THE NURSING ASSESSMENT AND PREDICTORS OF FLUID EXCESS IN THE POST-OPERATIVE CRITICALLY ILL PATIENT - A RETROSPECTIVE STUDY

by

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CHAPTER ONE

INTRODUCTION

The management of fluid and electrolyte disturbances in the critical care setting has become increasingly sophisticated throughout the years. Technological advances in monitoring equipment and the observation skills of the highly trained critical care nurse allow rapid recognition of life threatening changes in the critically ill patient.

Critical care nurses are concerned with identifying early indicators of potential patient problems. Through the nursing process, nursing diagnoses are formulated and appropriate plans of care are identified. The nursing diagnosis, fluid volume excess, as described by Carpenito (1983), merits attention as it relates to the critically ill patient population. Fluid volume excess is defined as a state of, or potential for excess fluid volume in the vascular, cellular or extracellular compartment(s) (Carpenito, 1983). If one were to monitor, for example, the post-operative abdominal vascular surgery patient for clinical manifestations of fluid balance, the factors which would contribute to a potential fluid imbalance resulting in fluid volume excess, from Carpenito's list of contributing factors of fluid excess, are: tissue insult, i.e., injury to the cell boundary; the inflammatory process; excessive fluid intake from intravenous therapy; over transfusion; and, excessive sodium intake.

Critical care nurses must thoroughly understand these contributing factors as they relate to all patients. The post-operative surgical patient offers an additional challenge to the nurse. For example, patients undergoing major abdominal vascular surgery are monitored for their responses to the volumes of intravenous crystalloid and colloid administered intra-operatively and post-operatively to establish hemodynamic stability. Continuous monitoring and early intervention in the fluid management of the patient undergoing major surgery may avoid post-operative fluid excess complications such as acute congestive heart failure (CHF) (Schwartz, 1984), circulatory overload, edema, and water intoxication, as well as several fluid volume deficit complications which may arise as a result of fluid imbalance and progress to organ failure (Trunkey, 1975; Valtin, 1979).

Evidence of volume excess is classically seen in the patient's physical examination, hemodynamic measurements and laboratory data. These data are analyzed by both nurses and physicians. The goal for patient evaluation is early detection of post-operative complications, especially those which may be life-threatening. Data interpretation helps in the prevention of those complications.

Critical care nurses can add to the body of nursing knowledge and research in the area of post-operative assessment of a patient's fluid balance. In the past, tradition and knowledge of physiology have dictated the focus of patient assessment.

A nursing study of fluid volume excess when acute congestive heart failure is a possible outcome may provide data from which to derive predictors or early indicators of fluid volume excess in post-operative patients. This investigator proposed to explore and compare data collected during the post-operative course of patients who had undergone major abdominal vascular surgery and would be at increased risk of fluid volume excess given usual treatment patterns. The intake and output (I & O) records, together with daily weights, have been shown to be valuable in determining fluid status (Valtin, 1979). However, there is more to consider than the I & O record and changes in daily weights for it is believed that with additional clinical data, a state of fluid volume excess may be identified earlier and appropriate interventions may be instituted.

The purpose of this study was to identify relationships between nursing assessments, hemodynamic measurements and laboratory values in the post-operative period of the major abdominal vascular surgery patient. The goal of this study was to identify the earliest indicators of fluid volume excess which could be identified by the bedside critical care nurse.

Conceptual Framework

The type of fluid volume excess most feared in the post-operative period occurs as the result of impaired left ventricular function. The overstressed myocardium may be unable to provide an adequate cardiac output. The immediate result of this reduction in cardiac output is an increase in renal sodium retention and reflex vasoconstriction. As the myocardium is unable to produce adequate wall tension to handle the additional increase in fluid volume the left ventricular end diastolic pressure will increase and produce pulmonary congestion. Failure to reduce this state of fluid volume excess known as congestive heart failure can allow continuation of the process until the patient exhibits symptoms of pulmonary edema.

The primary focus of this investigation was the identification of the clinical indicators of congestive heart failure. Congestive heart failure was used as a model of fluid volume excess seen in the selected patient population. Congestive heart failure (CHF) as described by

Michaelson (1983, Ch. 2, p. 44-84), was used as the physiologic framework for this study. Michaelson's framework for studying CHF explains the pathophysiology of heart failure, describes the physiologic basis for the clinical indicators of CHF, and the rationale for treatment. The framework by Michaelson is summarized and highlighted as it is used in this study.

Michaelson notes that professionals in critical care areas, as well as in other areas of health care, must systematically assess and reassess the status of patients with CHF and diagnose, intervene, and evaluate their response to therapy (1983). The management of CHF depends on the understanding of normal cardiac physiology and and pathophysiologic changes associated with heart failure (1983). One may refer to a standard text on cardiac physiology for a complete description of the mechanisms involved in the development and treatment of right and left heart failure, and acute and chronic congestive heart failure. Clinically, the changes associated with acute CHF are the result of an accumulation of extracellular fluid leading to pulmonary congestion, impaired systemic organ perfusion and reduced cardiac reserve with activated compensatory mechanisms (Michaelson, 1983; Vander, 1985).

A linear relationship between fluid deficit, fluid balance, and fluid excess may be helpful to put

Michaelson's framework into perspective. Figure 1, developed by this researcher, represents the linear relationship between fluid deficit, fluid balance and fluid excess. It is this relationship, based upon the physiological framework described by Michaelson and this researcher's clinical practice experience, that was used as a conceptual framework for this study.

A distinction has been made in the literature between acute and chronic heart failure. The differences are generally based on the clinical manifestations. Chronic heart failure results in symptoms of systemic congestion and is generally progressive to the point of debilitation. Acute heart failure reflects symptoms of pulmonary congestion and decreased systemic perfusion. Acute heart failure is generally thought to be preventable and is reversible if identified in its earliest stages (Michaelson, 1983; Valtin, 1979).

The appearance of acute pulmonary edema is the most catastrophic indicator of heart failure. The elevated pulmonary capillary wedge pressure as a result of left ventricular failure causes an elevated pulmonary capillary hydrostatic pressure which exceeds the oncotic pressure at the alveolar-capillary membrane resulting in movement of fluid and protein from the pulmonary capillaries into the alveoli. This pulmonary congestion may progress to acute

Figure 1

Fluid Balance Conceptualized on a Continuum

	Hypovolemic Shock	Severe Dehydration	Fluid Deficit	Fluid Balance	Fluid Excess	Circulatory Overload	CHF Leading to Acute Pulmonary Edema
Pulmonary Capillary Wedge Pressure (PCWP) mmHg:	0	0-2	2-4	5-12	14-16	16-18	18-20+
Central Venous Pressure (CVP) cmH_2O	0	2-3	4-5	6-12	>15	>20	>25
Cardiac Output (CO) l/min	<3.0	Variable	Variable	4-6	Variable	Variable	<3.0
Cardiac Index (CI) $l/min/m^2$	<2.0	Variable	Variable	2.5-4.0	Variable	Variable	<2.0
Breath Sounds (Descriptors)	Clear	Clear	Clear	Clear	Wheezes; Diminished Breath Sounds; Crackles on Inspiration	Fine Moist Rales 1/2 or More, ↑'d Wheezes	Wet; Rales Throughout; Fine Moist Rales Throughout

pulmonary edema if appropriate interventions are not taken immediately (Michaelson, 1983). The key points are that early recognition, the knowledge of the pathophysiology and appropriate therapeutic interventions in CHF will prevent complications and maximize the health status of the patient (Michaelson, 1983). It is this state of fluid excess which compromises the patient's hemodynamic status and leads to alterations in physical findings.

The state of fluid volume excess which becomes manifest in undesirable signs and symptoms is to be avoided in the critically ill. The nursing assessment is critical in the continuous monitoring of the critically ill patient. The nursing assessment may identify trends in fluid status which may alert the health care team before a potential complication leads to hemodynamic compromise.

Operational Definitions

Clinical Congestive Heart Failure: pulmonary capillary wedge pressure (PCWP) > 18-20; cardiac output (CO) < 5-6 liter/min.; cardiac index (CI) < 2.5 liter/min./m^2; mean arterial pressure (MAP) < 90mmHg; and, systemic vascular resistance (SVR) > 1200 dynes/sec./cm^{-5} (Michaelson, 1983).

<u>Fluid Volume Excess</u>: pulmonary capillary wedge pressure will be 14-16mm or higher, the central venous pressure elevated in most cases, the cardiac output variable, the cardiac index variable, and adventitious breath sounds appear as wheezes or fine moist rales. (Figure 1). Over a given period of time, there will be a weight gain and an intake greater than output. Fluid volume excess may not be a finite point on the linear relationship of fluid balance; for this study it was a contrast between fluid balance and circulatory overload.

<u>Hemodynamic Measurements</u>: the pulmonary artery systolic and diastolic pressures, the pulmonary capillary wedge pressure, mean arterial pressure (calculated: Diastolic B/P + 1/3(Systolic B/P - Diastolic B/P)), cardiac index and the central venous pressure measurement.

<u>Nursing Assessment Parameters</u>: auscultation of the heart, inspection, auscultation, palpation and percussion of the lungs and gastrointestinal tract, and a mental status/ neurological examination to identify alterations from normal physical examination. All body systems are included in the nursing assessment as well as an evaluation of the patient as a bio-psycho-social being.

<u>Swan-Ganz Flow-Directed Thermodilution Catheter</u>: a catheter is transvenously placed into the pulmonary artery to measure the pulmonary artery pressures for the purpose of

evaluating fluid status and cardiac performance. (Swan-Ganz is the registered trademark of the American Edwards Laboratories.)

