PREOPERATIVE WATER LOSS IN ELECTIVE SURGICAL PATIENTS

by

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Ann M Voda — March 20, 1979

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Date

My dear Lord, you have shown and given me the beauty and love of living. From this bountiful gift, I blissfully offer and share the goodness of life with others.

> "...The Lord is my strength
> and my shield. In Him my
> heart trusts and I find help;
> then my heart exults and with
> my song I give Him thanks."
> Psalm 27(28):7

This work is fully dedicated with love to my parents, Richard and Teresa, for their ever present love, devotion, generosity and support. Your continuing guidance and faith in me has lighted many paths of happiness.

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TABLE OF CONTENTS

TABLE OF CONTENTS--Continued

LIST OF TABLES

ABSTRACT

This study was conducted to determine if patients undergoing vaginal and abdominal hysterectomies entered the operating room in an early stage of dehydration. It was based on knowledge of the physiological mechanisms that occur when fluid is restricted, particularly the obligatory preoperative fluid loss due to enforced "nothing by mouth" (NPO) routine and the activation of antidiuretic hormone (ADH) release in these patients.

The data consists of admission and presurgical body weight measurements, measurements of sensible intake and output, and estimated measurement of insensible output based on body surface area.

Data analysis showed that all subjects lost weight during the overnight fast. Two subjects lost more than two percent of their initial body weight. Both were identified as having a short and overweight body build or excess adipose tissue. One subject was approaching dehydration, and had a tall and muscular-type body build.

The findings suggest that some preoperative vaginal and abdominal hysterectomy patients enter the operating room in an early stage of dehydration. Further work is

required so the hydration state can be monitored so to identify patients who are in an early stage of dehydration.

Monitoring patients preoperatively could minimize fluid loss by allowing a shorter NPO time. This could minimize the preoperative initiated ADH response which may be related to the postoperative inappropriate secretion of antidiuretic hormone syndrome documented in postoperative patients. This hypothesis needs to be tested.

CHAPTER 1

INTRODUCTION

When hospitalized presurgical patients are restricted of all intake of solid and liquid foods because of being placed on a "nothing by mouth" (NPO) routine, they are placed in a position of denying their systems of the most vital substance necessary for physiological functioning, water. Water, secondary to oxygen as being the most important constituent of life, comprises 50 to 70 percent of the weight of the body (Bland, 1963).

Water plays a major role in maintaining the milieu. Water is the environment in which all chemical reactions in the body occur. It is well documented that any increase or decrease of body water will alter these biochemical reactions (Metheny and Snively, 1974). Therefore, maintenance of the fluid volume or water balance of the internal milieu is of high priority.

Restricting oral intake for various periods of time in the presurgical period is a common event. The usual purpose is to minimize the volume of the gastrointestinal contents to decrease the chance of aspiration of these contents when patients are anesthetized and recovering from surgery.

Although factors such as age, sex, body build, activity as well as food and fluid intake, and elimination habits are known to influence the metabolic rate, they are rarely included when evaluating the possible results of an imposed NPO state in preoperative patients. However, during periods of fluid deprivation, both sensible and insensible water losses are obliged to occur. The net result of the NPO enforced routine is that all preoperative patients enter surgery in a fluid volume depleted state.

Clinically, water depletion or early dehydration in an adult is said to be present when more than two percent of the body weight is lost (Bland, 1963; Marriott, 1950). Lapides, Bourne and MacLean (1965) stated that at least three liters of fluid, or six percent weight, must be lost from the body before signs of dehydration can be seen. The signs of later dehydration are explainable on the basis of passive diffusion, or osmosis, of water from the cell to the extracellular fluid compartment. Thus, laboratory evaluations may be of little help in determining the presence of early dehydration because of water movements. Blood analysis in early dehydration will usually reveal normal levels of sodium, potassium, chloride, hematocrit and serum creatinine (Lapides et al., 1965; Metheny and Snively, 1974).

There have been very few clinical investigations to determine either the magnitude of dehydration or postoperative complications that occur in people who enter

surgery in a dehydrated state. Further, it is not known whether gender or body build is related to fluid loss.

Statement of the Problem

1) Did women undergoing abdominal or vaginal hysterectomies enter the operating room (operative period) in an early dehydrated state? 2) If so, was there a relationship between the presence of early dehydration and the body build of these persons?

Purpose

This study was designed to evaluate the immediate presurgical hydration level of women having either an abdominal or vaginal hysterectomy utilizing body weight change and other non-invasive measures as indicators of fluid loss. This study also examined the relationship between body build (i.e., body surface area and lean mass) and presurgical dehydration.

If a significant number of patients enter surgery in an early stage of dehydration, and if this dehydration is associated with a woman of a particular body size and shape, then nurses and other clinicians can use the body build factor to predict who will have an early dehydration problem, and to plan preventive and individualized NPO routines for these patients, such as shortening the time one is NPO.

Significance of the Problem

Lack of food and fluid intake results in water depletion or primary dehydration. Continued lack of fluid ingestion results in total body water depletion due to the continuance of obligatory sensible and insensible water losses. With continued dehydration, the electrolyte concentration in the extracellular water increases, and this body compartment becomes hypertonic or hyperosmolar. Maintenance of an isosmotic state in all body water compartments is accomplished by the passive diffusion of water from the intracellular compartment to the extracellular compartment and vice versa in response to osmotic gradients (Jensen, 1976). The net result is a volume contracted, hyperosmolar state of these compartments.

Monitoring the hydration state can be accomplished indirectly by utilizing body weight measurements and body surface area to estimate insensible losses. Even though this method of assessing hydration status is simple, non-intrusive and readily available for use by nurses, it is seldom, if ever, used to assess hydration status of NPO preoperative patients. In fact, little fluid volume monitoring is done with any preoperative elective surgery patient. The general routine is to place these patients on NPO at a predetermined time, such as midnight, and they remain NPO until they go to the operating room. The time can range from 6 to 14 hours.

Patients on NPO for long periods of time may be in an early stage of dehydration when they go to surgery. The significance of this clinical problem lies in the fact that the enforcement of the NPO routine by nurses leads to a state of osmotic disequilibrium. Enforcement of a monitoring routine as rigorously as the NPO routine would counterbalance the dehydrating effects of a long period of time on NPO.

Clinical assessment tools presently used to evaluate hydration state are those used to detect large volumes of fluid loss such as fullness and furrowing of the tongue, sunken eyeballs, skin turgor, and hand vein filling and emptying. Lapides et al. (1965) states that a decrease in the volume of the tongue with furrowing or a decreased turgidity of the skin are signs that become apparent only in well advanced dehydration. At this time, there is an average weight loss of three kilograms (kgs) or three liters of water. One can speculate that approaching or early dehydration is a silent, unnoticed, frequently unsuspected condition in the elective presurgical patient.

