selected, however, the total number of cases was not reported. The results did indicate a tendency to underestimate with increased blood loss.

Higgins (1982) is the first investigator to report on the estimation of blood loss by nurses. Higgins measured the ability of registered nurses (n=42) to visually estimate premeasured amounts of whole blood on perineal pads. Nurses who estimated blood loss on a daily basis were included in the study. The areas of clinical specialty of the participants were obstetrics, operating room and the emergency department.

Analysis of the data revealed no significant difference in accuracy of estimations among nurses with different specialties. The majority of nurses (n=30) overestimated the volume of blood present on the perineal pads. Twenty-five percent (n=10) underestimated blood loss. Estimates of small amounts of blood (5 ml.) and larger amounts of blood (80 ml.) varied widely with mean errors of estimation of 300% and 150%. The average mean error of estimation was 100% high. Moreover, Higgins found that there was a wide overlap when nurses were asked to qualify the blood loss as heavy, moderate or slight (Higgins, 1980).

Clough & Higgins (1981) tested a smaller sample of nurses (n=25) and noted similar results. Premeasured amounts of blood were placed on perineal pads, sponges, lap sponges and chux. The error in estimation increased as the amount of blood increased. The report does not state whether the tendency was to overestimate or underestimate the amount of blood present. There was, however, much inconsistency by nurses in the amounts they over- and understimated. In addition, there was marked disagreement among nurses as to what constituted heavy, moderate and slight amounts of blood. Although not specifically tested, the amount of dispersion of the blood or the absorbency of the pad appeared to affect the accuracy of estimation.

Problems in Blood Loss Estimation

Higgins' study (1980) indicates that nurses are more likely to overestimate blood loss. Conversely, the medical studies reviewed on the discrepancies present in blood loss estimation indicate that physicians will most often underestimate the amount of blood lost during a delivery or surgery. These latter studies have not gone unappreciated. Watson (1980) states that we may reasonably assume that the actual blood loss is twice the estimated amount.

Pritchard and his associates (1962) suggested the use of a one-plus to four-plus scale, such as that used to evaluate the degree of proteinuria, as it "could hardly be much less precise than the current common visual 'quantitation'" (p. 1278). This is the same concept used by nurses when the degree of postpartal blood loss present on a perineal pad is evaluated as scant, slight, moderate or heavy. Unfortunately this system appears to be as imprecise as guessing the volume of blood idn cubic centimeters. Higgins (1980) found that nurses' estimates of slight blood loss ranged from two to 150 cubic centimeters, moderate blood loss from five to 250 cubic centimeters and heavy loss from eight to 500 cubic centimeters.

These wide variations in estimates, both those quantified in cubic centimeters and those estimated by degree, are far from reassuring. With so little apparent agreement on what the amount of blood loss might be or even whether it is to be classified as slight or heavy, one may wonder how clear communication about postpartum bleeding is accomplished among health care practitioners.

Few current nursing texts define the terms used to assess blood loss. One text states that changing the two pads worn by a postpartum patient more than twice during the first two hours is excessive (Ingalls & Salerno, 1983). Two texts state that the estimated loss is probably half the true loss and urge that an accurate pad count is recorded (Bash & Gold, 1981; Reeder, Mastroianni & Martin, 1980). One text states that nurses can learn to estimate accurately through weighing or experimentation "with dark liquids poured onto cloth or perineal pads" (Bash & Gold, 1981, p. 510).

Jacobson (1985) has proposed a standard for assessing peripad saturation. According to Jacobson's standard, heavy blood loss is defined as "saturated peripad within one hour"; moderate blood loss is defined as "less than six-inch stain on a peripad" and a light amount is defined as "less than a four-inch stain on a peripad". A scant amount is defined as "blood only on tissue when wiped or less than one-inch stain on a peripad" (p. 175).

Operationalizing the ambiguous terms "light", "moderate" and "heavy" is the first step toward promoting a clear basis for communication about postpartum bleeding. Potentially, difficulties could arise when blood is saturating fabrics or pads other than peripads. Also the terms slight, moderate and heavy may take on different meanings with antepartum bleeding. The volume of blood that would be expected to make a four or six-inch stain on a peripad is not given by Jacobson.

Higgins (1980) noted that saturation of the two different brands of peripads used in her study differed by 40 cubic centimeters.

The problem of blood loss estimation is complicated by the inconsistencies present in the literature as to what constitutes a safe or normal amount of postpartum blood loss. Postpartum hemorrhage is traditionally defined as blood loss greater than 500 cubic centimeters within the first 12 hours after delivery (Crawford, 1984; Lucas, 1980; Watson, 1980). Yet studies have presented evidence indicating that 500 cubic centimeters is the average blood loss at vaginal delivery using the colorimetric method (Newton, 1966) and radioactive labeling techniques for determining blood loss (Pritchard, et al., 1962; Ueland, 1976). Brant (1967) found that blood loss exceeded 500 cubic centimeters in over 20% of the 57 vaginal deliveries studied using the colorimetric method of determining blood loss. Wallace (1967), also using a colorimetric method, found that over 80% of women having vaginal deliveries without episiotomy lost less than 200 cubic centimeters of blood. Average blood loss with an episiotomy was 327 cubic centimeters. At forceps delivery, mean blood losses of 518 cubic centimeters under general anesthesia, 412 cubic centimeters with pudendal block and 276 cubic centimeters with epidural block were recorded by Moir & Wallace (1967) using a colorimetric technique. Collea (1978) stated that the "normal patient may lose up to 500 ml. of blood and patients with postpartum hemorrhage may lose in excess of 1000 ml." (p. 133). Crawford (1984) reported that 200 cubic centimeters is the average blood loss at vaginal delivery without an episiotomy and 300 to 375 cubic centimeters is the average loss with an episiotomy.

One current nursing text lists normal blood loss at delivery as 200 to 400 cubic centimeters (Moore, 1983). Another states that the "total amount of lochia discharged [is] from 150 to 400 ml." (Ziegel & Cranley, 1984, p. 463).