Major Abdominal Vascular Surgery: the resection of an abdominal aortic aneurysm and the placement of an aorto-iliac bypass graft (bifurcated).

Review of the Literature

This review of the literature includes an overview of the available nursing and medical literature in the area of fluid balance and predictors of fluid balance, including the assessment of fluid balance, manifestations of fluid volume excess and research related to the identification of fluid excess in the critically ill post-operative patient. A review of the literature in the area of the nursing assessment and the patient population selected for this study, the post-operative patient with Abdominal Aortic Aneurysm (AAA) resection, are also included. In presenting the patient with the AAA resection, emphasis is placed on the physiologic changes documented in the literature in the immediate post-operative period. The most appropriate data to monitor in the early post-operative period for the AAA resection patient as identified in the literature are summarized.

A review of the available literature on fluid status, fluid balance and evaluation of the critically ill patient in the post-operative period with regard to fluid balance is relatively void of scientifically based research findings. The lack of a nursing research base for determining fluid balance in the critically ill patient makes this study of particular importance to nursing.

The profession of nursing is working toward establishing a body of knowledge which is unique and specific for nursing. Nursing as a profession must study the effect nurses have on patient outcomes. The development of a sound research base for the practice of professional nursing will support the recognition of nursing as a scientifically based profession which provides an irreplaceable service to the consumer. This study will begin to document the role the critical care nurses play in the assessment of patients.

In general, the interpretation of the fluid status of a patient is based on principles of physiology. The principles of diffusion and osmosis in the various body fluid compartments determine the effects on body systems when fluid enters or leaves the body. The cardiovascular and respiratory systems seem to be the most sensitive to changes in body fluids as the critically ill patient enters the post-operative period (Dudrick et al., 1983).

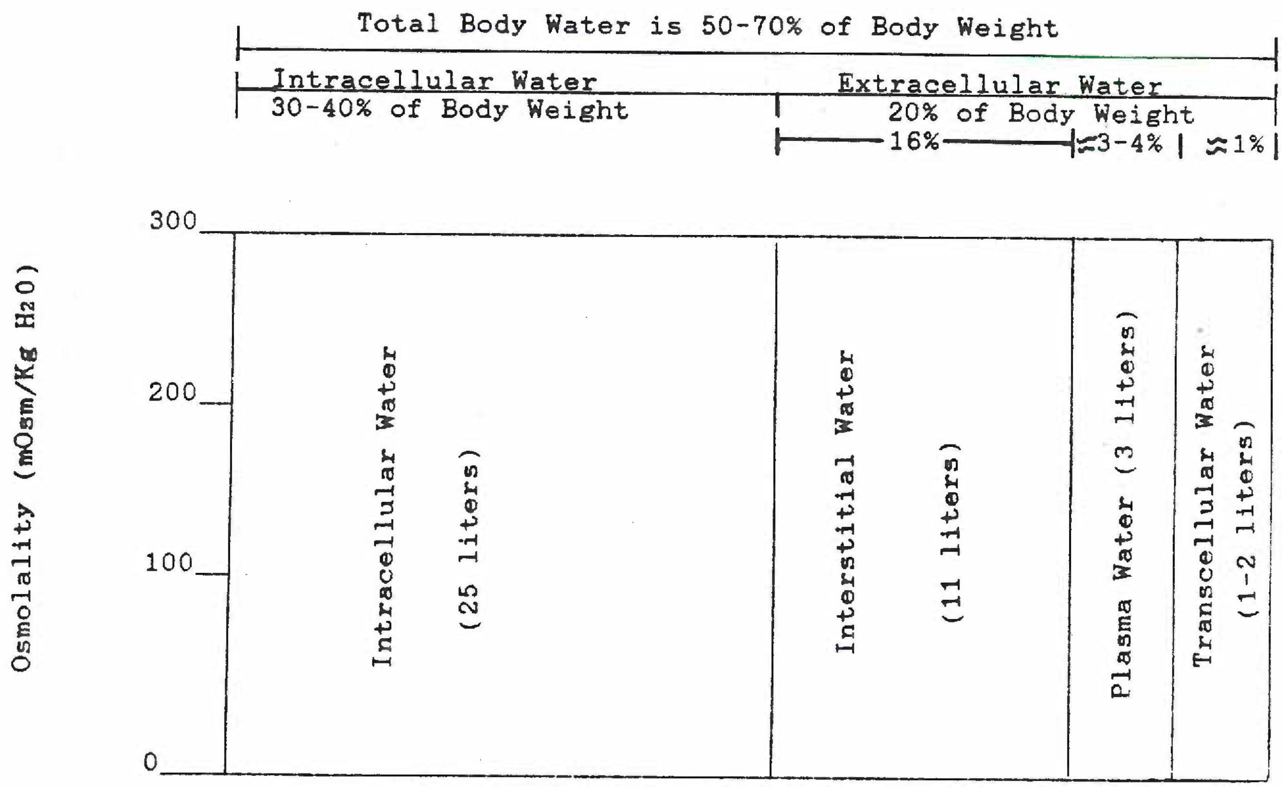
The body fluid compartments and the distribution of body fluids are extremely important when studying the critically ill surgical patient. The body fluid compartments consist of the intracellular and extracellular compartments. The extracellular compartment is further divided into the interstitial and intravascular spaces. Total body water is 50-60% of body weight. The intracellular fluid compartment is approximately 40% of body weight and the extracellular fluid compartment is 20% of body weight (Valtin, 1979). Figure 2 identifies the body fluid compartments. Fluid intake must equal fluid output for water homeostasis to occur (Valtin, 1979; Vander, 1985). Table 1 illustrates the usual routes of fluid intake and output.

The critically ill post-operative patient may have a fluid volume deficit as a result of incomplete crystalloid and colloid replacement intra-operatively. Following fluid replacement, the patient may rapidly develop signs and symptoms of fluid overload (Hardy, 1980).

Overload of the vascular system can result from the rapid administration of intravenous fluid to patients who cannot adapt to an acute intravascular volume expansion. Patients least likely to adapt to rapid volume infusions and/or excessive volume infusions are the elderly with limited cardiac reserve and inelastic blood vessels, and

Figure 2

Body Fluid Compartments



Adapted from Valtin, H. (1973) Renal Function: Mechanisms Preserving Fluid and Solute Balance in Health. Boston: Little, Brown, in Valtin, H. (1979). Renal Dysfunction: Mechanisms Involved in Solute Imbalance. Boston: Little, Brown.

TABLE 1

Normal Rates of Fluid Intake and Output in the Adult

Route	ml/day
Intake	
Drinking	1200
Food	1000
Metabolically produced	300
TOTAL	2500
Output	
Insensible loss (skin and lungs)	900
Feces	100
Urine	1500
TOTAL	2500

From Valtin (1979), Renal Dysfunction, p.21; and, Vander (1985), Renal Physiology.

infants and young children who normally have little extravascular fluid reserve. Patients with circulatory or renal disease generally tolerate fluid volume expansion very poorly (Hardy, 1980; Phipps et al., 1983).

Overloading of the vascular system can also result from fluid mobilization which causes an increase in hydrostatic pressure resulting in tissue edema. The vascular system may also be overloaded as a result of increased oncotic pressure of the intravascular space from rapid infusions of proteins such as plasma, albumin, blood, or plasma expanders, such that fluid enters the intravascular compartment from other fluid compartments to balance the oncotic and hydrostatic forces. The result can be a sudden rise in blood volume with a concomittant abnormal increase in the hydrostatic pressure of the vascular system and an abnormal increase in the oncotic pressure of the interstitial fluid compartment. As a result, fluid is pushed into the tissues causing edema (Phipps, et.al., 1983). If the left ventricle is unable to handle the increase in intravascular fluid, pulmonary edema may result if enough hydrostatic pressure pushes fluid across the alveolar-capillary membrane into the lungs.

Another route of fluid accumulation resulting in edema occurs when excess extravascular fluid is present with an inadequate intravascular fluid volume. This scenario generally occurs when fluid accumulates into a non-functioning extracellular space, the "third space". Third spacing of fluid frequently occurs in the presence of tissue injury and cell membrane disruption. Documented causes of "third spacing" are peritonitis, crush injuries, bowel obstruction, operative trauma and burns (Hardy, 1980). "Third spacing" is common at the operative site and in the legs of patients having major vascular surgery (Thompson et al., 1975). Third spacing occurs as a result of leaky capillaries and the large volumes of crystalloid frequently required for hemodynamic stability in patients with a major surgical procedure (Hardy, 1980).

Physiologic principles of fluid homeostasis seem to be the basis of patient evaluation and recognition of clinical manifestations of alterations in the post-operative patient. The following sections in the review of the literature will focus on how fluid status is determined in the clinical setting, problems posed by these measures and which parameters are presumed to be most important in patient assessment.

Predictors of Fluid Balance and Fluid Volume Excess

The traditional methods of evaluating fluid volume status in the post-operative patient are the intake and output, daily weights and vital signs, which may or may not include central venous pressure and/or pulmonary artery pressure measurements. The physical examination of the critically ill post-operative patient generally centers on the assessment of tissue perfusion and the adequacy of the ventilatory efforts (Kinney et al., 1981). There appear to be no research based patient studies to support the collection of the data mentioned thus far to determine or monitor the fluid status of the post-operative patient for fluid volume excess. It is primarily a nursing responsibility to monitor and accurately record a patient's intake and output for a twenty-four hour period. The inaccuracies of measuring and recording intake and output have been repeatedly reported in the literature (Abbey, 1968; Heath, 1971; Valtin, 1975; Oveson, 1981; Vander, 1985).