Definitions

Dehydration: loss of electrolyte free water, simple water depletion.

Body surface area: numerical representation of metabolic activity expressed in meters squared in relation to one's height and weight.

Body build: type of body construction; classification of small, medium or large bone structure in conjunction with being short, average or tall in height.

Obligatory water loss: loss of water from the body that must occur as a by-product of metabolism, metabolite excretion and thermoregulation.

Assumptions

1. All persons lose weight when deprived of fluids.
2. Short term fluid changes, gains or losses can be estimated by changes in body weight.

CHAPTER 2

CONCEPTUAL FRAMEWORK AND REVIEW OF LITERATURE

This chapter presents the physiological framework pertinent to preoperative dehydration and a review of the literature regarding relevant clinical work done on this phenomenon.

Dehydration

Dehydration is the loss of electrolyte free water from the body. Dehydration is also known as volume deficit. Metheny and Snively (1974, p. 18) state "Volume deficit results from an abrupt decrease in fluid intake...or from a combination of decreased intake and increased loss." Continued depletion of the extracellular fluid compartment results in water being drawn from the cells. This ultimately causes a deficit in the intracellular fluid compartment as well.

Dehydration occurs in all presurgical patients due to the enforcement of the NPO routine which occurs at midnight of the day of surgery. Deprivation of all food and fluid intake is a problem because when intake is restricted, water output continues. The obligatory losses,

by-products of metabolism, are both sensible (urine, feces and sweat) and insensible (water vapor through the lungs and skin), and are ongoing processes.

Hydration status is commonly evaluated by using an intake and output record. Since this record only measures sensible fluid gains and losses, its accuracy in predicting body hydration is unreliable. Obligatory losses, without fluid replacement, may render the surgical patient a greater risk if he/she enters surgery in a dehydrated or volume depleted state.

Sensible Losses

Sensible losses are water losses from the body that can be seen, felt and measured. These include the by-products of metabolism excreted in urine and feces, as well as sweat. With the restriction of solid and liquid intake, catabolic processes continue and waste metabolites are produced. These wastes need to be eliminated from the body in order to maintain physiological equilibrium. When persons are placed on restricted intake, such as persons on NPO, the body excretes waste materials in a minimum volume of water. "This minimal amount of urine output required to rid the body of the normal metabolic end-products each day is about 400 milliliters (ml)" (Guyton, 1976, p. 411). This is done to conserve water and maintain an isosmotic state in the fluid compartments.

A normal healthy adult excretes 600 to 2,500 ml of urine in 24 hours. The exact volume varies for the individual (Lapides et al., 1965). Bland (1963 stated that an average of 1,300 ml is excreted in 24 hours. Other averages of daily urine output are 800 to 1,500 ml (Vannetta and Fogelman, 1976), 1,000 ml (Mountcastle, 1968) and 1,700 ml (Brooks, 1968).

It is not known how much fluid can be restricted and still maintain adequate urinary metabolite excretion. In one experiment conducted by Lapides et al. (1965), seven normal healthy males, age 33 to 69 years, were restricted to a 1,500 calorie diet with 68 milliequivalents of sodium and a fluid intake of 360 ml per 24 hours. On the third to fifth day, dehydration became apparent as assessed by a furrowed, shrunken tongue. On this day, it was noted the average volume of urine excreted in 24 hours was 565 ml. Urine osmolality was greater than 1,000 milliosmols per kg. The specific gravity averaged 1.028.

Sensible fluid loss also occurs through defecation. Jensen (1976) measured the average total weight of feces evacuated per day as 250 grams of which 70 percent or 175 ml was water. Ganong (1975) and Guyton (1976) estimate the water contribution to the stool as 75 percent of total stool weight. Gump et al. (1968) determined the water content of 30 so-called normal stools by wet weight-dry weight method.

He found the average water contribution of the stool to be 273 ml per day.

In persons being prepared for surgery, another avenue of sensible water loss occurs due to the enforcement of another routine, the preoperative enema. The enema may be both an avenue of sensible loss and gain for surgical patients, depending on their hydration state. For example, water, particularly if tap water enemas are being administered, may be absorbed by the colon. Large volumes of water given to patients during an enema, such as when an order is given to administer enemas until clear, may cause water intoxication since absorption may be very rapid. "Coma and death due to water intoxication have been reported following tap water enemas in children with megacolon" (Ganong, 1975, p. 375).

Levitan (1962) conducted an experiment in which water and salt were administered as enemata into the human colon. After infusion of isotonic sodium chloride into the cecum, analysis of the evacuated stool revealed that the colon had the capacity to absorb 2.5 liters of fluid per day.

Insensible Losses

Loss of body water by evaporation from the lungs and by diffusion through the skin is known as insensible water loss (Brebner, 1956; Guyton, 1976; Jensen, 1976).

These losses continue just as with sensible losses, even though input is restricted. They can be measured directly with complex equipment. Clinically, only estimations of their loss can be made with some accuracy using nomograms of body surface area (BSA).

Gump et al. (1968) measured insensible loss using body weight changes. He found that the average insensible weight loss of 20 afebrile hospitalized surgical patients was 23 $\pm$ 7.7 grams per hour per metered square of body surface area (23 $\pm$ 7.7 gm/hr/m^2/BSA). Gump measured weight change using a sensitive hydraulic bed scale. Subjects wore a hospital gown and had a single sheet drawn up to the waist, and measurements were conducted in rooms where temperature and humidity were kept at comfortable limits by central air conditioning.

Hayes (1956) also measured insensible water loss. Subjects consisted of a control group of healthy male medical students and an experimental group composed of afebrile first postoperative day patients. The subjects were denied all food and fluid for 18 hours prior to the period of observation. The subjects were housed in rooms kept at constant temperature and humidity. They were weighed with a sensitive scale and the weight change recorded by electric contacts on a kymograph moving 2.54 cm per hour. There was no apparent difference between fasting

normal and fasting traumatized persons. Both groups lost an average of 750 ml water per meter squared of BSA per 24 hours (750 ml/m^2/BSA/24 hrs).

If one uses Gump's and Hayes' values to estimate insensible water loss using body surface area nomograms, different values are obtained. For example, a 70 kg adult with a height of 5'10" (BSA estimation 1.85 m^2) using Gump's values (23 $\pm$ 7.7 gm/hr/m^2/BSA) will lose approximately 42.550 gm of water (ml) per hour when afebrile. Over a 12 hour period, the estimated loss is 510.60 ml. Utilizing Hayes' formula (750 ml/m^2/BSA/24 hrs), this same adult will lose 963.75 ml insensibly over the same time period.