Medical studies have demonstrated a wide range in intrapartum and postpartum blood loss. There are many conditions which predispose a woman to excessive blood loss and postpartum hemorrhage. Variations also occur according to parity (Newton, 1966), type of anesthesia (Crawford, 1984; Moir & Wallace, 1967), with the use of forceps (Crawford, 1984; Moir & Wallace, 1967; Ueland, 1976) and with the incidence of episiotomy (Crawford, 1984). This is only a partial list of the variables which can affect the amount of postpartum blood loss. The confusion faced when attempting to define average blood loss was noted by Crawford, who commented that, "what is loosely termed the normal range of blood loss at delivery is ill-defined and, indeed, shifts quite considerably each few years" (1984, pp. 6-7).

Measuring Blood Loss

Accurate methods of measuring blood loss have been referred to earlier in the chapter and are summarized below for ease of comparison.

The hemoglobin extraction-dilution technique, also known as the colorimetric method, involves the collection of all blood and blood-stained materials in a solution to extract the hemoglobin. Hemoglobin extraction can be accomplished by using a solution of hydrochloric acid to convert the hemoglobin to acid hematin (Newton, 1966), or by simple agitation of the solution (Brant, 1967). A colorimeter is then used to read the hemoglobin concentration of the solution and of a venous sample of the individual's blood taken before delivery. Blood loss may then be calculated by using the formula (Brant, 1967):

$$\text{Blood loss} = \frac{\text{Volume of the solution} \times \text{hemoglobin concentration of the solution}}{\text{Hemoglobin concentration of the venous sample}}$$

Another method involves the radioactive labeling of red blood cells (Pritchard, et al., 1962; Read & Anderton, 1977) or serum proteins (Ueland, 1976). The specific technique used to determine blood loss varied by study. Pritchard and his associates (1962) used radioactive chromium to label the red blood cells of parturient women. Blood-soaked materials were dried in glass jars. A measured volume of water was then added to the jars to dissolve the hemoglobin contained within. The radioactivity per milliliter was measured from the hemoglobin solution in the jars and from the patient's venous blood. The volume of blood lost by the patient was calculated by the formula:

$$\text{ml. of blood loss} = \frac{\text{Total volume water} \times \text{radioactivity per ml}}{\text{Radioactivity per ml. of blood}}$$

The colorimetric method and radioactive tracing of blood cells are the most accurate methods of blood loss measurement. Both methods are time-consuming and too costly to employ on a routine basis.

Moreover, the injection of radioactive material into another's body is subject to risks which preclude its routine use.

The determination of blood loss by weighing blood soaked materials is known as the gravimetric method. Most dry peripads and sponges are fairly uniform in weight. Assuming that one milliliter of blood weighs one gram, the numerical difference between the weight of the blood soaked material and the dry weight of the material will equal the number of milliliters lost. This method is simple, inexpensive and appropriate to nursing. There are inherent disadvantages to this method as well. It may be too time-consuming when a patient is hemorrhaging. Problems can arise when blood soaked linens and drapes are too bulky and difficult to weigh. During delivery, the presence of amniotic fluid, meconium and urine can also make this method impractical.

Assessing Blood Loss Indirectly

The hemoglobin/hematocrit differential is calculated by subtracting the postpartum hematocrit (or hemoglobin) from the predelivery hematocrit (or hemoglobin). Blanchette (1977) states that because this is an indirect measure it is inexact.

Ueland (1976) proposed revising the definition of postpartum hemorrhage as "blood loss from vaginal delivery that results in a decline in hematocrit 24 hours postpartum" (p. 676). His argument was based on studies which showed a slight rise in the hematocrits of vaginally delivered patients and a corresponding decline in the hematocrits of cesarean delivered patients on the first postpartum day (Pritchard, et al., 1962; Ueland, 1967). Brant (1967), however, found no correlation between alterations in hemoglobin levels and net blood deficits. The administration of intravenous fluids will also cause a decline in the hematocrit and hemoglobin, confounding the usefulness of these values as indicators of excessive blood loss (Crawford, 1984; Lucas, 1980).

Vital signs and blood pressure are carefully monitored by nurses during the immediate postpartum period. The use of pulse and blood pressure as indicators of blood volume status may be misleading due to the already increased blood volume at term. Tachycardia and a decreased systolic pressure are late signs of hypovolemia indicating a blood loss of over 1200 cubic centimeters (Lucas, 1980). When blood loss has been slow and enduring the appearance of these signs may be even more ominous (Brant, 1967).

The tilt test is used to detect acute blood loss by measuring the pulse and blood pressure of a subject in the supine position and then again one minute after sitting or standing. A fall in blood pressure, increased pulse or the subjective experience of weakness or dizziness is considered a positive test.

The application of the tilt test is limited. Knopp, Claypool & Leonardi (1980) noted that its use was reliable only in detecting acute blood loss of 1000 cubic centimeters when tested on young, healthy adults. Also a negative test does not preclude the possibility that significant blood loss has occurred.

Urinary output can be assessed by an indwelling catheter as an indicator of blood volume status. Adequate renal perfusion can be assumed when the urine output is greater than 30 cubic centimeters per hour. Urine flow less than this indicates that blood has been shunted to the more vital areas of heart and brain. Other, earlier indicators of shunted blood are pale mucous membranes, cold fingers, ears and nose, and minor changes in heart rate.

Central venous pressure and Swan-Ganz catheter placements are invasive procedures used in cases of severe postpartum hemorrhage. The central venous pressure measurement is especially useful for monitoring volume replacement. This is a measurement of the heart's ability to cope with venous return. The pulmonary wedge pressure, via the Swan-Ganz catheter, reflects left atrial pressure and a decreased blood volume (Watson, 1980).

In summary, there are various means available to assess blood loss in the postpartum patient. Of the more accurate direct measurements, only the gravimetric method is appropriate for nurses.
Disadvantages of this method are that it is time-consuming and difficult to weigh large bulky materials. Monitoring vital signs, blood pressure and assessing for adequate tissue perfusion are indirect means of monitoring blood volume changes which are obviously within the realm of nursing.

Conclusions and Summary

The literature was reviewed for studies pertaining to blood loss estimation. Medical studies have indicated the tendency for physicians to underestimate blood loss at delivery. The degree of underestimation appears to increase with larger blood losses.

Evidence indicates that nurses tend to overestimate blood present on perineal pads. Discrepancies are especially pronounced when larger and smaller amounts of blood are present. The nurses tested demonstrated little agreement as to what constitutes heavy, moderate or slight blood loss (Clough & Higgins, 1981; Higgins, 1980).