Pflaum (1979) studied the intake and output records of thirty (30) hospitalized medical-surgical patients in a random sample while monitoring the collection of the data. Pflaum reported that the data in her study invalidate the accepted nursing practice of assessing fluid balance in the patient by using only the intake and output records. Intake and output records compared with daily weights may alert the clinician to insensible losses, fluid shifts, or calculation inaccuracies (Pflaum, 1979).

Some interesting points about Pflaum's study need to be addressed. First, the daily weights were referred to as the absolute correct measurement, with the intake and output record changes compared to these true values. There appears to be no evidence in the literature to substantiate daily weights as being accurate, or being studied to any reasonable extent. There is endless mention in the nursing and medical literature about measuring the patient's weight at the same time and under the same circumstances each day to ensure an accurate weight (Valtin, 1979; Kinney et al., 1981; Dudrick et al., 1983; Vander, 1985). It does seem that these weights may not be very accurate in the post-operative setting due to fluid shifts, invasive lines and varying amounts of dressings and bandages. A patient's weight may not always be measured at precisely the same time each day due to unforeseen circumstances.

Patients with incomplete intake and output records were included in Pflaum's study. The recordings of "q.s." (quantity sufficient), and "no entry" were given zero for the computations used. Deletion of these patients from the analysis could significantly change the results. When values are not entered, the records are meaningless, especially if the results of the study are used to monitor the critically ill patient. It is difficult to make generalizations about what nursing practice should and should not include from Pflaum's study. Pflaum does state that the intake and output should not be used alone in assessing a patient's state of hydration; however, the rationale cannot be concluded from her study. Further study is warranted to determine which factors or parameters can be used to assess a patient's fluid status.

Oveson (1981) reviewed the literature on intake and output records for a study on measuring equipment and techniques for maintaining accuracy in recording intake and output. Questions were raised as to the accuracy of the intake and output records and the validity of the intake and output records as tools in the assessment of fluid balance. Oveson then studied patients receiving hyperalimentation and found no correlation between the intake and output records and daily weights. It was concluded that despite these findings, the measurements of body weight and the recording of intake and output are accepted nursing practice.

Beck (1982) measured the intake and output of neurological patients in an attempt to obtain measuring accuracy. The intake and output records were compared to the daily weight changes obtained on ten hospitalized patients. There were no reported correlations of the difference between intake and output and the change in daily weight over a given period of time.

Beck's finding is most interesting in that one would expect there to be a strong correlation if the measurements were accurate. With regard to Beck's study, it would seem most reasonable that the two most difficult parameters to determine, water production by metabolism and insensible loss, are important in establishing the correlation as described. Clinically speaking, the water produced by metabolism and an exact measure of the insensible loss of a patient are not practical procedures to perform on each patient. These measures could not only add great expense to the already enormous health care bill, but may not be technically possible.

The study by Beck did not specifically address the determination of a patient's hydration state, nor which clinical parameters should be monitored. Beck provides an understanding of how intake and output and daily weights are related. These measures are commonly used together to determine fluid balance, even though they do not exactly correlate.

From Beck's study, we know that intake and output and change in daily weight do not correlate. The clinical practitioner is left with clues as to the changes which may be occurring in a patient's fluid balance, but nothing definite in terms of what parameters are going to signal the "red alert" in patients every time.

Heath (1971) has referred to a patient's hydration state as a fluid balance that exists when the intake of water and solutes equals the losses. Fluid imbalance is anticipated when there is a history of sodium and water gain and/or loss; there is a change in the patient's level of consciousness; a change in body weight which shows a 24 hour gain or loss of 0.5 pounds or more; and, a 24 hour intake and output record that shows an excess gain or loss of fluids. Heath mentions specific data that are collected and organized to evaluate a patient's fluid balance, but this collection of data is not identified.

Serum osmolality may be one of the more reliable measures of a patient's hydration (Grant & Kubo, 1975). There is a free movement of water across cell membranes and it is thought that the osmolality of the intracellular and extracellular compartments are equal. This combination suggests the serum osmolality to be important in patient evaluation (Grant & Kubo, 1975).

The serum sodium concentration may be of some use in predicting fluid status. The importance of the serum sodium must be viewed in light of other data when assessing fluid status. It is possible to have an overall body excess of sodium and an overall increase in body water which results in an overall body fluid excess where the serum sodium may not reflect this. In instances where there is an equal loss of body water and sodium, the result is an isotonic dehydration (Grant & Kubo, 1975; Valtin, 1979; Vander, 1985) which indicates that the plasma sodium concentration and serum osmolality are important in determining water balance, as well as the daily body weight.

When monitoring the blood urea nitrogen (BUN) as a measure of the hydration status of a patient, it is important to note that a rising BUN can indicate dehydration, gastrointestinal bleeding or even renal failure (Kinney et al., 1981). Therefore, this measure is probably not of the greatest importance in assessing hydration status, but it may be useful.

The hematocrit provides information regarding the portion of the total blood volume occupied by the red blood cells. Grant & Kubo (1975) cautioned that the hematocrit is probably not of the greatest importance in monitoring hydration status when it falls within normal limits consistently.

del Greco (1979) commented that the recording of the intake and output are the most widely used methods of determining fluid balance. The use of the body weight to determine body fluid balance is based on the assumption that the patient's dry weight does not change, and the changes in the patient's weight on a day to day basis are due to fluid changes. del Greco stated that over several days to weeks, this assumption may not be valid; however, Valtin (1979) concluded that in patients who are not eating, it is estimated that the body weight change over a 48-72 hour period will accurately reflect an acute change in water balance.

Insensible fluid or water loss is difficult to measure in patients and frequently seems to interfere with the accuracy of the intake and output records. Valtin (1979) reports that a febrile patient may have an insensible water loss through the skin which may be double or triple normal losses. Catabolic states will increase the water of oxidation and hence the fluid input to the body. It may be impossible to measure insensible water loss and the effects of catabolic states on water balance in patients, as dilution techniques involve the injection of a foreign substance into the body, which is expensive and requires specially trained personnel (Vander, 1985). Therefore, probably the most accurate means of monitoring patients to intervene and prevent dangerous expansion of body fluids is the daily weight.

Thus far, the intake and output record, daily weights and laboratory values such as the serum osmolality, serum sodium, BUN, and Hct have been mentioned with regard to predicting a patient's fluid status. There are no studies in the nursing or medical literature at this time to predict accurately a patient's fluid volume status, let alone any sense of which measures are most important to monitor in the critically ill post-operative patient. The nursing literature which addresses patient assessment may clarify this area further.

The Nursing Assessment

When a nursing assessment is done, there are significant measures to monitor which may indicate a patient's fluid status.

- The blood pressure is monitored for alterations from baseline (Kinney et al., 1981).
- The heart rate, as well as heart sounds, are monitored to determine possible indications of pathology (Dubrick et al., 1983).
- The central venous pressure or the presence of jugular venous distension are assessed to determine the blood volume entering the right atrium (Kinney et al., 1981).
- Pulmonary artery pressures by the use of the Swan-Ganz catheter allow the measurement of the pressure of the blood in the pulmonary artery and the measurement of the cardiac output and cardiac index (Kinney et al., 1981).

. Urine output as measured hourly will provide an estimation as to the blood volume received by the kidneys (Appleton, 1985; Van Meter, 1982).

. The presence of edema is assessed to determine the extent of fluid retention (Kinney et al., 1981).

. Daily weights, when collected under the same circumstances, provide a measure of the fluid status of the patient (Dudrick et al., 1983).

. The intake and output records for a twenty-four (24) hour period provides data on fluid balance (Abels, 1979; Kinney et al., 1981, Dudrick et al., 1983; Appleton, 1985).

Patient care manuals and textbooks mention what the nurse should collect in terms of data. These resources do not identify what has been found to be valuable research based information to monitor in the post-operative period of patients. With little nursing information available on not only what, but why particular patient data are collected, it is necessary to review literature which pertains to the measures traditionally monitored in the post-operative period of the critically ill patient for further clarification. These include daily weights, intake and output, blood pressure, heart rate, CVP, pulmonary artery pressures, cardiac output and index, changes in the patient's physical assessment and the laboratory values which might indicate an alteration from normal.

Roberts (1979) reported that daily measurements of weight are necessary for determining whether interventions have been effective. It is the changes in daily weight that reflect the changes in body fluid volume. Roberts qualifies this statement by reporting that a stable daily weight may not reflect pooled fluids in body compartments which would create an intravascular volume deficit which is not reflected in a weight change. Thus, a stable appearing weight may not accurately reflect the stability of the body fluid compartments.

Three significant diagnostic measures to monitor in the critically ill patient are the daily weight, central venous pressure reading, and the intake and output record to determine a patient's fluid volume. A physiologically based explanation can be given for the importance of these three measurements (Roberts, 1979).

Currently, accepted nursing practice revolves around the use of the nursing process and identification of pertinent nursing diagnoses. The contributing factors of the diagnosis fluid volume excess have been previously described (Carpenito, 1983). The defining characteristics and objective data to be measured when monitoring the patient with this particular nursing diagnosis have particular importance to the nurse assessing the patient. The signs and symptoms frequently manifested by patients with an excess fluid balance in the clinical setting are:

. Presence of edema
. Weight gain
. Taut, shiny skin
. Increased pulse volume - a bounding pulse
. Increased blood pressure
. Tachycardia or an arrhythmia
. Jugular venous distension at 45 degrees
. Tachypnea, labored or shallow respiratory efforts
. Cough
. Rales or rhonchi
. Change in mental status; lethargy, confusion or restlessness
. Intake greater than output
. Orthopnea, dyspnea on exertion, or shortness of breath
. Weakness or fatigue
. Altered laboratory tests (electrolytes, hematocrit/ hemoglobin, blood urea nitrogen)
. Altered hemodynamic measurements (Carpenito, 1983)

These signs and symptoms observed and reported in patients have been identified as useful for nurses to gather and analyze. The remaining articles to be presented in this literature review emphasize what patient data the nurse should collect, but do not include a rationale for the data to collect.