For clinical purposes then, the above mathematical equations provide clinicians with ways to estimate insensible fluid loss. Exact measurements of insensible loss are not possible clinically since these can be obtained only with very sensitive electronic equipment or invasive radioisotope dilution procedures.

Body Surface Area

Body surface area represents a quantitative, though approximate, index of total metabolic activity. DuBois and DuBois (1915) were among those who measured adults using covering and geometric methods. Mathematical

computations involved in obtaining surface area nomograms were the same ones used to derive area and volume of cylinders (Snively, 1957).

The DuBois nomogram is considered quite accurate for clinical purposes. The nomogram chart is designed so that, with knowledge of a patient's height and weight, a diagonal line is drawn through calibrated markings. The line intersects at a specific point in the surface area column. This indicates the body surface area in square meters.

As one's body surface area increases, insensible water loss also increases (Hutchin, 1971). Insensible water loss is further increased by any factor which accelerates metabolism such as fever (Hayes, 1968).

Body Weight and Body Water

Body water contributes 50 to 70 percent of one's total body weight. Actual percentage is dependent on age, sex and amount of fatty tissue. In general, the younger the individual, the higher the percentage of body fluid due to a smaller body surface area and increased muscle mass. An overweight or obese individual contains less fluid than a thin person. This is because adipose tissue is relatively anhydrous and contains little water. Thus, women have a lower body water content than men because of

the greater weight of lean muscle and smaller amount of fat in the male.

As has been noted, it is extremely complex and time consuming to measure the content of body water directly. Therefore, clinicians use several methods to determine the need for water replacement. One such method is to keep accurate intake and output records in conjunction with estimating the insensible water loss.

Another method includes weighing the patient in addition to the above. Changes in body weight are parallel with body water balance (Gump et al., 1968). Rapid weight fluctuations closely correspond to changes in fluid volume (Bland, 1963; Marriott, 1950; Metheny and Snively, 1974). This is because one liter of water, or 1,000 ml, weighs 1,000 gm or one kilogram, and one gram equals one millileter. It is possible to estimate body water changes if body weights are reliable (Bland, 1963). The weighing of patients with potential or actual fluid imbalances is of value in the clinical area because accurate measurements of body weight are easier to attain than accurate intake and output measurements.

One would expect body weight loss when fluid intake is less than fluid output, and conversely, weight gain when fluid intake exceeds output. Painter, Holmes and Gregerson (1948) conducted 12 studies in fluid changes

in 15 dogs in relation to body weight. The dogs were dehydrated by deprivation of both food and water. Measurements of weight, plasma volume, available fluid, total water and electrolytes were made and repeated on the fifth and eleventh days. The average extracellular fluid loss was 67 percent on the fifth day and 57 percent on the eleventh day. The average intracellular fluid loss was 6.5 percent on the fifth day and 16 percent on the eleventh day. The intracellular compartment contributed an average of 33 percent of the total water lost by the fifth day, and 44 percent by the eleventh day. "Thus, as the degree of dehydration increases, the intracellular compartment gives up relatively more of its water" (Painter et al., 1948, p. 73). Weight loss at five days was 9 to 12 percent body weight, and 15 to 20 percent body weight by the eleventh day.

Rapid body weight loss is extremely helpful in the diagnosis of extracellular fluid volume deficit. Using body weight to assess fluid deficit, a weight loss of two percent or more of the total body weight is early dehydration. With a more pronounced or moderate deficit, a five percent weight loss occurs, and a severe deficit is present if eight percent loss or more of the total body weight is lost (Bland, 1963; Marriott, 1950; Wolf, 1958).

Urine Specific Gravity

Urine specific gravity is a convenient, simple and reliable method for evaluating the ability of the kidney to maintain fluid and osmolar balance. The specific gravity of urine is the weight of the urine compared to the weight of an equalled volume of distilled water. This measurement indicates the amount of dissolved solids in the excreted urine. Usually, the urine volume and the specific gravity reflect the state of hydration.

Thus, the state of hydration can be assessed by obtaining a specific gravity reading of urine. In healthy persons, a concentrated urine signifies a water deficit and the specific gravity is high, about 1.030. A dilute urine implies adequate hydration, but it may also imply a possible overhydrated state.

Review of the Literature

Body water is divided into two main compartments, the intracellular space and the extracellular space. The extracellular compartment is further subdivided into the plasma and the interstitial fluid. Men and women differ in the amount of body water in the intracellular fluid compartment. The intracellular fluid compartment contributes 40 percent to the body weight of a male and 30 percent to the weight of a female (Hutchin, 1971).

Body water is the single largest constituent of all living organisms. Water consists of 50 to 70 percent of the total body weight of a human, the variation depending on age, sex and body fat content (Bland, 1963).

Water is ingested as food and drink, and is also derived as a by-product from the oxidation of foodstuffs. In an average diet, approximately 10 to 12 grams of water is obtained from every 100 calories metabolized (Hutchin, 1971).

As has been mentioned, body water is lost constantly by vaporization from the lungs and skin, and in gastro-intestinal discharge. Skin water loss in the absence of sweating averages 300 to 500 ml per day. This value is affected by body temperature and environmental surroundings (Hutchin, 1971). Kuno (1967) approximated cutaneous insensible perspiration for a resting man at room temperature to be 16 grams per square meter of body surface area per hour (15 $gm/m^2/BSA/hr$).

Maintenance of the constancy of the internal environment under different metabolic conditions and changes in oral intake is a primitive survival function found in all animals. Body fluid tonicity and volume are closely guarded and monitored. Deviations of one or both, set off a chain of comepnsatory corrective measures to regain normal conditions.

Regulation of Body Water

Primary dehydration occurs with an uncompensated, simple water loss. With dehydration, both intra- and extracellular fluid compartments change proportionately in response to osmotic gradients. As extracellular fluid becomes concentrated, cell water shifts toward the extracellular space. Cellular dehydration then stimulates the release of antidiuretic hormone from the posterior pituitary gland. The effect of ADH is to maximally reabsorb water in the distal tubules and collecting ducts with the formation of small amounts of concentrated urine. Hence, the system attempts to return to a homeodynamic state by restoring water to hyperosmolar compartments and by minimizing obligatory water loss from the kidney.

Cellular dehydration appears to be the primary stimulus for ADH secretion. Osmoreceptors, located in the supraoptic nuclei of the hypothalamus, become volume depleted, evoke thirst and increase ADH release. "These receptors are not stimulated by a rise in body fluid tonicity as such, but rather by any change in the composition of the extracellular fluid that causes cellular dehydration, and thus, a reduction in the volume of the osmoreceptors" (Andersson, 1971, p. 411).