The difficulties inherent in visual estimation of blood loss may be compounded by the inconsistencies present in the literature as to what constitutes a normal or safe amount of blood loss at parturition. Intrapartum and postpartum blood loss are also influenced by the type of medical management a woman receives during delivery.

Methods of direct measurement and indirect assessment of blood loss were reviewed and summarized. Monitoring vital signs and the individual's general condition are of value in protecting the postpartum woman from debilitating blood loss. Still, visual estimation of blood loss remains an important aspect of intrapartum and postpartum care for, "the amount lost is best determined by close observtion of the bleeding as it occurs combined with an ability to make a realistic estimate of the loss" (Brant, 1967, p. 399).

CHAPTER III

METHODOLOGY

This chapter describes the methodology of the study. A description of the study's design is presented, followed by the plan for sample selection, setting and data collection. The plan for analysis of the data is also discussed.

Research Design

This study was intended as a replication of Higgins' (1980) thesis, "Measuring Nurses' Accuracy of Estimating Blood Loss". A descriptive study very similar to that of Higgins' was designed to find out if an as yet untested sample of maternity nurses were more likely to overestimate or underestimate blood loss. The degree of consistency which nurses exhibit when estimating blood loss as slight, moderate or heavy was another aspect of Higgins' original study to be replicated. The current study was also designed to seek out relationships between the type of material containing blood, the amount of blood present and the degree of accuracy in estimation.

Sample and Setting

A convenience sample of 39 nurses involved in the care of parturient and postpartum women was utilized for this study. The sample included nurses from labor and delivery, postpartum recovery and the postpartum maternity units. The nursing staff at the two facilities accessed were employed to work specifically in one of these three areas, although often required to "float" to another if the need arises. The criteria for participation in the study were that the subjects are licensed, registered nurses and employed to work in the hospital's maternity area.

Approval from the Human Subjects Committee of the University of Arizona was obtained before permission was sought to access the two hospitals for both setting and sample. Approval was then obtained through the research and education departments of two large hospitals in metropolitan Arizona.

Data Collection

Two patient carts were set up to hold 20 items containing outdated blood. The 20 items consisted of five different materials commonly used in the obstetrical area: bedpans, perineal pads, blue "chux", flannel pads, and four by four gauze sponges. Each grouping of four by four sponges were opened to a four by eight size, five sponges thick to simulate the dressings used to cover the incisions of cesarean-delivered women. Each of the five materials contained blood in the amounts of 25, 50, 80, and 150 cubic centimeters. Thus, each subject was required to estimate four different amounts of blood contained within five different materials with varying degrees of absorbency. The order of presentation of the materials was randomized throughout the data collection to control for extraneous variables.

Both verbal information and a written disclaimer were presented to nurses participating in the study to describe the purpose and the nature of the investigation. Assurance that participation was completely voluntary and responses confidential and anonymous was provided.

The items were number one through 20. The subjects were asked to begin with number one and continue sequentially until finished. Subjects were also informed that the materials contained outdated blood. A box of gloves were available if subjects wished to pick up the items. The true amounts of blood present on the materials were made available to each nurse as she completed the study.

Arrangements were made with United Blood Services (UBS) to save outdated blood for use in the study. The limited availability of whole blood required the use of packed red blood cells. Saline was added to each unit of packed red blood cells to restore it to its original volume of 450 milliliters. On comparison, no visible difference could be discerned between whole blood and packed red blood cells diluted with saline.

Instrument Development

The instruments developed by Higgins and used to record information in the study "Measuring Nurses' Accuracy in Estimating Blood Loss" were used in the current replication of her study. The "General Information" sheet was modified somewhat for use in this study (Appendix C). Open ended questions concerning where and how nurses first learned to estimate were given categorical choices to narrow the types of responses and to facilitate analysis of the data. The categories on the questionnaire were derived from the responses given during Higgins' original study. An additional exploratory question was added to the questionnaire in hopes of eliciting cognitive styles or thought processes involved in estimation. Because the focus of this study was on maternity nurses, areas of specialization were limited to those found within the maternity setting.

The recording sheet was developed by Higgins, who commented on its clarity and convenience for recording data (Higgins, 1980). The sheet provides boxes numbered one through 20 which allow subjects to record each estimation in cubic centimeters and to check the estimation of each item as either slight, moderate or heavy (Appendix D).

Plan for Analysis of the Data

Descriptive statistics were utilized in data analysis to determine if significant relationships exist among the variables under study. The plan for analysis is described according to the instruments used in data gathering and the research questions under study.

The Information Sheet. Percentages and frequencies were used to organize the data obtained by the information questionnaire. This data provided the demographic characteristics of the sample. The sample was categorized according to educational preparation, length of experience in blood loss estimation, and where and by what method estimation was first learned. Themes as to methods or techniques used by nurses to aid in the process of estimation were also categorized.

The Recording Sheet. Frequency distributions, mean estimates and mean error scores were computed to determine the accuracy of nurses in blood loss estimation. To compute mean error scores a "disaccuracy" variable was created by taking the difference between the estimated amount of blood and the actual amount present for each observation. Only absolute values were used in recording "disaccuracy" scores. For example, both an overestimate and an underestimate of 25 cubic centimeters on a given item were recorded as "disaccuracy" scores of 25, thus, avoiding neutral scores. Frequency distributions were also used to evaluate the consistency exhibited by the sample when estimating blood as slight, moderate or heavy.

Multivariate observations were used in a secondary analysis of the data. Simultaneous hypothesis testing was accomplished by the development of 95% confidence statements about each component mean. The statistical null hypothesis tested was that there would be no significant difference between estimations of the item and the actual amount of blood present (25, 50, 80, or 150 cubic centimeters). The difference between the direct hypothesis test and simultaneous hypothesis testing is, with the latter, if the null hypothesis is rejected, the observation at fault can be directly pinpointed. This test was used to determine if the amount of blood or the material containing it statistically affected the accuracy of the estimations by the sample. The value of this type of analysis is that the assumption of independence is not violated. That is, the 20 observations made by each of the subjects cannot be considered as independent of each other and were treated accordingly.

Limitations

The generalizability of the study's findings is a limitation due to the use of a convenience sample. Therefore, the extrapolation of the findings to the population of maternity nurses is limited.