Kee (1972) has discussed the responsibility of the nursing staff to assess the fluid and electrolyte status of patients. This includes the assessment of the pre-operative status, the type of surgery the patient undergoes, and the post-operative assessment. The role of the nurse is to assess, intervene and evaluate the fluid and electrolyte changes. Kee does not address which information and data are important.

In patients suspected of having edema, the American Association of Critical Care Nurses Clinical Reference Manual (Kinney et al., 1981) directs critical care nurses to monitor and record intake and output, assess edematous tissues and daily weights, monitor vital signs and laboratory data, and assess changes in venous pressure. The signs and symptoms of hypervolemia are increased weight, systemic edema, increased central venous pressure, dyspnea, moist rales, puffy eyelids, hypertension, and bounding pulses. The critical care nurse must also observe patients for signs of left ventricular heart failure. The signs most frequently described are: rales, labored respirations, a third heart sound, tachycardia, arrhythmias, and cool, moist skin.

In summary, most data in the literature support using daily weights, intake and output, clinical assessment findings which tend to be alterations from normal limits, and certain laboratory tests to determine a patient's fluid status. Many thoughts, opinions and traditional approaches to patient evaluation for fluid balance status have been presented from findings in the literature. Much of what has been presented is based on principles of physiology and what is currently accepted clinical practice. It is time to substantiate common practice at the bedside with sound scientific findings.

The data examined for this study were the following measurements and assessment findings traditionally used in evaluating patients:

. Intake and output records

. Daily weights

. Hemodynamic measurements

. Auscultation of breath sounds

. Cardiac assessment

. Serum osmolality, serum sodium, hematocrit, and BUN

. The presence and degree of edema.

Since the purpose of this study was to identify early, key indicators of fluid excess, those measures most frequently monitored in the clinical setting were thought to result in an identification of those early, key indicators.

It was assumed that critical care nurses were monitoring the appropriate patient parameters.

The Abdominal Aortic Aneurysm Patient

The population for study in this investigation were patients who had undergone abdominal aortic aneurysm (AAA) resection. These patients require an intensive care unit environment and highly skilled monitoring post-operatively. Shoemaker et al. (1984) emphasize that advanced cardiorespiratory monitoring in the intensive care unit identifies correctable physiologic alterations in the early stages. This monitoring supplements clinical judgement with more objective physiologic criteria, against which therapy may be titrated (p. 105).

The AAA resection patient is at risk for a multitude of complications intra-operatively and post-operatively. It is the post-operative phase of care that the critical care nurse will have impact upon and, therefore, was the focus of this investigation. A determination of fluid balance is essential early in the post-operative course to intervene effectively for hemodynamic stability. Before discussing potential complications, a brief overview of the AAA patient is in order.

The diagnosis of an abdominal aortic aneurysm is generally made on physical examination by the finding of a palpable pulsatile abdominal mass. Contrast aortography, x-ray of the abdomen, ultrasonic scan and abdominal sonograms are useful diagnostic tools which can aid in the diagnosis and extent of the aneurysm involvement (Artz & Hardy, 1975; Thompson et al., 1975). Atherosclerosis is the leading cause in the development of an abdominal aortic aneurysm. In the presence of arterial occlusive disease, the assumption is that there are atherosclerotic processes in varying degrees in all vessels of the body, including the coronary arteries (Artz & Hardy, 1975).

In a study by Thompson et al. (1975), 74% of the 108 patients with AAA resection had serious pre-existing atherosclerotic conditions. These conditions included cardiac disease (43 patients), hypertension (43 patients), diabetes mellitus (8 patients), chronic obstructive pulmonary disease (19 patients), renal disease (19 patients), and carotid artery disease (8 patients), all of which may have put increased stress on the myocardium. The population undergoing aneurysm repair are primarily the elderly, ages 60 - 80, who have additional medical conditions that may lead to the development of fluid overload following surgery.

The surgical procedure of AAA resection generally involves opening the aneurysm sac, evacuating the clots, suturing lumbar arteries and suturing into place a pre-clotted knitted dacron graft. During the clamping procedure, heparin is used. Once hemostatis is achieved, the operative field is closed (Artz & Hardy, 1975; Thompson et al., 1975). Probably one of the most significantly occurring events intra-operatively is the cross-clamping of the aorta prior to graft insertion. Cross-clamping causes a decrease in total peripheral resistance, a change in renal blood flow, a decrease in cardiac output and an increase in systolic blood pressure. The release of the clamp on the aorta once the graft is in place causes hypotension due to hypovolemia, as there tends to be an incomplete blood loss replacement and fluid sequestration during surgery, compounded by varying degrees of pre-operative dehydration. There is a need for adequate fluid volume replacement which is most reliably guided by the use of the Swan-Ganz thermodilution catheter (Bernhard & Towne, 1983 in Moore).

The release of the cross-clamp causes vasodilitation in the extremities. There is myocardial depression as a result of ischemic venous return, a decrease in systolic blood pressure, and a 25-50% decrease in blood flow to the coronary, carotid, renal, hepatic and splanchnic vascular beds (Rutherford, 1984).

Additional complications from AAA resection are injury to the small intestine, injury to the inferior vena cava and iliac veins, hypotension, respiratory complications, bowel and urinary tract infections, aortoduodenal fistula, graft infection, venous thrombosis and fluid and electrolyte imbalances, to mention a few (Artz & Hardy, 1975; Thompson, 1975; Way, 1983).

In addition, post-operative cardiac failure is a potential complication in patients over age 40 undergoing general surgery when general anesthesia is used. The incidence of left ventricular failure and pulmonary edema is 4%, with fluid overload as the most common cause in those patients with a limited cardiac reserve (Pellegrini, in Dunphy & Way, 1981).

Physiologically, the concern over fluid status revolves around the post-operative phase of the patient's recovery. Circulatory and hormonal responses to the surgical insult cause a conservation of sodium and retention of water by the kidneys which occurs despite the status of the extracellular fluid volume (Humphreys & Sheldon, in Dunphy & Way, 1981). ADH is apparently released during the administration of general anesthesia. The stress response to the surgery, in addition to the ADH release, causes renal vasoconstriction, an increase in the circulating aldosterone which results in the retention of sodium and water (Humphreys & Sheldon, in Dunphy & Way, 1981). This has significant impact on the post-operative status of the surgical patient. If the fluid therapy has been excessive to maintain systolic blood pressure and tissue perfusion, the patient is at high risk for circulatory overload as the fluid returns to the intravascular compartment (Humphreys & Sheldon, in Dunphy & Way, 1981) as the circulatory status returns toward baseline when the stress response resolves. It is known that patients with atherosclerosis, of the magnitude suggested, tend to be the elderly with inelastic blood vessels that cannot manage large volumes of intravascular fluids effectively. The tendency is toward depletion of cardiac reserve and the possibility of left ventricular failure and pulmonary edema when large volumes of fluids are received post-operatively. Patients with abdominal aortic aneurysm resection fit this description. The implication for nursing is careful monitoring for changes in patient status during the critical period of fluid mobilization post-operatively.

Summary and Purpose of the Study

The review of the nursing and medical literature presented describes the data to be collected during the post-operative monitoring of the AAA resection patient. For the most part, the rationale for the monitoring of the particular parameters is not available. The usual methods of evaluating the patient's fluid volume status have been presented. Findings from studies on intake and output and daily weights have been discussed. The literature includes findings from several studies as well as suggestions from several authors on which parameters should be monitored and assessed. However, rationale for the monitoring of the particular parameters is not available. One cannot make specific determinations on what is most important to monitor in the post-operation AAA resection patient based on the material presented in the review of the literature. Predictive correlates of the clinical manifestations of fluid volume excess have yet to be identified.

Nursing Implications

Early recognition of the post-operative complications of surgery requires a highly skilled health care team. The recognition of fluid overload, whether potential or actual, depends upon careful analysis of such factors as intake and output measurements and records, changes in daily weights, laboratory data, bedside hemodynamic measurements, and the clinical assessment of the patient. Identifying the key indicators and parameters of a potential problem in the care of the critically ill post-operative patient requires a high degree of discrimination and data processing by the critical care nurse. Early recognition of a potential complication may prevent disastrous consequences for these patients. A study of specific data collected by nurses on a particular patient population should provide information for planning nursing care.

In many instances, a retrospective study of a particular patient population provides information that was not clearly understood in the early patient management phase. This particular investigation focused on the nursing assessment that was performed on a post-operative patient population. Abnormal physical examination findings may be compared to changes in hemodynamic measurements, intake and output records, and daily weight changes in order to substantiate changes in a patient's fluid status. Not all surgical patients are invasively monitored for hemodynamic changes. It becomes necessary and most important to study those who are monitored in this manner to assist in identifying significant changes in physical examination at the earliest possible moment.

Frequently one body system appears to be affected more than another in the treatment of patients. One system, perhaps more involved than another, may provide clues as to how the body has tolerated a particular surgical procedure. In the population studied in this investigation, patients who have undergone AAA resection, fluids were given in large volumes to achieve hemodynamic stability. Adding fluids to the body in some instances will alter the careful balance of fluids within the various compartments of the body. Once this balance is disturbed, major body systems may be affected. One indication of the circulatory effects of fluid volume excess is a change in the respiratory system, as seen with pulmonary edema (Michaelson, 1983; Vander, 1985). This is manifested by fluid collection in the alveoli. The critical care nurse is most often responsible for early identification of changes in the respiratory status of these patients through frequent physical examination. As breath sound changes are identified by the critical care nurse, medical intervention may be instituted.