Experimentally, when concentrated electrolyte solutions are administered into an artery of the

hypothalamus, the supraoptic nuclei send impulses to the neurohypophysis and ADH is secreted into the bloodstream. However, when pure water is administered into the hypothalamic artery, there is cessation of impulses and thus, cessation of ADH release. "The ADH that has already been produced is destroyed by the tissues at a rate of one-half every five minutes" (Guyton, 1976, p. 1,001). Antidiuretic hormone concentrations in body fluids can vacillate from small to large amounts, or vice versa, in the matter of minutes (Guyton, 1976).

Osmoreceptors are sensitive to variations in sodium concentration in the extracellular fluid. With increased osmolality (increase in sodium) of the extracellular fluid, the supraoptic cells become dehydrated and shrink in size. Osmoreceptors do not respond to increases in potassium, urea or glucose concentration, and are actually sodium concentrated receptors (Guyton, 1976).

Antidiuretic hormone increases water reabsorption in the collecting tubules by stimulation of the epithelial cells. This stimulation activates adenyl cyclase in the epithelial cell membrane or in the cell cytoplasm. This causes rapid formation of cyclic adenosin monophosphate (cyclic AMP). Increases in cyclic AMP are associated, for reasons that are yet unknown, with marked increases in the permeability of water in the luminal border of the

epithelial cells. This causes and increase in water reabsorption by osmosis in the collecting tubules.

Though there is retention of body water, sodium and other osmotically active substances are excreted in the urine. This water retention and loss of sodium causes dilution of the osmotically active substances. This return to normal of the extracellular fluid osmolality causes the osmoreceptors to swell and thus decrease their rate of impulse discharge. Hence, there is an inhibition effect on the hypothalamus and the secretion rate of ADH is lessened (Andersson, 1971, Guyton, 1976).

The "normal" rate of ADH release is far too little to cause a significant pressor effect. However, certain factors can cause amounts large enough to result in a mild pressor effect on the circulatory system. These factors include hemorrhage, trauma, pain, anxiety, morphine, nicotine, tranquilizers and some anesthetics.

Antidiuretic hormone release is also directly affected by various phases of the surgical procedure. Moran and Zimmerman (1967) measured ADH secretion in eight surgical patients during the preoperative recumbent phase, operative phase and recovery phase of surgery. The amount of released ADH was expressed as micropressor units per millileter of whole blood. The micropressor unit is equivalent to 2.5 picograms. Moran found the average release of ADH in the

recumbent preoperative phase was 0.6 microunits, but rose to 1.7 microunits at the end of the overnight NPO fast. Skin incision was associated with ADH levels of 2.5 microunits. With visceral manipulation of the peritoneum, ADH blood levels rose to 10 microunits. Antidiuretic hormone blood levels plateaued in 6 to 12 hours, and then gradually declined to normal by the fifth postoperative day.

High levels of ADH before, during and after surgery indicate that fluid retention is cumulative and begins with preoperative dehydration. The end result is excessive water retention due to the postoperative inappropriate secretion antidiuretic syndrome. Intravenous infusions at this time only add to fluid accumulation because of ADH induced oliguria.

"There is . . . a distinct correlation between the magnitude of the operative trauma and the duration of the altered ability to excrete a water load" (Hayes and Goldenberg, 1963, p. 490). The release of ADH after injury is not under the normal feedback control mechanisms. Its release seems to be required and is under the influence of higher hypothalamic centers. Oliguria is said to be expected despite postoperative intravenous infusion. Overhydration does not suppress the ADH response. Risks associated with inappropriate ADH release include edema, renal shutdown,

cardiac stress and decompensation (Deutsch, Goldberg and Dripps, 1966). This leaves "the control of homeostasis literally in the hands of the individual administering parenteral fluid therapy and entirely dependent upon his understanding of factors which constrain the ADH system" (Moran and Zimmerman, 1967, p. 639).

Preoperative Fasting Weight Loss

Danforth (1978) studied the fasting weight loss of surgical patients 60 years of age and older. The sample was composed of six men and four women who were to undergo various operative procedures. Body weight measurements were used as a major indicator of fasting fluid losses. One subject lost more than two percent of his admission weight and was assessed as entering surgery in an early stage of dehydration. The remaining nine subjects lost a considerable amount of body weight during the overnight fast. The range of weight loss for all subjects was 0.8 to 5.3 pounds. Danforth also found that weight loss was related to the size of the patient. Tall, heavy subjects lost the most weight. No positive relationship was found between number of hours on NPO and the amount of fluid lost. Danforth also suggested that the frequency of major operations in the elderly may contribute to an increased amount of fluid lost in the NPO period in subsequent surgeries.

Voda (1978) studied the preoperative fasting weight loss of 40 patients, 16 male and 24 female, ages ranging from 17 to 82 years. All were to undergo various elective surgical procedures.

All subjects lost weight. Eight of the 40 subjects (20 percent) had lost more than two percent of their initial body weight. Of these, six were in the age range of 60 years or older. Voda also found that subjects being prepared for abdominal surgery experienced a greater percentage of body weight loss. There was no correlation between BSA and weight loss.

No other clinical nursing studies of dehydration of persons on NPO during the presurgical period were found.

CHAPTER 3

DESIGN AND METHODOLOGY

This chapter presents the design and methodology that was used to study the phenomena of preoperative dehydration and fasting weight loss. A description of the sample and the means for protection of human rights is given. A discussion of the measurements and estimations obtained are also presented.

Design of the Study

A descriptive design was utilized to evaluate body water loss in preoperative patients.

Methodology

Sample

The sample consisted of 10 female patients from one southwestern hospital who met the criteria for admission to the study. All subjects were to undergo an abdominal or vaginal hysterectomy the following day. Subjects were identified by consulting the hospital's preadmittance list in the gynecology clinic and on the gynecology floor. Nursing units were telephoned the expected day of subject

arrival to verify admission. The subject's chart was read when she was admitted to the nursing unit. Age, diagnosis, surgical procedure and physician's orders were verified. Appendix B and C contain data of the sample (N=10).

Criteria for Subject Selection

The following criteria were used for subject selection:

1. The subject entered the hospital as an elective surgical patient. Persons with pre-existing chronic illnesses of cardiac, renal, adrenal or liver disease were not included in the study.
2. Individuals had not been receiving or were not taking diuretics.
3. Subjects were able to speak, read and write English.

Protection of Human Rights

The subjects were assured of complete confidentiality prior to the study, during data collection and after the study was completed. The investigator guaranteed the subjects that the information they supplied verbally, their medical records and any other information gathered would not be publicized indiscreetly, and no individual names would be reported.

The project was approved by The University of Arizona Human Subjects Committee. All consent forms (Appendix A) are retained in a secure, confidential file in the College of Nursing.