Another limitation of the study design was the small sample size relative to the large number of questions (20 observations) asked of each subject. The multivariate approach to the analysis of the data assumes that there is a normal distribution of estimations for each item. The variances of the 95% confidence statements about the component means would, therefore, be more stable with a much larger sample size.

CHAPTER IV

PRESENTATION AND ANALYSIS OF THE DATA

The study, presented in the preceding chapters, was designed to describe blood loss estimation abilities of nurses specializing in maternity care. Another purpose of the study was to seek out relationships which might exist between educational achievement, experience in estimation and accuracy in blood loss estimation.

This chapter is concerned with the presentation and analysis of the data. The demographic characteristics of the sample are described. The data will then be presented and analyzed.

Characteristics of the Sample

A convenience sample of 39 registered nurses from two major hospitals in Arizona participated in the study. All of the nurses were female, with ages ranging from 21 to 63 years. The mean age of the sample was 40.2 years.

The basic nursing program attended by 56% (n=22) was a diploma school. Associate degree programs were originally attended by 28% (n=11) and baccalaureate degree programs by 15% (n=6) of the nurses participating in the study.

The highest level of nursing education achieved by the sample was a diploma by 41% (n=16), an associate degree by 23% (n=9) and a baccalaureate degree by 26% (n=10). A master's degree was earned by three nurses. One nurse was certified as a nurse-midwife.

Table 1. Highest Level of Education Attained by the Sample n=39

	Number	Percentage
Diploma	16	41%
Associate Degree	9	23%
Baccalaureate Degree	10	26%
Master's Degree	3	8%
Certified Nurse Midwife	1	3%

Experience in blood loss estimation by the sample ranged from one to 37 years. Twenty-six percent (n=10) of the nurses had been estimating blood loss from one to three years. Thirty-four percent of the sample (n=13) had from four to 11 years experience estimating blood loss. The remaining 40% of the sample (n=15) reported from 15 to 37 years of experience in blood loss estimation.

Blood loss estimation was first learned on the job by 74% of the nurses (n=29). The remainder of the sample first learned to estimate in nursing school (n=6) or both on the job and in nursing school (n=3). One nurse reported that she "never learned" to estimate blood loss.

How these nurses first learned to estimate blood loss varied considerably among the sample. Guessing was reported by 26% (n=10) as how they first learned to estimate. Nurses also learned by weighing (n=6), by asking others (n=5), and by weighing and experimenting with measured amounts of blood or other fluids (Table 2). Of the nurses who learned to estimate on the job, the majority learned either by guessing, asking others or both (n=21).

Over half of the nurses comprising this sample worked in labor and delivery (n=21). Eight nurses worked regularly in the postpartum recovery area and one nurse worked in both of these areas. Six nurses worked on the maternity floor and one nurse reported that she worked both on the maternity floor and in postpartum recovery. Two nurses worked regularly in all three maternity areas regularly.

Table 2. Length of Experience in Blood Loss Estimation n=39

Years of Experience	Number	Percentage
1 - 3	10	26%
4 - 6	8	21%
8 - 11	5	13%
15 - 20	8	21%
22 - 37	7	19%

Table 3. Where Blood Loss Estimation Was First Learned

	Number	Percentage
Nursing School	6	15%
On the Job	29	74%
Both School and Job	3	8%
Never Learned	1	3%

Table 4. How Blood Loss Estimation Was First Learned n=39

Method	Number	Percentage
By Weighing	6	15%
By Guessing	10	26%
By Asking Others	6	15%
By Experimenting With Measured Amounts of Blood or Other Liquid	1	3%
By Weighing and Guessing	1	3%
By Guessing and Asking Others	5	13%
By Weighing and Experimenting With Blood or Other Liquids	5	13%
By Asking Others and Experimenting With Blood or Other Liquids	3	8%
By Guessing and By Experimenting With Blood or Other Liquids	1	3%
By Using All of the Above	1	3%

An exploratory question on the demographic tool asked for specific techniques used as aids in blood loss estimation. Table 5 lists these themes. Some type of measurement system was used by half of the nurses who answered this question (n=13). A number of nurses (n=11) reported using various perceptual techniques such as visualization, sight comparison, and weight estimation. Three nurses reported relying on experience. One nurse straightforwardly reported using "guesstimation".

Nurses' Responses as to What Constitutes Slight, Moderate and Heavy Postpartum Blood Loss

Table 6 lists the frequency and percentage of responses to each category of slight, moderate or heavy for each item. The majority of nurses considered 25 cubic centimeters a slight amount on all materials except the chux. Fifty-eight percent of the respondents (n=22) considered 25 cubic centimeters of blood on the chux a moderate amount. "Slight" was chosen by 39% (n=15). One nurse considered this item to be a heavy loss.

The chux with 50 cubic centimeters of blood was considered moderate loss by 67% of the nurses (n=24). Eleven percent (n=4) chose "slight" and 22% (n=8) chose "heavy" for the same item. The amount of 50 cubic centimeters on the remaining four materials, the bedpan, perineal pad, flannel pad and four by four gauze, was considered as either slight or moderate loss with the respondents close to evenly divided on the two choices.

Table 5. Techniques Used by Nurses to Estimate Blood Loss

Technique Used	Frequency
Volume Displacement	5
Weight	2
Measuring	2
Weighing and Measuring	1
Using Graduates	2
Measuring in Centimeters	1
Estimated Weight	2
Sight Comparison	2
Visualizing by Cups, Teaspoons, Tablespoons or cc.'s	3
How Saturated	2
Experience	3
Observation	1
Guesstimation	1

Table 6. Blood Loss Estimated as Slight, Moderate, or Heavy by Material and Amount n=38 *n=37 **n=36

Material	Amount (cc.'s)	Slight Freq.	Slight Pct.	Moderate Freq.	Moderate Pct.	Heavy Freq.	Heavy Pct.
chux	25	15	39%	22	58%	1	3%
**chux	50	4	11%	24	67%	8	22%
chux	80	2	5%	13	34%	23	61%
chux	150	--	--	6	16%	32	84%
bedpan	25	33	87%	5	13%	--	--
bedpan	50	17	45%	20	53%	1	3%
bedpan	80	5	13%	29	76%	4	11%
bedpan	150	2	5%	13	34%	23	61%
peripad	25	34	89%	4	11%	--	--
peripad	50	19	50%	19	50%	--	--
peripad	80	7	18%	26	68%	5	13%
*flannel	25	34	92%	3	8%	--	--
flannel	50	23	61%	15	39%	--	--
flannel	80	9	24%	23	61%	6	16%
flannel	150	2	5%	18	49%	17	46%
4x4	25	27	71%	11	29%	--	--
**4x4	50	17	47%	15	42%	4	11%
*4x4	80	3	8%	26	70%	8	22%
*4x4	150	1	3%	16	46%	20	54%