In the critical care unit, nursing management of the critically ill patient frequently overlaps with the medical management. Critical care nurses are given the responsibility of identifying alterations in the physical examination, hemodynamic measurements and laboratory values, and notifying the physician about the earliest possible indication of an alteration from normal. Continued education in the highly specialized critical care field has produced skilled critical care nurses who can identify alterations in patient status based on the nursing process and a knowledge of pathophysiology.

With the institution of nursing diagnoses in the critical care areas, nursing has the added responsibility of documenting the nursing process, monitoring interventions and evaluating patient outcomes. The goal for patient care is a return to an optimal level of wellness. This study may add to the growing body of research based knowledge and provide nurses with scientifically based guidelines for patient assessment and data collection. It was hoped that priorities in data collection might be identified.

It was suspected that changes in breath sounds might be the earliest clinical manifestation of fluid overload in the selected population, and that this change in breath sounds might correlate with changes or trends in the pulmonary capillary wedge pressure of the particular patient.

Problem Statement

The earliest possible indicators of fluid volume excess are sought during the nursing assessment and evaluation of the post-operative abdominal aortic aneurysm resection patient. There is very little research data to indicate which clinical manifestations, hemodynamic measurement changes or laboratory data provide the earliest indications of the development of fluid volume excess following abdominal vascular surgery such as AAA resection. The post-operative AAA resection patient could develop signs and symptoms of fluid volume excess, and therefore must be monitored very closely so that acute congestive heart failure does not ensue. Congestive heart failure may be difficult to manage as a post-operative complication.

One possibility in the scheme of monitoring the post-operative course of patients who have undergone major abdominal vascular surgery is to monitor one particular system for indications of fluid volume excess. The respiratory system, where changes in breath sounds occur, may provide useful information. Acute pulmonary edema is a dramatic form of fluid overload which is manifested by not only the cardiac component of the life-threatening condition, but also by the very subtle to quite dramatic changes in breath sounds over a short period of time.

It seemed reasonable that a descriptive study of patient care data from a retrospective point of view might provide comparisons and correlations to derive important considerations for patient evaluation in the clinical setting.

The research question posed for this study was: What is the relationship between nursing assessment parameters, hemodynamic measurements, intake and output records and daily weights in the development of fluid volume excess in a sample of patients who have undergone abdominal aortic aneurysm resection?

The following additional clinical questions were answered to some degree as the data were analyzed and interpreted. These clinically relevant questions were:

1. What are the key variables that nurses could use to determine a patient to be in a fluid excess state?
2. What role do adventitious breath sounds play as an indication of fluid volume excess in the post-operative abdominal aortic aneurysm resection patient?

CHAPTER TWO

METHODS

The purpose of this descriptive study was to identify the earliest indicators of fluid excess from a chart review of a sample of patients who had undergone abdominal aortic aneurysm (AAA) resection. This section will describe the sample population, the setting and routine care provided to the patients who had AAA resection included in this study. The data collection methods, design and procedures of the study, and methods for data analysis will be presented.

Sample Population

The patient population proposed for this study included patients admitted to an Intensive Care Unit (ICU) who had AAA resection with the intra-operative placement of a woven Dacron bifurcated vascular graft. This patient population was selected based on the large volume of crystalloid and colloid replacement required intra-operative and post-operatively to maintain hemodynamic stability. A sample of fourteen patient charts were selected for this study. Medical records were chosen from a log listing patient admissions over the last two years. Chart selection was based on the primary diagnosis, accessibility of the chart, and the specific criteria for inclusion in the study.

Setting

This retrospective study examined the medical records of fourteen patients selected who had undergone AAA resection at a 400+ bed private non-profit metropolitan hospital in Portland, Oregon. All patients were recovered and stabilized post-operatively in the Medical/Surgical Intensive Care Unit of this hospital.

The majority of patients cared for in this ICU have had vascular surgery. Two groups of vascular surgeons typically perform these surgeries. These surgeons have standing orders which include: IV maintenance fluids; oxygen therapy; the collection of laboratory data; the collection of clinical data; medications; activity; nutritional considerations; conditions under which to notify the physician; intake and output measurements; and daily weights.

The majority of the elective AAA resection patients were admitted on the day or evening shifts. Twenty-four (24) hour intake and output records were collected from 6am to 6am, with records starting immediately upon the patient's arrival to the ICU from the surgical suite. All daily weights were taken at approximately 4am starting the morning after surgery, unless a need to know the current weight sooner was identified. Chest X-rays were obtained immediately post-operatively and at appropriate intervals as the patient's condition required.

The medical records of the patients selected indicated that the following conditions were met to be included in this study:

1. Intravenous fluids as the only source of intake.
2. A functional Swan-Ganz thermodilution catheter in the pulmonary artery as verified by chest X-ray and waveform tracings.
3. A urinary catheter to gravity drainage.
4. Intake and output measurements recorded.
5. Documentation in the patient record of fluid overload.
6. Daily laboratory tests.
7. Continuous electrocardiographic monitoring.
8. Physical assessments documented by professional ICU nurses or physicians at least every four hours.
9. Daily weights obtained at or near the same time under the same conditions.

To avoid potential bias, this investigator did not care for the patients included in this study.

Design

The design of this study was descriptive and retrospective. The focus was to review collected patient data for indications that a fluid overload process had occurred. The purpose was to identify the earliest indications of fluid volume excess. These findings were examined to identify early key indications of fluid volume excess which may lead to congestive heart failure in the post-operative AAA resection patient. These findings may provide insights in the fluid management of patients undergoing other major surgical procedures which require large amounts of fluids to achieve and maintain hemodynamic stability. The data were collected by reviewing the medical records of those patients selected. Code numbers were assigned to each chart selected to insure anonymity.

Data Collection Procedures

The data for this study were obtained from each patient's medical record. The data collected provided information as to the fluid status of the patient. All data were recorded in the time sequence as they occurred during the patient's post-operative course. Three data collection tools designed by this researcher were devised and refined for use in this study. A pilot study of three patient medical records identified minor areas for change in the data collection tools. The data collection tools included:

1. Data Collection Sheet #1: Patient Profile.
2. Data Collection Sheet #2: Clinical Data.
3. Data Collection Sheet #3: Fluid Analysis Sheet.

Data Collection Sheet #1 (Appendix A) identified the condition of the patient on admission to the hospital. Demographic data and significant pre-existing medical problems were identified from the history and physical examination performed and recorded by the physician, and from the nursing data base. Baseline data collected on the patient's admission provided a basis for comparison during the hospital course. Pre-existing conditions noted on admission may have affected the patient's response to the surgical intervention.

Data Collection Sheet #2 (Appendix B) was designed to gather data from the critical care unit flow sheet with pertinent additions noted from the physician's progress record. This information provided data about the sequence in which clinical data was noted and recorded. The critical care nurse was primarily responsible for the acquisition of the data. Notation was made as appropriate when data were used from the physician's progress notes. Data collected from the patient's medical record with regard to the clinical post-operative course focused on changes in the pulmonary, cardiac/cardiovascular, and neurological systems which have been described, noted or derived from the review of the literature. Pertinent laboratory data with regard to patient status and possible correlates of excess fluid volume were noted.

Data Collection Sheet #3 (Appendix C), the Fluid Analysis Sheet, was used to collect, calculate and display for analysis the intake and output and daily weight records of the patient for the period of time examined.

These data collection sheets provided information regarding breath sounds, physical assessment, hemodynamic measurements, intake and output measurements, daily weights, and laboratory values documented in the chart.

Data Analysis

In this descriptive study, data were examined to compare changes in patient status with descriptors of fluid overload. Contingency and summary tables were used to display data. Identified changes in breath sounds, hemodynamic measurements, and discrepancies in intake and output records and gains in weight were analyzed carefully in these patients to identify the earliest indicator(s) of fluid volume excess. It was suspected that changes in breath sounds could have been one of the earliest clinical manifestations of fluid overload in the selected population. It was also suspected that this presumed change in breath sounds would correlate with changes or trends in the pulmonary capillary wedge pressure of the particular patient.

CHAPTER THREE

RESULTS

The Intensive Care Unit (ICU) of the hospital selected admitted 84 patients with the diagnosis Abdominal Aortic Aneurysm (AAA) resection from January 1984 to June 1986. A retrospective chart review revealed that 19 of the 84 patients had a Swan-Ganz catheter for pulmonary artery pressure monitoring and a secondary post-operative diagnosis of fluid overload. Five of the 19 patients with fluid overload did not meet the criteria for inclusion in this study. The five patients were deleted from data analysis for the following reasons: no documented daily weights; the initial post-operative period was not in the ICU; an unusual bypass graft procedure was performed; a re-operation was done due to a false aneurysm; and a Swan-Ganz catheter was inserted in the ICU 16 hours post-operatively for evaluation of low urinary output and suspected cardiac failure. Patients meeting the criteria for inclusion in this study totaled 14.

Subjects

Fourteen patient charts were obtained from the medical records department of the selected hospital. The mean age of the sample was 74.6 years with ages ranging from 59 to 87 years. Twelve patients were male and two were female. The admitting diagnosis of 12 of the 14 patients was Abdominal Aortic Aneurysm. One of the twelve patients was admitted to the ICU pre-operatively for evaluation. Two patients were initially admitted to the hospital with other diagnoses. One had a pre-operative diagnosis of a possible ruptured appendix. During general anesthesia a thorough abdominal examination revealed a large abdominal aortic aneurysm. Surgery identified the aneurysm to be leaking. Another patient was admitted to the hospital with a suspected incarcerated hernia. He became dizzy after several hours in the hospital, as the hematocrit dropped below 30. A computerized axial tomogram of his abdomen revealed a leaking abdominal aortic aneurysm. This patient initially refused surgery for the aneurysm and some hours later consented to the operation.