Design Limitations

This study was limited by the following factors:

1. The study was conducted in one hospital.
2. The study sample was small.
3. The age range of the subjects was wide.

Measurements

Body Weight

Subjects were weighed upon hospital admission and the morning of surgery. The subjects were weighed to the nearest 0.05 kilogram on the same mechanical balance scale made by Detecto Scales, Inc. (Brooklyn, New York).

Prior to the study, the scale was calibrated to the nearest 0.05 kg using standard weights manufactured by the Elgin Company. The investigator made five random weighings of five standard weights. These weights were 47.72, 52.27, 56.81, 61.36 and 65.90 kg. A second trial run was made of five weighings of each weight with the same five standard weights and was made by a volunteer from the Biomedical Engineering Department of the University of Arizona Health Sciences Center. The scale was

found to be accurate to within 0.1 kg. Calculation data can be seen in Appendix F. The scale was calibrated with an 11.36 kg standard weight before each subject was weighed. The subject was brought to the scale for weighing so as not to move or jar the scale from one location to another after calibration.

To ensure accuracy, specific protocols were followed during the weighings. The subjects emptied their bladder prior to each weight measurement, the same clothing was worn each time by the subject and the subjects stood in the same position on the scale. This was designated by white tape placed horizontally on the floor of the scale. The tape was not removed during the study. Each subject placed the tips of her toes at the top edge of the tape and stood perfectly still until the balance lever was stabilized at midpoint. The subject's weight was then recorded.

Height

The height of the subject was recorded in centimeters on admission. This was obtained by using the calibrated height measurement lever of the same mechanical balance scale used for body weights. All subjects stood straight in bare feet. Measurements were recorded to the nearest 0.25 cm.

Body Temperature

Body temperature was recorded in Centigrade on admission, and the morning of surgery. The same electronic thermometer made by the LaBarge Company, Inc., Model ET-12, was used throughout the study.

Urine Specific Gravity

Specific gravity was measured on the hospital admission urine, and on the immediate presurgical urine. The Merco Midget Urinometer manufactured by Mercer Glass Works, Inc., New York, was used during the study. The urinometer was calibrated in 0.001 units.

The urine samples were fresh and well mixed. The cylinder was filled three-fourths of the way with urine. The urinometer was placed in the cylinder and given a gentle spin. Readings were done on a level surface at eye level. Readings were measured by an imaginary line drawn from the lower area of the meniscus to the scale on the urinometer. Results were recorded to the nearest 0.001 unit.

Intake and Output

Measurements of all sensible fluid entering and leaving the body from the time of hospital admission to the morning of surgery was observed and recorded by the investigator (Appendix D). All liquid was precisely measured

to the nearest 0.5 ml using graduated laboratory cylinders. All readings were done on level surfaces at eye level.

All subjects were prepared for surgery the evening of admission by administration of a soapsuds enema until clear. The investigator administered all enemas. Enema inputs and outputs were recorded by first measuring liquid and feces in the graduated cylinder. The liquid was then separated (strained from the solid fecal material using a galvanized screen) and the liquid remeasured (Appendix E). Calculation of the patient's intake and output was concluded when the subject was prepared for surgery either by starting of an intravenous infusion or the administering of the preoperative injection.

Estimations

Body Surface Area

Body surface area estimations were made using the DuBois and DuBois (1957) nomogram. Using the subject's height and initial body weight, a diagonal line was drawn through calibrated markings. The line intersected at a specific point in the surface area column. This indicated the body surface area in square meters. Areas were recorded to the nearest 0.01 unit.

Insensible Losses

The subject's insensible output was estimated using body surface area. Values reported by Hayes (1956), 750 ml per meters squared of surface area per 24 hours (750 ml/m^2/SA/24 hrs), were used to calculate insensible loss. The calculated wt hour loss was divided by 24 to arrive at the insensible loss per hour, and multiplied by the total number of hours the subject participated in the study. Calculations were made to the nearest 0.01 ml.

Data Analysis

Multiple bivariate correlation coefficients using the Pearson statistic (correlation coefficient) were calculated to determine the linearity of relationships. Variables analyzed in this study included

1. Actual weight loss: weight one (W_1 minus weight two (W_2).
2. Percentage of admission weight lost: (actual weight lost) divided by (admission weight x .01).
3. Total water elimination balance including fecal contribution: (total fluid intake minus total fluid output) minus 70 percent of the stool volume.
4. Specific gravity change: specific gravity one (SG_1) plus or minus specific gravity two (SG_2).

5. Estimated total insensible loss: 750 ml multiplied by the estimated BSA divided by 24. This amount was multiplied by the number of participation hours.
6. Estimated body surface area: DuBois and DuBois surface nomogram.
7. Total water elimination balance including fecal contribution: All fluid intake minus all fluid output.

CHAPTER 4

PRESENTATION AND ANALYSIS OF DATA

This study was designed to determine if women undergoing vaginal or abdominal hysterectomies entered surgery in a state of early dehydration, and, if so, was there a relationship between the presence of dehydration and body build. This chapter presents the data of this study, as well as the statistical analysis of the data.

Subject Data

Ten female, afebrile subjects from one southwestern hospital met the criteria for admission to the study. Admission diagnoses included pelvic pain, cervical dysplasia, cancer-in-situ, ovarian carcinoma stage III, adenocarcinoma of the endometrium and the desire for sterilization. Six subjects had vaginal hysterectomies; four had abdominal hysterectomies. The subject's ages ranged from 24-60 years with a mean of 39.6 years, and a standard deviation of 13.59. Height ranged from 150.25-171.25 cm with a mean of 160.55 cm, and a standard deviation of 6.18. Admission weight was 56.50-85.05 kg with a mean of 64.75 kg, and a standard deviation of 9.70. Presurgical weight ranged from 55.70-82.80 kg with a mean of

63.94 kg, and a standard deviation of 9.13. Estimated body surface area ranged from 1.56-1.91 m^2 with a mean of 1.67 m^2, and a standard deviation of 1.26. Study participation time ranged from 14-16 hrs with a mean of 15.7 hrs and a standard deviation of 6.74. Enforced NPO time ranged from 4.40-6.10 hrs with a mean of 5.46 hrs, and a standard deviation of 4.99. This data is presented in Table 1.

Subjects entered the hospital the day before surgery at approximately two o'clock in the afternoon. Data collection was carried out for each subject until the following morning when either an intravenous infusion was started or a preoperative injection given. All data reflect calculations for a 16 hour time period except for two subjects who were studied for 14 and 15 hour periods due to their admission later in the afternoon.

Weight Data

Changes in weight for the ten subjects are presented in Table 2. All subjects lost weight during the overnight fast.