Eighty cubic centimeters of blood on the chux was thought to constitute a heavy loss by 61% (n=23) and a moderate loss by 34% (n=13). Two nurses considered this item to represent a slight loss. When evaluating 80 cubic centimeters of blood on the bedpan, perineal and flannel pads, 61 to 76% considered the amount as moderate loss. Eleven to 16% of the respondents considered it as heavy loss and 13 to 24% thought it represented only a slight loss. Evaluations of 80 cubic centimeters on the 4x4 gauze showed slight increase in the number considering this a heavy amount (n=8). The majority of respondents, 70% (n=26) thought this represented moderate blood loss.

The chux with 150 cubic centimeters of blood was considered as heavy postpartum loss by 84% of the respondents (n=32). This amount in the bedpan was considered as heavy loss by 61% (n=23) and as moderate loss by 34% (n=13). On the remaining three materials, the responses were divided between moderate and heavy. One or two respondents considered 150 cubic centimeters as slight loss on all materials with the exception of the chux.

The respondents were most consistent when evaluating the amounts 25 cubic centimeters on all items except the chux. This sample was most inconsistent when evaluating 80 cubic centimeters, although a small majority considered it a moderate amount on all materials except the chux. There was a marked ambiguity between the choices of slight and moderate for 50 cubic centimeters and moderate to heavy for 150 cubic centimeters. Occasionally, a response was made by combining the choices, that is, slight to moderate or moderate to heavy. This type of response was omitted from the data. A few respondents used the recording sheet as a type of visual analogue scale. The section in which the check or mark appeared was recorded as the choice regardless of its proximity to another choice. If it was unclear which choice was marked, the observation was treated as missing data.

The differences in choices between blood on the chux and blood on the other materials suggests greater difficulty estimating blood from a chux. Several nurses commented that it was more difficult to estimate blood from a chux because they were less familiar with it.

Comments also stated that the different materials holding the blood suggested different areas of bleeding, that is, the 4x4 gauze suggested abdominal bleeding rather than vaginal loss. One respondent wrote that the association of material to the site of blood loss affected her decision when evaluating the loss as slight, moderate or heavy.

Another respondent commented that the bright red color of the blood would concern her more than the amount present. Other comments indicated that the decision as to whether the loss was evaluated as moderate or heavy would be affected by a continued blood loss.

In summary, the nurses participating in the study evaluated blood loss on a chux differently than on the other four materials. With the exception of blood present on the chux, the majority of nurses consistently evaluated 25 cubic centimeters as slight postpartum loss. A majority also considered 80 cubic centimeters as moderate loss, although there was much less agreement demonstrated. There was a division of responses between slight and moderate for 50 cubic centimeters and moderate and heavy for 150 cubic centimeters of blood. Several respondents indicated a preference for qualifying their estimation by combining choices. Comments, both written and verbal, indicated that the amount of blood is only one part of the total picture when postpartum blood loss is evaluated.

Findings Related to Blood Loss Estimations in Cubic Centimeters

The sample of nurses participating in this study varied widely in their estimations of blood loss. Table 7 lists the lowest and highest estimates for each of the 20 items. Estimations of 25 cubic centimeters of blood ranged from five to 200 cubic centimeters on all materials except the chux. The high estimate for 25 cubic centimeters on the chux was 500 cubic centimeters. Estimations of 50 cubic centimeters of blood ranged from 10 to 500 cubic centimeters; estimations of 80 cubic centimeters ranged from 10 to 900 cubic centimeters. Materials containing 150 cubic centimeters were estimated as holding from 20 to 800 cubic centimeters of blood.

Three observations were treated as missing data and omitted. These were observations of the chux containing 50, 80 and 150 cubic centimeters of blood. These amounts were estimated as 1000, 1000 and 2000 cubic centimeters respectively. It was considered best to omit these data to avoid skewing the results.

The number of responses which were within 10 cubic centimeters of the true amount are also listed (Table 7). Accurate responses were more frequent when the smaller amounts of blood (25 and 50 cubic centimeters) were present in bedpans, perineal pads or flannel pads. When considered by material only, estimates within 10 cubic centimeters

Table 7. Range of Blood Loss Estimations in Cubic Centimeters
n=39 *n=38

Material	Amount	Estimations (cc.'s) Minimum	Maximum	Within 10 cc's
chux	25cc	5	500	3
*chux	50cc	10	400	4
*chux	80cc	15	400	3
*chux	150cc	20	600	4
bedpan	25cc	5	200	22
bedpan	50cc	10	300	17
bedpan	80cc	10	500	7
bedpan	150cc	20	800	5
peripad	25cc	5	200	17
peripad	50cc	10	500	17
peripad	80cc	15	600	11
peripad	150cc	25	500	9
flannel	25cc	5	100	16
flannel	50cc	10	300	16
flannel	80cc	15	900	5
flannel	150cc	15	800	5
4x4's	25cc	5	200	9
4x4's	50cc	5	250	11
4x4's	80cc	15	400	5
*4x4's	150cc	20	700	5

of the true amount were most frequent on the perineal pads with 54 responses and on the bedpan with 51 responses. Estimates were within 10 cubic centimeters of the true amount in 42 cases on the flannel pad, in 30 cases on the 4x4 sponges, and in 16 cases on the chux.

From these findings it appears that the nurses in this sample had the least difficulty estimating blood in the amounts of 25 and 50 cubic centimeters, particularly when blood was contained in a perineal pad, bedpan or flannel pad. There appeared to be greater difficulty estimating blood in the amount of 150 cubic centimeters and blood contained in a chux.