Table 2 displays the demographic characteristics of the population during the study period. For each patient the age, sex, past medical history and rationale for surgery are identified. For descriptive purposes, Table 3 provides

TABLE 2

DEMOGRAPHIC CHARACTERISTICS OF THE PATIENT POPULATION

SUBJECT NUMBER	AGE	SEX	RATIONALE FOR SURGERY	PAST MEDICAL HISTORY.
2	69	M	Elective	COPD, Dementia, CVA.
3	71	M	Elective	MI 1971, Stable Angina, Smoker-60pk/year.
4	84	M	Emergency	Atrial Fibrillation, COPD, HTN, Gout, Prostate Surgery.
6	69	F	Elective	Mitral Regurgitation, Smoker, TIA's, Intermitteent Atrial Fibrillation, HTN x 10 yrs, Angina, CABG 10 yrs & 3 yrs prior
8	63	F	Elective	Coronary Artery Disease, MI, Chest Pain x 31 yrs, COPD, CVA 3 yrs Prior, Thyroid, Tremulous.
9	68	M	Elective	CABG, 1 AV Block, LVH, Heavy Smoker. HTN, Malabsorption Syndrome, Bilateral Carotid Endartarectomies, Pre-Op Renal Dysfunction (BUN 37/CR 2.1).
10	84	M	Elective	MI, CABG, Mild CHF, Resolved Unstable Angina, Left Carotid Endartarectomy, TURP, Poor Historian.
11	87	M	Elective	Amputation Right Hand 1930's, COPD, Poor Memory.
12	68	M	Elective	Angioplasty 3 Weeks Prior with Cardiac Arrest, Coronary Insufficiency, Angina with Exertion, Borderline Diabetes, CVA, HTN.
15	86	M	Elective	MI with Arrest 3 yrs Prior, Angina, Intraventricular Conduction Delay, COPD, Right BK Amp., PVD, Carotid Endartarectomy 3 yrs Prior.
17	59	M	Elective	CABG 12 yrs & 4 yrs Prior, Obese, Arthritis, No Angina, Negative Stress Test.
18	78	M	Elective	MI 16 yrs Prior, CABG 10 yrs & 3 Months Prior, Prostate Ca, Gout, Left Ulnar Nerve Palsy.
19	87	M	Emergency	Atrial Fibrillation on Admission - No Cardiac History, HTN, Admit With Hernia & 3+ Pitting Edema & Rales.
21	71	M	Elective	MI 1 yr Prior, 1° AV Block, Athero-sclerotic Cardiovascular Disease, COPD, HTN.

the following information: the time of admission to the ICU immediately following surgery; length of time the Swan-Ganz catheter was functional for the purposes of this study; length of time the patient was in the ICU post-operatively; complications during the ICU post-operative period; diuretics given; and, vasoactive medications delivered via continuous intravenous infusion for hemodynamic stability. Each of the patient characteristics will be described more completely as they pertain to the post-operative period.

Past Medical History

The past medical history revealed ten patients with cardiac disease and four patients without documented cardiac disease. Of the patients with cardiac disease, six had previous myocardial infarctions, five had at least one hospitalization for coronary artery bypass graft, one had mild congestive heart failure and five patients had arrhythmias prior to surgery. Six patients had angina. Three of them were diagnosed as having coronary artery disease and two patients had prior cardiac arrest. Eight patients had a history of a pulmonary related disease and six had no documented pulmonary disease or smoking history. Six of the eight patients with pulmonary disease had chronic obstructive pulmonary disease, the other two were smokers of

TABLE 3

Descriptive Characteristics of the Post-Operative Abdominal Aortic Aneurysm Resection Patient

Patient Number	Military Time of Admit Post-Op	Length of Time Swan in & Functional	Length of Time in ICU	Diuretics Given in ICU	Medication via Drip in ICU	Complications	Disposition of Patient
2	2000	83 hrs	6 days (1 1/2 days pre-op)	None	Aminophyllin Nipride Lidocaine	Fluid Overload, Respiratory Insufficiency	Transfer to Floor
3	1300	37 hrs	1.5 days	Lasix x 3 doses	Lidocaine Tridil, Dopamine	Fluid Overload, Aspirated, ARDS, ?MI	Expired
4	2000	39 hrs	2.8 days	Lasix x 2 doses	Aminophyllin	Fluid Overload	Transfer to Floor
6	1700	88 hrs	4 days	Lasix x 4 doses	Dobutrex	Fluid Overload, ST-T Δ's 24° Post-Op, 1° AV Block 48° post-op	Transfer to Floor
8	1200	179 hrs	13 days	Lasix x 8 doses with Swan in	Aminophyllin	Fluid Overload, Pneumonia, ARDS	Transfer to Floor
9	1400	91 hrs	10 days	Lasix x 2 doses Mannitol x 2	Insulin Dopamine	Fluid Overload, Acute Renal Failure, 2° Rhabdomyolysis, Rt. BK Amputation	Transfer to floor, Renal Failure Resolves
10	1300	50 hrs	3 days	Lasix x 2 doses	None	Fluid Overload, Mild CHF	Transfer to Floor
11	1400	94 hrs	4 days	Lasix x 3 doses	Lidocaine Dopamine	Fluid Overload, Bradycardia + Hypotension During Angiogram-Temp. Pacemaker	Transfer to Floor (5 days Later Pul. Edema)
12	1200	49 hrs	2.3 days	Lasix x 4 doses	Nipride	Fluid Overload, ST-T Δ's on EKG 24° Post-Op	Transfer to Floor
15	1200	71 hrs	4 days	Lasix x 4 doses	Lidocaine	Fluid Overload	Transfer to Floor
17	1600	31 hrs	2.5 days	None	None	Fluid Overload	Transfer to Floor
18	1400	23 hrs	2 days	Lasix x 1 dose	None	Fluid Overload	Transfer to Floor
19	1200	74 hrs	4.5 days	Lasix x 7 doses	None	Fluid Overload, urine myoglobin	Transfer to Floor
21	1300	54 hrs	3 days	Lasix x 1 dose	Pronestyl	Fluid Overload	Transfer to Floor

considerable duration. The patients with a history of smoking were assumed to have some degree of pulmonary disease and included in that group.

Other pre-existing patient disease entities included: three patients with previous peripheral vascular surgery; four patients with neurological disorders or pathology; two patients with endocrine disorders; six with hypertension, three patients with prostate problems; and, one patient with renal dysfunction. Additional medical problems included gout, edema, pulmonary rales, obesity and arthritis. One patient had a malabsorption syndrome.

Post-Operative Characteristics

Table 3 shows that the mean post-operative stay for patients following aneurysm resection was 4.5 days with a range of 1.5 to 13 days. All patients had a secondary diagnosis of fluid overload post-operatively. The mean number of hours the Swan-Ganz catheter was in place and functional post-operatively was 68.8 hours with a range of 23 to 179 hours. Once a patient's Swan-Ganz catheter was discontinued, data were no longer collected. Patient 19 was started on hyperalimentation after 74 hours of Swan-Ganz catheter monitoring. The initiation of hyperalimentation suggested a change in metabolic status and would have made the data more difficult to interpret, as none of the other patients received hyperalimentation during the study period. Therefore, data were not collected on Patient 19 once hyperalimentation was started.

Post-operative complications which were not directly related to fluid excess occurred in 9 patients. Table 3 identifies complications noted during the ICU recovery period as pulmonary system related (Patients 2, 3 and 8), cardiovascular system related (Patients 3, 6, 9, 10, 11 and 12) and renal system related (Patients 9 and 19). Patients 2 and 8 required prolonged mechanical ventilation and patient 3 died of presumed fulminant adult respiratory distress syndrome and a possible myocardial infarction. Patient 11 required a temporary pacemaker during the aortogram preceding the surgical procedure, which may have been related to a contrast dye reaction. The pacemaker remained in place for a short time post-operatively as well. Patient 10 had mild congestive heart failure post-operatively. Two patients (6 and 12) had ST-T changes on the 12 lead EKG during the 24-48 hour post-operative period. In addition, patient 6 developed a first degree AV block about 48 hours post-operatively. Patients 9 and 19 were monitored for myoglobinuria post-operatively. Patient 9 had a previous history of renal dysfunction and developed acute renal failure related to rhabdomyolysis occurring in a lower extremity. The lower extremity later required amputation. Patient 9 required hemodialysis in the immediate post-operative period. Renal function returned in this patient some weeks later. Five patients had no complications other than fluid volume overload.

Medications Post-Operatively

The subjects' data were tallied to identify instances when diuretic medications and/or vasoactive medications were administered intravenously in the ICU post-operatively. Twelve patients received one to eight doses of Lasix during the ICU recovery period to stimulate urine output. Patient 9, in addition to Lasix, also received two doses of Mannitol during the first 20 hours post-operatively. Two patients did not receive any diuretics during the study period.

Three patients required Dopamine to increase renal blood flow, three patients received Aminophyllin for pulmonary purposes, six patients received antiarrhythmic medications and two patients received Nipride for blood pressure control during the early post-operative period. One patient received Dobutrex for the first six hours post-operatively to stimulate cardiac performance. Tridil was administered to Patient 3 before he expired. One patient required an insulin infusion in the early post-operative period for high blood sugars.