Subjects C and G lost more than two percent of their initial body weight (W_1). Subject C lost 1.25 kg (2 percent body weight) with a total fluid loss of 1,793.20 ml and subject G lost 2.25 kg (2.64 percent body

Table 1. Central Tendencies and Variability of Sample Characteristics

	Central Tendencies		Variability
	Range	Mean	Standard Deviation
Age (yrs)	24-60	39.60	13.59
Height (cm)	150.25-171.25	160.55	6.18
Admission Weight (kg)	56.50- 85.05	64.75	9.70
Presurgical Weight (kg)	55.70- 82.80	63.94	9.13
Estimated Body Surface Area (m^2)	1.56- 1.91	1.67	1.26
Study Participation Time (hrs)	14-16	15.70	6.74
Enforced NPO Time (hrs)	4.40- 6.10	5.46	4.99

Table 2. Variable Change Data. Comparison of Weight Lost, Estimated Total Insensible Loss, Total Water Elimination Balance Excluding Feces, Total Water Elimination Balance Including Feces, Urine Specific Gravity (N=10)

Subject	Weight Lost (kg) (W_1-W_2)	Percentage of Body Weight Lost	Estimated Total Insensible Loss (ml)	Total Water Elimination Balance Excluding Feces (ml)	Total Water Elimination Balance Including Feces (ml)	Urine Specific Gravity Change
A	0.45	0.73	846.56	+978.0	+671.4	-.020
B	0.60	1.00	775.65	+10.0	-144.0	-.010
C	1.25	2.00	773.85	-1,628.0	-1,793.2	-.008
D	0.80	1.41	798.22	-881.0	-983.9	-.017
E	0.50	0.78	818.12	-312.0	-466.0	-.009
F	0.15	0.26	773.54	-1,113.0	-1,225.0	+.005
G	2.25	2.64	812.70	-523.0	-663.0	-.012
H	0.05	0.08	731.04	-659.0	-897.0	+.009
I	0.60	0.03	780.00	-417.0	-560.5	-.007
J	1.45	1.81	955.00	-1,994.0	-2,214.5	-.008
Range	0.05-2.25	0.03-2.64	731.04-955.00	-1,994- +978	-2,214,5- +671.4	-.02- +.009
Mean	.81	1.07	806.46	-653.90	-827.57	-.0077
Standard Deviation	6.66	8.76	60.91	835.10	813.93	—

weight) with a total loss of 663 ml water from the time of hospital admission.

All subjects except Subject A had a corresponding negative water balance weight loss including fecal contribution. Subject A, after calculation of sensible intake and output and estimation of insensible output, showed a positive water balance of 671.40 ml. Her weight did not correlate with this; she had a weight loss of 0.45 kg, 0.73 percent of admission body weight.

Subject B lost 0.60 kg (1 percent body weight). Total fluid loss was 144.0 ml with an insensible loss contribution of 775.65 ml.

Subject D lost 0.80 kg (1.41 percent body weight). Her total fluid loss was 983.9 ml. Insensible loss was estimated at 798.22 ml.

Subject E lost 0.50 kg (0.78 percent body weight). Total fluid loss was 466 ml, insensible loss 818.12 ml.

Subject F lost 0.15 kg (0.26 body weight). Total fluid loss was 1,225 ml with an insensible contribution of 773.54 ml.

Subject H lost 0.05 kg (.08 percent body weight). Total fluid loss was 897 ml. Insensible loss was estimated at 731.04 ml.

Subject I lost 0.60 kg (.03 percent body weight). Total fluid loss was 560.50 ml, insensible loss being 780.00.

Subject J lost 1.45 kg (1.81 percent body weight). She lost 2,214.50 ml water, insensible loss was 955.00.

The mean weight loss for the ten subjects due to the NPO overnight fast was 0.81 kg with a standard deviation of 6.66. The mean percentage of body weight lost for the sample was 1.07 with a standard deviation of 8.76.

The mean estimated insensible loss for the subjects was 806.46 ml with a standard deviation of 60.91.

The mean total water elimination balance excluding feces was -653.90 ml with a standard deviation of 835.10; and the sample mean including feces was -827.57 with a standard deviation of 813.93.

Urine specific gravity mean was .0077.

Weight-Water Loss
Variable Correlations

Table 3 presents the Pearson correlation coefficients ($N=_{10}$) for each variable. A strong positive correlation (.92) was seen between weight change and percentage of weight lost. Positive correlation coefficients are also seen between weight change and percentage of weight lost (.92), weight change and estimated body

Table 3. Correlational Matrix of Variables (x100): Weight Change, Percent of Weight Lost, Total Water Elimination Balance Including Feces, Specific Gravity, Estimated Body Surface Area, Total Water Elimination Balance Excluding Feces (N=10)

	Weight Change	Percent of Weight Lost	Total Water Elimination Balance Including Feces	Specific Gravity	Estimated Insensible Loss	Estimated Body Surface Area	Total Water Elimination Balance Excluding Feces
Weight Change	—						
Percent of Weight Lost	92	—					
Total Water Elimination Balance Including Feces	-32	-38	—				
Specific Gravity	-42	-47	-38	—			
Estimated Insensible Loss	44	41	-26	-43	—		
Estimated Body Surface Area	74	67	-20	-29	78	—	
Total Water Elimination Balance Excluding Feces	-33	-35	99	-38	-23	-17	—

surface area (.74), percentage of weight lost and estimated BSA (.67), and estimated total insensible loss and estimated BSA (.78).

Negative correlations were seen between total water elimination balance including feces and weight change (-.32) and total water elimination balance including feces and percent of weight lost (-.38).

Specific gravity had a negative correlation to weight change (-.42) percent of weight loss (-.47) and total water elimination balance including feces (-.38).

Estimated insensible loss was correlated positively with weight change (.44) and percent of weight lost (.41); negatively with total water elimination balance including feces (-.26) and specific gravity (-.43).

Estimated body surface area showed negative correlation to total water elimination balance including feces (-.20) and specific gravity (-.29).

Total water elimination balance excluding feces correlated positively with total water elimination balance including feces (.99); negatively with weight change (-.33), percent of weight lost (-.35), specific gravity (-.38), estimated insensible loss (-.23), and estimated BSA (-.17).

CHAPTER 5

DISCUSSION OF THE FINDINGS

The findings and their meaning in terms of nursing and medical intervention are discussed in this chapter. Possible reasons for the outcomes of the variables are discussed.

Danforth's study showed that the weight loss of NPO preoperative patients was associated with fluid loss and weight loss seemed to be related to the size of the patient ($r=0.6459$ and 0.4933). It would be assumed, then, that subjects in this study would have had a loss of weight with a corresponding negative water balance.