Mean estimates for each item by material and amount are listed in Table 8. When blood was contained in the chux, the mean estimates demonstrate considerable overestimation. The discrepancy between the true amount and mean estimate narrowed when blood was contained in a material other than a chux. To illustrate, the mean estimate for 25 cubic centimeters on the chux was 101.41 (S.D.=88.59). The same amount of blood in a bedpan had a mean estimate of 39.74 (S.D.=39.27), on a perineal pad it was 41.15 (S.D.=31.88), and the mean estimate on a flannel pad was 39.1 (S.D.=24.71). In all cases, the mean estimates indicate that the nurses in this sample were more likely to overestimate.

It is also interesting to note that as the actual amount of blood increased, the standard deviation scores increased as well. For example, the mean estimate of 25 cubic centimeters of blood in a bedpan had a standard deviation of 39.27 which increased to 56.65 when the true amount was 50 cubic centimeters; when the true amount

Table 8. Mean Estimates of Blood by Material and Amount
n=39 *n=38

Material	Amount (cc.'s)	Mean Estimate (cc.'s)	Standard Deviation
chux	25	101.41	88.59
*chux	50	144.21	84.67
*chux	80	168.4	98.72
*chux	150	261.3	140.07
bedpan	25	39.74	39.27
bedpan	50	75.66	56.65
bedpan	80	121.92	95.39
bedpan	150	179.05	152.15
peripad	25	41.15	31.88
peripad	50	78.46	84.7
peripad	80	103.33	96.17
peripad	150	161.92	101.93
flannel	25	39.1	24.71
flannel	50	68.72	53.9
flannel	80	132.44	151.59
flannel	150	179.1	141.4
4x4's	25	50.26	36.15
4x4's	50	74.49	51.71
4x4's	80	127.44	91.69
*4x4's	150	174.87	130.48

was 80 cubic centimeters, the mean estimate had a standard deviation of 95.39 which increased to 152.15 for the mean estimate of 150 cubic centimeters of blood in a bedpan. This nearly proportional increase in the standard deviation scores by actual amount of blood is an indication of the degree of error which is encountered when attempting to use the mean estimates to describe the accuracy of blood loss estimation by this sample. It also reflects the general difficulty this sample of nurses encountered when estimating larger amounts of blood.

For the purpose of this study, a "disaccuracy" variable was created by taking the difference between the true amount present on the materials and the estimated amount recorded by each subject. These values were treated as absolute numbers, that is, both an underestimate of 25 cubic centimeters and an overestimate of the same amount became a "disaccuracy" score of 25, thus, avoiding the potential for neutral scores.

These "disaccuracy" variables were used to compute the mean error scores for each of the 20 items (Table 9). With the exception of the chux, the lowest mean error scores occurred on the materials containing 25 and 50 cubic centimeters of blood. The mean errors for estimates of blood loss on the chux are high, ranging from 77.9 (S.D.=87.198) for 25 cubic centimeters to a mean error of 128.68 (S.D.=123.85) for 150 cubic centimeters of blood. On all materials containing blood, the mean error in estimation increased as the actual amount of blood increased.

A secondary multivariate analysis of the data was performed using simultaneous confidence statements about each component mean

Table 9. Mean Errors of Blood Loss Estimations in Cubic Centimeters by Material and Amount n=39 *n=38

Material	Amount (cc.'s)	Mean Error Scores	Standard Deviation
chux	25	77.9	87.20
*chux	50	100.53	76.85
*chux	80	99.53	87.55
*chux	150	128.68	123.85
bedpan	25	21.92	35.66
bedpan	50	34.34	51.72
bedpan	80	61.15	84.05
bedpan	150	93.20	128.48
peripad	25	20.0	29.56
peripad	50	41.03	79.24
peripad	80	49.74	85.25
peripad	150	68.08	76.02
flannel	25	20.26	19.83
flannel	50	33.33	46.09
flannel	80	78.85	137.07
flannel	150	96.80	106.27
4x4 gauze	25	31.41	30.80
4x4 gauze	50	37.82	42.67
4x4 gauze	80	70.00	75.42
*4x4 gauze	150	87.76	98.74

for each of the 20 items estimated in cubic centimeters. The purpose of this analysis was to carry out simultaneous hypothesis tests and to construct simultaneous 95% confidence intervals about each component mean. The statistical null hypothesis tested was that there would be no significant difference between the true amount present on the given materials (25, 50, 80 and 150 cubic centimeters) and the estimations made by the nurses participating in the study. If the null hypothesis is rejected, simultaneous testing allows an easy determination of which observation is at fault.

The 95% confidence statements about each component mean have been listed in Table 10. It can be noted from the table that there is a wide variance into which a statistically appropriate estimate could fall. The chux containing 25 cubic centimeters of blood, for example, has a 95% confidence statement of -30.346 to 233.295. This means that any estimate greater than -30.345 cubic centimeters and less than 233.295 cubic centimeters is statistically appropriate for this item. Because only two observations were not within this range, the null hypothesis cannot be rejected. Thus, there is no statistically significant difference between the true amount of 25 cubic centimeters of blood on a chux and the estimates made by the sample. There was an average of 2.15 observations not within the range for statistically appropriate estimations. On this basis the statistical null hypothesis cannot be rejected for any of the remaining 19 items. No significant difference between the amount of blood, the type of material and accuracy in estimation can be found by this test.

Table 10. Simultaneous 95% Confidence Statements About Each Component Mean n=39 *n=38

Material	Amount	[95% C.I.]
chux	25cc	[-30.346, 233.295]
*chux	50cc	[16.591, 271.831]
*chux	80cc	[19.570, 317.269]
*chux	150cc	[50.1, 472.50]
bedpan	25cc	[-18.70, 98.19]
bedpan	50cc	[-9.77, 161.08]
bedpan	80cc	[-20.06, 263.90]
bedpan	150cc	[-29.41, 423.50]
peripad	25cc	[-6.29, 88.61]
peripad	50cc	[-47.618, 204.54]
peripad	80cc	[-39.799, 246.465]
peripad	150cc	[10.217, 313.629]
flannel pad	25cc	[2.33, 75.874]
flannel pad	50cc	[11.50, 148.938]
flannel pad	80cc	[-93.186, 358.058]
flannel pad	150cc	[-31.35, 398.558]
4x4 sponges	25cc	[-3.543, 104.055]
4x4 sponges	50cc	[-2.47, 151.444]
4x4 sponges	80cc	[-9.04, 263.91]
*4x4 sponges	150cc	[-21.876, 371.61]

When viewed within a clinical perspective, the results of this analysis lend themselves to a different interpretation. Clinically, there is a significant difference between 25 cubic centimeters and an estimate of 233 cubic centimeters of blood. It has already been noted that nurses appeared to have more difficulty estimating blood on the chux than on the other materials. This variance is especially wide. The variances are not so wide when 25 cubic centimeters was estimated from the bedpan (-18.7 to 98.19), from the perineal pad (-6.29 to 88.61), from the flannel pad (2.33 to 75.874) and from the 4x4 gauze (-3.54 to 104.055). However, even these narrowed statistical variances demonstrate clinical differences between the actual amount and estimates given for that amount.