Post-Operative Complications

Patients developed primarily cardiovascular and pulmonary related complications post-operatively. One patient developed renal failure which was treated with acute hemodialysis. Considering the fact that post-operative complications occurred in over one-half of the patients studied, nursing assessment parameters, hemodynamic measurements and laboratory data were analyzed to identify relationships suggesting the onset of fluid volume excess.

Possible Predictors of Fluid Volume Excess

All patient data from Data Collection Tool #2 were plotted on a graph to compare pulmonary capillary wedge pressure (PCWP) on the vertical axis, with hours post-operation on the horizontal axis (see Appendix D). In an attempt to compare changes in other assessment variables with the first time they occurred following surgery, the nursing assessment parameters, other hemodynamic measurements and laboratory data were plotted along the vertical axis as well during the initial phase of data analysis. These graphic records of the patients' post-operative course allowed a direct visual comparison of changes in patient status hour by hour. While evaluating these graphic records patient by patient post-operatively, it became evident that most of the variables[1] could not be the earliest predictors of fluid volume excess in these post-operative aneurysm resection patients by merely noting the frequency at which they were measured or documented. Laboratory data and chest x-rays were ordered at specific times during the day and could not be predictors of what was occurring hour by hour with the patient. The intake and output records as tabulated in this study were not hour by hour indications of what was occurring in the patient post-operatively. The intake and output were recorded for each eight hour period and a cumulative 24 hour total calculated. The intake and output records will be discussed more thoroughly in a later section in this chapter. The daily weights were measured at the same time, under similar circumstances each day. Weights provide information on a 24 hour to 24 hour basis only.

The variables which were recorded with enough frequency to be potentially predictive of a patient's

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[1] Such as the chest x-ray, cardiac output, cardiac index, presence of edema, skin color, temperature and moisture, arterial blood gases, serum sodium, hematocrit, blood urea nitrogen, ventilator settings, and specific gravity.

changing fluid status were identified as the changes in patient's breath sounds: the first change in breath sounds (BS-1) and persistent changes in breath sounds (BS-2); cardiac rhythm and rate; blood pressure (B/P); central venous pressure (CVP) (not measured consistently in all patients); neurological status (NS); and, the pulmonary capillary wedge pressure (PCWP). The pulmonary capillary wedge pressure was measured and documented every one to two hours in the early ICU post-operative period. The pulmonary capillary wedge pressure was assumed at this point to be the indication that the patient had fluid imbalance. The variables measured with enough frequency were compared and related to changes in the PCWP to identify early predictors of fluid volume excess.

Table 4 is a summary of variables which have been identified as possible predictors of fluid volume excess in the post-operative AAA resection patient. Frequency of responses were tallied to determine which if any of the variables were early predictors of increasing PCWP, an early sign of fluid excess. The responses suggesting a possible prediction of increasing PCWP were compared to the total number of responses for that variable for each patient. A percentage of possible prediction of that variable could then be calculated for comparison purposes. Each of the six

TABLE 4

SUMMARY TABLES FOR PREDICTORS OF FLUID EXCESS

Subject No.	1. Breath Sounds[1] Is there a PCWP increase of at least 4mmHg[1] or a PCWP ≥14 within 2 hours after an initial[2] change in breath sounds suggesting fluid excess[3]? (yes=1; no=0)		2. Breath Sounds[2] Is there a PCWP increase of at least 4mmHg[1] or a PCWP ≥14 within 2 hours after any[2] breath sounds suggesting fluid excess[3]? (yes=1; no=0)		3. Cardiac Rhythm/Rate Is there a PCWP increase of at least 4mmHg[1] or a PCWP ≥14 within 1 hour after[2] a new tachycardia or appearance of PACs and/or PVCs? (yes=1; no=0)		4. Blood Pressure Is there a PCWP increase of at least 4mmHg[1] or a PCWP ≥14 within[2] 2 hours after a new hypertensive time period? (yes=1; no=0)		5. Central Venous Pressure Is there a PCWP increase of at least 4mmHg[1] or a PCWP ≥14 within[2] 2 hours after of an increase in CVP above normal? (yes=1; no=0=no measurement and/or no abnormality)		6. Neurological Status Is there a PCWP increase of at least 4mmHg[1] or a PCWP ≥14 within 2 hours after[2] a change in neurological status indicating restlessness or agitation without evidence of hypoxemia? (yes=1; no=0= no abnormality)	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
2	2	16	3	18	3	21	2	7	1	2	1	4
3	2	2	2	2	2	8	0	3	0	1	2	3
4	0	4	1	10	1	9	1	2	0	0	3	2
6	1	1	1	4	1	15	3	7	0	0	0	0
8	4	32	4	45	0	18	2	12	0	2	1	9
9	0	3	0	8	0	6	4	5	3	2	0	0
10	0	3	0	5	0	0	1	6	0	0	0	0
11	0	7	1	8	3	23	0	2	0	0	0	4
12	1	1	1	1	0	0	1	4	0	0	0	0
15	2	5	3	8	0	1	4	1	0	1	1	0
17	0	6	0	6	0	3	0	4	0	0	0	0
18	0	3	0	3	0	0	2	1	0	3	0	0
19	0	3	0	3	0	8	1	6	0	4	0	4
21	0	11	0	13	0	1	0	6	0	0	0	0
TOTALS:	12	97	16	134	10	113	21	66	4	15	8	26

Key

1. PCWP ↑4mmHg; or ↑3 if >11; or ↑5-6 if <11 or ↑to ≥14 (from <14 meeting with one other criterion).
2. Allowing 4 hours for stabilization post-operatively in the ICU.
3. Breath sounds suggesting the development of fluid excess: New wheezes, rales, new onset of fine moist rales or crackles, and/or one of the above plus suctioning moderate to large amounts of thin frothy pulmonary secretions.

variables identified will be described in relationship to the tallied findings.

Breath Sounds

For this study, adventitious breath sounds suggesting fluid excess were identified as new wheezes, rales, fine moist rales or crackles, and/or if suctioning thin frothy secretions may suggest fluid excess. Two descriptions of changes in breath sounds are related to changes in PCWP (Table 4). The first breath sound variable (BS-1) was defined as any new wheezes, rales, fine moist rales or crackles, and/or suctioning thin frothy secretions followed within two hours by an increase of the PCWP at least 4mmHg. or a PCWP > 14 as described in Table 4. The second breath sound variable (BS-2) was defined as all instances when a breath sound suggesting fluid volume excess was identified in the nursing record. The comparison to the change in PCWP was the same as that made for the first change in breath sounds (BS-1). The time frame for change and the amount of change in the PCWP were set at arbitrary values to be potential predictors of fluid excess. This investigator suggested that a change in breath sounds could possibly occur up to two hours before a change in PCWP suggesting fluid volume excess. These time and measurement criteria were set based on this investigator's perception of fluid volume excess described previously in Figure 1 and the review of the literature. A description of the findings of each of the variables as they were identified in each patient's medical record follows.

Breath Sounds - Variable 1

The data collected suggested that breath sounds as defined for variable 1 may have predicted an increase in PCWP and a trend toward fluid volume excess 50% of the time in patients 3, 6 and 12. Fluid excess was possibly predictable 29% of the time for patient 15 and 11% of the time for patients 2 and 8 based on the first change in breath sounds noted. No potential prediction was identified in patients 4, 9, 10, 11, 17, 18, 19 or 21. The amount of data available for analysis was small.

Breath Sounds - Variable 2

Breath sounds variable 2 identified all instances when breath sounds could suggest fluid volume excess as defined by this investigator. The results of the tally of frequencies for patients 3 and 12 suggested that breath sounds might be predictive of fluid volume excess 50% of the time. Patient 15 had a potential prediction of 27%, patient 6 at 20%, patient 2 at 14.3%, patient 11 at 11%, patient 4

9% and patient 8 at 8%. No prediction was suggested in patients 9, 10, 17, 18, 19 or 21.

Cardiac Rhythm and Rate

Changes in cardiac rhythm and rate appeared to predict the trend to fluid volume excess. This variable identified a new tachycardia or the appearance of premature arterial contractions (PACs) and/or premature ventricular contractions (PVCs) as possible predictors of fluid excess in the post-operative period. Analysis of the cardiac rhythm and rate data showed that the appearance of a new tachycardia or PACs and/or PVCs suggested a trend toward fluid excess 20% of the time in study patient 3. Data suggested the potential to predict the trend to fluid excess was 12.5%, 11.5%, and 10% of the time in patient's 2, 11 and 4 respectively. Patient 6 had a 6.3% possibility of prediction. No prediction was suggested in patients 8, 9, 15, 17, 19 or 21. Patients 10, 12 and 18 had no abnormalities in cardiac rhythm or rate.

Blood Pressure

The occurrence of a hypertensive episode post-operatively beginning up to two hours prior to a change in PCWP was defined as being suggestive of a trend toward fluid volume excess (Table 4). Data on patient 15 identified an 80% chance of predicting a trend toward fluid volume excess based on the appearance of a new hypertensive episode. In patient 18, a hypertensive episode seemed predictive 66.7% of the time. Patient 9 became hypertensive two hours before a change in PCWP 44.4% of the time. Patient 4 showed a 33% trend in prediction and patient 6 a 30% chance of prediction. Trends to fluid excess seemed to be predicted in patient 2 at 22%, patient 12 at 20%, and patients 8, 10 and 19 at 14.3%. No prediction was noted in patients 3, 11, 17 or 21.