Subject A, however, lost 0.45 kg (.73 percent body weight), but had a positive fluid balance when the intake and output was calculated. She was found to have a fluid gain of 671.40 ml, despite the fact that Subject A's body surface area (utilizing her initial body weight of 61.30 kg and her height of 171.23 cm) was the third largest estimated BSA of 1.72 m^2. She also had the largest sensible intake of 1,766 ml. Her urinary output for 16 hours was 960 ml. Her estimated insensible loss was the second largest at 846.56 ml. According to fluid volume measurements, she retained 1,018 ml of fluid at the end of the

enemas (Appendix E). This amount was consistent with, or may be explained by Ganong (1975) and Levitan's (1962) studies on colon reabsorption during enema administration.

As previously explained, loss or gain of one kg body weight can be equated with a corresponding loss or gain of one liter fluid. Since Subject A showed a loss of body weight and a gain of body fluid when intake and outtake calculations were completed, it is possible that she lost considerable water in insensible means. Error in measurements and estimations by the investigator could have also contributed to this outcome. Insensible water loss is a result of cellular metabolism and is associated with caloric or heat expenditure. Anxiety and/or apprehension over the surgery could have helped to increase water loss in this subject. Furthermore, body and room temperature, and room humidity affect body water loss. Though Subject A was afebrile as determined by oral electronic readings, the true body core temperature was unknown. Body temperature can become increased by environmental conditions; thus, being a warm and humid room may increase the perspiration rate, which increases the insensible loss. These factors were not controlled in this study.

Activity level also contributes to the amount of body water loss as reflected by an increase in basal metabolic rate. Factors such as pacing, especially when

coupled with anxiety and the sleep-wake cycle, influence this rate. Since the investigator did not remain with the subjects the entire time before the surgery, energy expenditures related to activity are unknown.

Subject D lost 1.41 percent body weight or 80 kg and was assessed to enter surgery in a fluid deficit or volume depleted state. The total fluid loss was 983.9 ml, insensible loss contribution was 798.22 ml. She was the fifth tallest woman (160.00 cm) and had the second smallest estimated BSA (1.58 m^2). She was 25 years old and her body build contained more adipose tissue than lean muscle mass.

Subject J was the second heaviest of weight at 80.05 kg. She was the tallest of the subjects at 169.50 cm. This 28 year old subject was a tall and muscular woman and her body build was a large frame. This subject was approaching a state of early dehydration as she lost 1.81 percent body weight or 1.45 kg. Her total water loss of 2,214.5 ml at the end of the study is equated with such a weight change.

Subject F lost 0.15 kg (0.26 percent body weight), yet calculated fluid loss at the end of the study was 1,225 ml; insensible loss was estimated at 773.54 ml. No association was seen between Subject F's weight loss and water balance, either with fecal contribution or estimated

total insensible loss. She was the second oldest, 58 years; the fourth shortest, 158.25 cm; and had the second smallest BSA of 1.58 m^2.

Subject H lost 0.08 percent body weight (0.05 kg), but fluid loss was .879 ml; insensible loss estimated at 731.04 ml. Subject H was the third shortest at 157.00 cm, weighed 59.70 kg and her body contained excess adipose tissue. When compared with subject F, both had excess adipose tissue and significant fluid deficits, but weight loss and percentage of body weight loss was small.

It is interesting to note that subject F and H had the lowest oral intake of the sample. Subject F's oral intake was 370 ml and subject H's was 221 ml. Danforth's study showed four patients who had ceased drinking fluids shortly after the evening meal, weighed in at values close to their admission weights. Two of these subjects also had a small amount of oral fluid intake, 350 ml and 390 ml. The remaining two subjects had a sensible oral intake of 800 ml and 2,300 ml. Subjects C and G entered surgery in early dehydration. A loss of 2.00 percent body weight (1.25 kg) and 2.64 percent body weight (2.25 kg) was seen respectively. No relationship can be seen between subject G's weight loss and water balance since such a large weight loss had a corresponding water loss of only 663 ml.

Subject G was 50 years old and was overweight for her height of 161.00 cm. This subject weighed the most (85.05 kg).

Subject C was a 32 year old female who carried the fourth greatest amount of weight at 62.45 kg. She was the second shortest woman at 156.00 cm. This patient had a medium build and excess adipose tissue.

In order to ensure that patients are entering surgery properly hydrated and in the best possible physiological condition, the fluid intake balance must equal or approximate fluid output balance. One approach would be to allow the patient to drink water or take ice chips up until the time of surgery. With this practice, the patient is responding to his own thirst regulatory stimulus to maintain hydration. However, the actual amount of fluid allowed in the preoperative period would need to be highly individualized due to one's body surface area.

An alternate management for proper hydration would be an intravenous infusion beginning at the onset of the NPO routine. The patient would receive needed fluids to replace sensible and insensible losses while maintaining an empty stomach so as to prevent aspiration during surgery. The individual dosage is calculated primarily on the patient's preoperative fluid volume, "which is assessed

mainly by acute changes in body weight" (Metheny and Snively, 1974, p. 114). In patients whose fluid volume is normal, only maintenance therapy is required. These maintenance requirements are met by administering 3 ml/m^2 BSA/min. via intravenous infusion (Metheny and Snively, 1974).

Eight of the 10 subjects had a decreased urine specific gravity from the time of admission until the morning of surgery. During all admission and presurgical readings, all subjects had a specific gravity within the normal range of 1.003 to 1.030. Clinically significant specific gravity values can only be obtained approximately 24 hours after body insult. Environmental heat, stress and food intake immediately prior to a reading can falsely increase specific gravity values. Therefore, the readings obtained in this study were not significant.

Conclusions

Some patients about to undergo elective surgery do enter the operating room in an early stage of dehydration due to food and fluid restriction. Routine enemas given the night before surgery for abdominal and/or bowel related areas may deplete the patient of isotonic fluid. Patients also become dehydrated due to radiographic examinations. Those persons most prone to this dehydrated

state include short and overweight (excess adipose tissue), as well as tall and muscular females. Routine monitoring of the hydration status preoperatively could prevent excessive fluid loss. Howell (1977, p. 101) stated that "baseline body weight is a most valuable parameter to check the day before surgery. If any major deviation from normal is present, weight loss can be replaced pound for pound with isotonic electrolyte solutions."

Maintenance of the internal milieu is of primary importance. The tonicity and volume of the extracellular fluid must be maintained as normal as possible at all times. Following a surgical procedure, the body's limits for tolerating water and electrolyte administration are distorted.

Precise clinical tools need to be developed to lessen nursing error in measurements, estimations and calculations of the preoperative hydration status. Accurate determinations in monitoring these patients allow for individualized fluid replacement and/or maintenance therapy at this time. Successful fluid management should make only maintenance fluid necessary in the postoperative period.