One limitation of this study is the small sample size for the relatively large number of questions asked of each subject (20 questions per subject). It is possible that with a much larger sample the variances would be smaller and more stable than those reported here.

Relationships Among the Study Variables

Pearson's correlations were used to determine if nursing education or years of experience estimating blood loss were related to accuracy in estimation. The "disaccuracy" scores were used to compute an average error score which was used in the correlations. Thus, the variables were actually correlated with the inaccuracy in estimation.

The highest level of education achieved by the sample (Table 1) was not significantly related to the average error in estimation ($r=15$, $p=.180$). It is possible that with a larger sample a significant relationship could be revealed between higher education in nursing and increasing inaccuracy in estimation. Clinically, the data suggests a trend which warrants further investigation.

No significant relationship was found between years of experience estimating blood loss (Table 2) and the average error in estimation (p=.376). Thus, the results indicate that, in this sample, there is no relationship between a nurse's education or length of experience estimating blood loss and her accuracy, or inaccuracy, in visual blood loss estimation.

Summary

Thirty-nine registered nurses were asked to estimate 20 items which consisted of five different materials, each containing one of four premeasured amounts of blood. The blood on each of the 20 items was estimated in cubic centimeters. The nurses were also asked to estimate each item as slight, moderate, or heavy postpartum loss.

Frequency distributions, mean estimates and mean error values were presented and analyzed. The majority of nurses had the most difficulty estimating blood loss on the chux, the most likely reason being less familiarity with this material. On all materials except the chux, the majority of nurses considered 25 cubic centimeters as slight loss. A smaller majority considered 80 cubic centimeters as moderate loss. The sample was divided when evaluating the amounts of 50 and 150 cubic centimeters of blood.

Nurses varied widely in their estimations of blood loss in cubic centimeters, however, a greater degree of accuracy was demonstrated when smaller amounts of blood were estimated. The mean error in estimations increased as the true amount on the materials increased. The data suggests that nurses are more likely to overestimate blood loss.

A multivariate analysis of the data was performed by developing 95% confidence statements about each component mean for the 20 items. The null hypothesis, there would be no significant difference between a given item's true amount and the estimations of that item, was not rejected in any of the 20 cases.

Although the findings of the study were not statistically significant, there is evidence for clinical significance in blood loss estimation. The small sample size used to answer a relatively large number of questions was a limitation of the study design and of the multivariate approach to data analysis.

CHAPTER V

DISCUSSION AND CONCLUSIONS

This study, like that of Higgins' (1980), measured the accuracy of nurses' estimations of blood loss. The study's findings are discussed in relation to the conceptual framework. Implications for nursing research suggested by the findings in relation to the conceptual framework are briefly discussed. Implications for nursing practice and education are considered. Finally, recommendations for further research are suggested.

The Findings in Relation to The Conceptual Framework

Visual estimation is the most subjective method of evaluating blood loss. Livingston (1978) has stated that sensory perception may be in error simply because it is not recognized to be so. The first step toward improving perceptual efficiency in blood loss estimation requires that attention is directed toward that goal. Experience and practice increase perceptual efficiency in estimation (Heil, 1983; Gibson, 1969; Piaget, 1969). This study found no significant correlation between education or length of experience in blood loss estimation and accuracy in estimation. These findings are in agreement with those of Higgins' (1980). This suggests that although nurses have had years of experience estimating blood loss, the experience was compromised by the lack of adequate and/or accurate feedback. Within the sample of nurses studied, 74% learned to estimate blood loss on the job, the majority of these by guessing and asking the opinions of others. Common sense tells us that the feedback provided by these methods is limited in accuracy.

Psychological studies on size estimation have shown that subjects estimate more accurately when able to rely on their familiarity with the test objects (Liam, 1981). Although multivariate analysis of the data did not show statistically significant differences among the materials containing blood, the frequencies of accurate responses were fewer, the mean error values higher and the variances wider when blood loss was estimated from the chux. Nurses also commented that estimating blood from the chux was difficult for them because they did not use it. The same values also suggest that the sample of nurses experienced greater difficulty estimating blood loss as the actual amount of blood increased.

The use of a standard for estimating blood loss according to peripad saturation has been suggested by Jacobson (1985) to improve the consistency of estimations by maternity nurses and to facilitate clear communication among health care providers. The findings of this study, like that of Higgins' (1980), indicates that nurses do not consistently agree on what they consider slight, moderate or heavy postpartum loss.

It is conceivable that a nurse's cognitive style influences her ability to visually estimate blood loss. Thus, some individuals may be better able to recognize and correct perceptual inaccuracies than others. However, the literature on perception and cognition tells us that accuracy in visual estimation will increase given that attention is directed toward that goal and that opportunities to practice are provided.

Implications For Nursing Research

An important implication for nursing research was brought forward through both the conceptual framework for the study and the search for an appropriate statistical plan for data analysis.

Piaget (1969) described the role of centration as the tendency to assign one object a privileged role as the standard by which others are judged. The tendency is to overestimate the object chosen as the standard. Although a few nurses commented that they based subsequent observations on a previous one, the frequent random ordering of the items made this tendency difficult to recognize.

The existence of this tendency, called the role of centration (Piaget, 1969), suggests implications for nursing research. It is not unusual for a study design to require multiple observations by each subject. However, underlying many popular statistical tests is the assumption of independence, that is, each observation is assumed to be independent of the others. This presents a dilemma for multiple observations by a single subject are necessarily interdependent. One resolution of this problem has been to use an otherwise appropriate test and ignore the violation. Even when the violation of the assumption of independence is acknowledged the problem remains, for this compromise introduces a source of error into the study which is difficult to measure.