Implications

Some women undergoing elective vaginal or abdominal hysterectomies lose more than two percent of their body

weight during the enforced NPO period when fluid replacement is restricted. This weight loss can be equated with fluid loss clinically and inevitably result in an early stage of dehydration. Antidiuretic hormone is released as a compensatory mecahnism. Moran and Zimmerman (1967) found that high levels of ADH are secreted, beginning with the preoperative NPO fast. Anxiety, anesthesia, hemorrhage, cutaneous and visceral pain all provoke for additional ADH release, and thus, a culminating effect of postoperative water retention.

Nurses participate in creating dehydrated states and are in a prime position to monitor the hydration state of all presurgical patients. Their role in assuring optimum hydration include weighing patients on accurate scales, maintaining intake and output records which include sensible as well as insensible water balances, and by providing fluids up until absolute NPO is enforced. Future studies need to be directed toward finding out how long fluids can be given safely to patients entering the operating room and who is the person at high risk for short and long periods of NPO. Inappropriate secretion of ADH postoperatively may be related to state of dehydration when one enters surgery, but this hypothesis needs to be tested.

Recommendations

The following recommendations for further investigation based on this study include:

1. Larger sample size of at least 25 randomly selected subjects within a narrow age range.
2. Use of a sensitive metabolic bed scale.
3. Recording room temperature and humidity at periodic intervals.
4. Drying and weighing of stools for accurate water contribution.
5. Use of a control and experimental group where the experimental group is forced fluids prior to the NPO routine and the control group is not.

APPENDIX A

SUBJECT'S CONSENT FORM

Preoperative Body Water Loss in Elective Surgical Patients

Principal Investigator: Lorraine C. Haertel, R. N.

The purpose of this study is to estimate the amount of overnight water loss that occurs in hospitalized surgical patients who are placed on a routine fluid restriction called nothing by mouth (NPO). The subjects will be persons who are undergoing elective surgery. The reason this study is being conducted is to find out whether there is a correlation between age, body type, and amount of overnight NPO water loss and whether measurement of overnight weight loss is correlated with estimated water loss.

Your physician has determined according to his or her preoperative routine, the specific time your preoperative fluid restriction will begin. If you decide to participate as a subject in this study, you will be weighed upon hospital admission and just prior to going to surgery the next morning. Your height will be measured on admission. Also, from the time of admission until you are taken to surgery, a record will be kept of all fluids that you drink and all fluids that leave the body such as your urine and feces. Two of these urine samples will be analyzed for their concentration (osmolality).

Your participation in this study will conclude when you leave the ward to enter the operating room. The data collected will be kept confidential, available to the principal investigator and her thesis committee members at The University of Arizona, College of Nursing. Your identity will be coded. The results of the study may be published. If so, only coded anonymous data will be reported.

There is no monetary benefit to you if you participate as a subject. This study may have benefits to future patients such as improved nursing care in monitoring the water balance in preoperative patients.

Investigator_____ Date_____

"I have read the above 'Subject's Consent.' The nature, demands, risks and benefits of the project have been explained to me. I understand that I may ask questions and that I am free to withdraw from the project at any time or not participate at all without incurring ill will or affecting my nursing care."

"I also understand that this consent form will be filed in an area designated by the Human Subjects Committee with access restricted to the Principal Investigator and/or authorized representatives of the particular department.

Subject's Signature_____ Date_____

Witness' Signature _____ Date_____

APPENDIX B

RAW DATA (N=10)
CHARACTERISTICS OF THE SAMPLE

Subject	Age	Height (cm)	Admission Weight (kg)	Presurgical Weight (kg)	Estimated BSA	Study Participation Time	Enforced NPO Time
A	24	171.25	61.30	60.85	1.72	16	5.45
B	47	159.75	59.65	59.05	1.61	16	5.25
C	30	156.00	62.45	61.20	1.62	16	5.20
D	25	160.00	56.50	55.70	1.58	16	6.10
E	32	162.50	64.00	63.50	1.68	16	5.35
F	58	158.25	57.65	57.50	1.58	16	5.40
G	50	161.00	85.05	82.80	1.88	14	5.50
H	42	157.00	59.70	59.65	1.59	15	4.40
I	60	150.25	61.10	60.50	1.56	16	6.00
J	28	169.50	80.05	78.60	1.91	16	6.00

APPENDIX C

RAW DATA (N=10)
COMPARISON OF ADMISSION DATA AND MORNING OF SURGERY DATA FOR SUBJECTS

	ADMISSION				MORNING OF SURGERY		
Subject	Weight (kg)	Height (cm)	Temperature (C^{O})	Specific Gravity	Weight (kg)	Temperature (C^{O})	Specific Gravity
A	61.30	171.25	37.0	1.027	60.85	36.5	1.007
B	59.65	159.75	36.9	1.025	59.05	36.4	1.015
C	62.45	156.00	36.8	1.028	61.20	36.4	1.020
D	56.50	160.00	36.5	1.027	55.70	36.0	1.010
E	64.00	162.50	36.6	1.026	63.50	36.6	1.017
F	57.65	158.25	36.6	1.015	57.50	36.0	1.020
G	85.05	161.00	37.0	1.020	82.80	36.7	1.008
H	59.70	157.00	36.6	1.017	59.65	37.2	1.026
I	61.10	150.25	36.4	1.018	60.50	36.7	1.011
J	80.05	169.50	37.3	1.021	78.60	36.7	1.013

APPENDIX D

SENSIBLE INTAKE-OUTPUT FOR SUBJECT (N=10)

Subject	Oral Fluid Intake	Urinary Output	Sensible Balance
A	1,766	960	+806
B	1,270	270	+1,000
C	1,286	2,505	-1,219
D	928	643	+285
E	966	510	-456
F	370	820	-450
G	1,046	922	+124
H	221	154	+67
I	685	432	+253
J	1,391	2,340	-949

APPENDIX E

ENEMATA BALANCE
(N=10)

Subject	Intake	Output with Fecal Volume Measurement	Output without Fecal Volume Measurement
A	3,000	2,420	1,982
B	4,200	4,635	4,415
C	5,470	5,342	5,106
D	3,400	3,915	3,768
E	4,500	4,670	4,450
F	2,500	2,550	2,390
G	3,675	3,710	3,510
H	2,900	3,235	2,895
I	6,000	6,095	5,890
J	4,000	4,405	4,090

APPENDIX F

SCALE CALIBRATION MEANS

Weight Applied	TRIAL 1 Mean of 5 Weighings	TRIAL 2 Mean of 5 Weighings	Difference Between Means
47.72	47.74	47.78	+.04
52.27	52.23	52.29	+.06
56.81	56.76	56.80	-.04
61.36	61.28	61.38	+.10
65.90	65.78	65.86	+.08

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