The adoption of an exploratory attitude toward data analysis has been advocated by Jacobsen (1981). Simple descriptive analysis of the data in combination with multivariate analysis or other inferential or confirmatory analysis is also suggested by Jacobsen. The additional use of descriptive data allows the researcher a particularly clear picture of the actual data (Jacobsen, 1981). One strength of this study, therefore, is the combination of statistical techniques which avoided violating the assumption of independence. A limitation of the study, relative to the multivariate approach to data analysis, was the small sample size used to make multiple observations.

Implications For Nursing Practice and Education

Hemorrhage remains a leading cause of maternal mortality. Excessive bleeding may occur suddenly or slowly over time. Newton (1966) noted that even "moderate" losses may debilitate the mother who must return home to care for her family as well as a newborn.

Postpartum hematocrits and hemoglobin levels may be of little value in determining the degree of maternal blood loss. Brant (1967) found no correlation between hemoglobin levels on the third postpartum day and net blood deficits. It is likely that one liter of blood would have to be lost before a significant drop in the hematocrit could be detected (Pritchard, et al., 1962).

Evaluating and recording blood loss during parturition and the puerperium is a primary nursing concern. Visual estimation is employed at this time. The value of visual estimation is its simplicity of use. The costs in time and money are negligible. However, findings from this study, and from previous studies, indicate that a great deal of accuracy is sacrificed when visual estimation is employed. Generally, as the amount of blood present on the materials increased, the mean error values increased. While some nurses demonstrated considerable accuracy in their estimations, 95% confidence statements about each component mean showed unexpectedly wide variances.

Maternity nurses are taught to perceive differences in the color, consistency and nature of lochia, yet are not routinely taught to quantify blood loss. Estimation is a perceptual ability which should improve with experience. The length of experience has not been shown to be related to accuracy in estimation. This suggests implications for nursing education both in schools of nursing and in institutions employing nurses who estimate blood loss.

Higgins (1983) suggested the use of a slide-tape presentation to facilitate learning in nurses with certain cognitive styles. The presentation would be followed by hands-on experience measuring, pouring and weighing different amounts of blood. The data collection method used for this study also provided one form of feedback to nurses on their ability to estimate. Posting the dry weights of materials and encouraging nurses to check their estimations on a gram scale would provide an ongoing means of attaining feedback.

Standards for reference, such as Jacobson's standard for perineal pad volume-saturation (1985), could be utilized to develop consistency in the assessment of postpartum blood loss. The sizes, in centimeters, that different volumes of blood would make on sheets or other bulky items could also be posted for quick reference. In summary, there are a variety of inexpensive methods which can be utilized to facilitate perceptual learning and increase the accuracy of visual blood loss estimation.

Recommendations For Further Study

The findings of this study suggest that maternity nurses are not consistent in how they evaluate postpartum blood loss. Visual estimations of blood loss in cubic centimeters also varied considerably. The conceptual framework for this study was drawn from the physiological and psychological literature on cognitive processes which indicate that visual estimation is a perceptually learned process. The literature also indicates that perceptual efficiency, such as accuracy in estimation, should increase with experience. This study found no relationship between experience and accuracy in estimation. Further research into this area is suggested by the following:

1. Replicate this study with a larger, multi-hospital sampling of nurses to see if similar findings emerge.

2. Redesign the study to determine if how nurses learned to estimate and the type of perceptual techniques used to estimate are related to accuracy in estimation.

3. Teach a group of nurses to estimate using standards for reference and teach another group to estimate by allowing them to pour measured amounts of blood onto materials. Test the accuracy of estimations by each group.

APPENDIX A

HUMAN SUBJECTS REVIEW APPROVAL

THE UNIVERSITY OF ARIZONA
TUCSON, ARIZONA 85721

COLLEGE OF NURSING

MEMORANDUM

TO: Victoria Bockman, BSN, RN
College of Nursing

FROM: Ada Sue Hinshaw, PhD, RN — Director of Research
Merle Mishel, PhD, RN — Chairman, Research Committee

DATE: November 8, 1985

RE: Human Subjects Review: Blood Loss Estimation By Maternity Nurses

Your project has been reviewed and approved as exempt from University review by the College of Nursing Ethical Review Subcommittee of the Research Committee and the Director of Research. A consent form with subject signature is not required for projects exempt from full University review. Please use only a disclaimer format for subjects to read before giving their oral consent to the research. The Human Subjects Project Approval Form is filed in the office of the Director of Research if you need access to it.

We wish you a valuable and stimulating experience with your research.

ASH/fp

APPENDIX B

DISCLAIMER SHEET

DISCLAIMER

BLOOD LOSS ESTIMATION BY MATERNITY NURSES

You are being asked to voluntarily participate in a study by answering the questions on the information sheet and by recording your estimations of the blood present on the 20 items before you. Your consent to participate is assumed when you answer the questions.

The purpose of this study is to learn how maternity nurses estimate blood loss. Any questions you have will be answered at any time. There are no known risks.

Your participation is completely voluntary. You may choose to answer all or some of the questions. You may also choose to withdraw at any time without fear of incurring any difficulties or ill consequences. Your name is not to be used on either sheet. All answers will remain confidential.

APPENDIX C

GENERAL INFORMATION SHEET

RO _____

ID _____

GENERAL INFORMATION

Sex: M F Age _____

In what type of program did you receive your basic nursing education?

Diploma _____ Associate _____ Baccalaureate _____

What is the highest degree or level of education you have obtained?

____

How many years have you been estimating blood loss? ________

Where did you first learn to estimate blood loss? nursing school ______

on the job ______ never learned _____

other (please specify) ____

How did you first learn to estimate?

by weighing _____ by guessing _____ by asking others _____

by experimenting with measured amounts of blood or other liquids

_____ other (specify) ____

Is there any specific technique or method you use as an aid in estimation? ____

____

What is your major area of specialization? (select one)

Labor & Delivery _____ Postpartum Recovery _____

Postpartum Floor _____

APPENDIX D

RECORDING SHEET

RO ______

ID ______

RECORDING SHEET

There are 20 items with certain amounts of blood on them.

a) Check the column if the blood on the item is slight, moderate, or heavy.

b) Write your estimate of the amount of blood in cubic centimeters (cc.'s).

Item	Slight	Moderate	Heavy	Amount of Blood in cc.'s
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				
11				
12				
13				
14				
15				
16				
17				
18				
19				
20				

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