Central Venous Pressure (CVP)

Data were analyzed to identify a change in CVP above normal beginning up to two hours prior to a change in PCWP suggesting a trend toward fluid volume excess. The CVP measurements for patients in this study were recorded on an occasional basis. It appeared in the nursing records that some nurses measured the central venous pressure in addition to the PCWP and others did not. Central venous pressure measurements were documented inconsistently on patients 2, 3, 8, 9, 15, 18 and 19. Five patients (4, 10, 11, 12 and 17) had no CVP measurements while the Swan-Ganz catheter was in use. Patient 6 had CVP measurements in the low normal range despite a PCWP suggesting fluid excess. Patient 21 had no increases in CVP above normal post-operatively.

Patient 9 had CVP measurements above normal up to two hours prior to the change in PCWP 60% of the time. Patient 2 had a 33% suggested prediction of suspected fluid excess. No prediction was identified in patients 3, 8, 15, 18 or 19.

Neurological Status

Neurological changes have many indications. For the purposes of this study, neurological changes suggesting a trend to fluid volume excess by the change in PCWP were restlessness or agitation without evidence of hypoxemia. The frequency of the documented changes of restlessness or agitation in patients were tallied on Table 4 when they were followed within 2 hours by a PCWP increase of 4mmHg. Data analysis showed seven patients (6, 9, 10, 12, 17, 18 and 21) with no alterations in neurological status. A majority of these patients did become confused or disoriented during the ICU experience. Since these symptoms may be attributed to causes other than fluid volume excess, they were not included in the definition of neurological changes for this study. Patient 15 had one episode of a neurological change followed by a 4mmHg increase in PCWP within 2 hours possibly suggesting fluid volume excess. This one observation gave a frequency of 100% possible prediction. However, one documented change does not provide enough data to make a prediction such as this. The data collected on patient 4 suggested that neurological changes predicted an increase in PCWP 60% of the time. Patient 3 had a 40% rate of possible prediction of fluid volume excess. Patients 2 and 8 had neurological changes predicting fluid excess 20% and 10% of the time, respectively. Two patients (11 and 19) had no abnormalities in neurological status.

Intake and Output and Daily Weights

This section will examine the intake and output and changes in daily weights recorded in the medical record on all patients during the study period. Intake and output measurements were recorded and weights were measured daily and documented within one hour of each other in all patients. A different weight scale was used on admission to the hospital than was used post-operatively in the ICU. Table 5 shows the results of the calculations for intake and output, with the inclusion of an estimate for insensible loss (Appendix C), and the recorded daily weights. Day 1 included the operating room (OR) totals for each patient. The amount of fluid given intra-operatively provided additional data about the patient's potential hemodynamic status post-operatively in the ICU.

TABLE 5

Results of the Study: Fluid Balance Analysis

Subject Number	Age	Sex	Admit Weight (kg)	Weight (kg)/Intake-output (cc) for 24° Period: Day 1 (Includes OR)	Day 2	Day 3	Day 4	Day 5	Day 6	Weight Difference (cummulative)	I-O (cc) Difference (cummulative)
2	69	M	70.4kg	71.9kg	71.7kg	69.2kg	66.8kg			-3.6kg	+2211cc
				+4586cc	+314cc	-1412cc	-1277cc				
3	71	M	69.5kg	75.3kg	expired					+5.8kg	approx. +4594cc
				+5315cc	±721cc						
4	84	M	68.8kg	70.3kg	68.9kg	66.3kg				-2.5kg	+2036cc
				+4484cc	-1603cc	-845cc					
6	69	F	75.4kg	76.6kg	78.9kg	76.9kg	74.9kg			-0.5kg	+4518cc
				+4024cc	+1667cc	+242cc	-1415cc				
8	63	F	63.2kg	68kg	68.7kg	68.6kg	68kg	68kg	70kg	+6.8kg	+7195cc
				+5292cc	-235cc	-557cc	+605cc	+1286cc	+804cc		
9	68	M	68.6kg	75.9kg	81.2kg	78.3kg (77.5kg $\bar{p}$ dial)	78.2kg (77.5kg $\bar{p}$ dial)			+9.6kg	+2846cc
				-435cc	+1420cc	+1147cc	+714cc				
10	84	M	68.2kg	69.3kg	69.1kg	65.4kg				-2.8kg	+ 949cc
				+3010cc	-61cc	-2000cc					
11	87	M	55.9kg	64.9kg	65.5kg	64.8kg	61.3kg			+5.4kg	+3864cc
				+7248cc	+861cc	-345cc	-3900cc				
12	68	M	73.2kg	73.2kg	73.8kg					+0.5kg	- 938cc
				+ 232cc	-1170cc						
15	86	M	79.5kg	79.1kg	79.4kg	78.8kg	trans-ferred			-0.7kg	+2412cc
				+2960cc	+725cc	-233cc	-1040cc				
17	59	M	86.4kg	91.4kg	91.8kg					+5.4kg	+2580cc
				+1955cc	+625cc						
18	78	M	68.4kg	71.4kg	77.4kg	trans-ferred				+9kg	+5760cc
				+3952cc	+2638cc	-830cc					
19	87	M	90.9kg	101.3kg	100.8kg	98.3kg	95.3kg			+5kg	+6085cc
				+11,420cc	-465cc	-2730cc	-2140cc				
21	71	M	75kg	77.5kg	80kg	77.5kg	trans-ferred			+2.5kg	+ 165cc
				+580cc	-100cc	-465cc	+150cc				

Ideally, a patient's fluid status might be predicted based on the daily weight changes over a short period of time. It has been thought that intake and output reflect changes in daily weight. A body weight gain of one kilogram (kg) is generally estimated to equal one liter of fluid added to the body over a relatively short period of time (Valtin, 1979; Kinney et al., 1981; Vander, 1985). After two to three days, muscle mass changes may begin to occur and may contribute to weight changes. The review of the literature has addressed this issue to some extent. Investigators such as Pflaum (1979), Beck (1982) and Oveson (1981) could not identify a correlation between intake and output and change in daily weights. The relationship of intake and output records to changes in daily weights have been addressed to some extent in this study.

Analysis of the data for days one and three indicated the majority of patients experienced a discrepancy between intake and output and change in daily weight. The only correlation seen between these two parameters occurred in three patients on day one.

Table 6 shows the weight change from admission through the first post-operative day and the fluid balance intra-operatively through Day 1.

Table 6

Weight Change and Fluid Balance for Day 1

Patient	Weight Change	Fluid Balance
2	+1.5Kg	+4586cc
3	+5.0Kg	+5315cc
4	+1.5Kg	+4484cc
6	+1.2Kg	+4024cc
8	+4.8Kg	+5292cc
9	+7.3Kg	- 435cc
10	+1.1Kg	+3010cc
11	+9.0Kg	+7248cc
12	0.0Kg	+ 232cc
15	-0.4Kg	+2960cc
17	+5.0Kg	+1955cc
18	+3.0Kg	+3952cc
19	+10.4Kg	+11,420cc
21	+2.5Kg	+ 580cc

Although not a close relationship, the change in weight for Patients 11, 18 and 19 was within 2 liters (or

2 kg) of the difference in intake and output for Day 1. A closer colleration could be seen in patients 3, 8 and 12.

Table 7 displays the intake and output difference and the change in daily weight for Day 2. Seven patients (2, 4, 6, 10, 11, 15, 17 and 19) had an estimated 500cc or less difference in the intake and output compared to the change in daily weight based on 1 kilogram = 1000cc, for Day 2. Two additional patients (6 and 8) had less than 1000cc difference, bringing the total to 9 patients with a less than one liter difference in intake and output versus daily weight change for Day 2.

Table 7

Weight Change and Fluid Balance for Day 2

Patient	Weight Change	Fluid Balance
2	-0.2Kg	+ 314cc
3	------	-------
4	-1.4Kg	-1603cc
6	+2.3Kg	+1667cc
8	+0.7Kg	- 235cc
9	+5.3Kg	+1420cc
10	-0.2Kg	- 61cc
11	+0.6Kg	+ 861cc
12	+0.6Kg	-1170cc
15	+0.3Kg	+ 725cc
17	+0.4Kg	+ 625cc
18	+6.0Kg	+2638cc
19	-0.5Kg	- 465cc
21	+2.5Kg	- 100cc

Patient 19 closely resembled the desired relationship of intake and output to change in daily weight. The weight decreases 0.5 kg, or approximately 500cc. The fluid balance calculation was negative 465cc, a very close comparison.

Nine patients had complete intake and output and daily weight measurements for Day 3. When excluding the patient receiving dialysis, five of the nine patients had differences in fluid balance and a coinciding change in weight which was 400cc to 900cc (0.4 kg - 0.9 kg) difference. These seemed to more closely resemble a predicted relationship between the intake and output and change in daily weight than the relationship and differences noted during Day 1, but not as closely as Day 2.

Table 8 displays the weight change and fluid balance for Day 3.

Table 8

Weight Change and Fluid Balance for Day 3

Patient	Weight Change	Fluid Balance
2	-2.5Kg	-1412cc
4	-2.6Kg	- 845cc
6	-2.0Kg	+ 240cc
8	-0.1Kg	- 557cc
10	-4.7Kg	-2000cc
11	-0.7Kg	- 345cc
15	-0.6Kg	- 233cc
19	-2.0Kg	-2730cc
21	-2.5Kg	- 465cc

The dialysis patient (9) was deleted from a portion of the data analysis, Day 3, because of the interference of hemodialysis on intake and output and change in weight during the procedure. No other patients received hemodialysis.

The discrepancy in fluid balance and change in daily weight certainly could be related to the difficulties in measuring insensible loss, as well as the presumed inaccuracies in fluid measurement. The important consideration for data interpretation is: What is the acceptable difference when relating intake and output to changes in daily weight?

The study population dwindles from Day 4 on. Fluid balance relationships to changes in daily weight become more difficult to interpret as these patients have gone into a catabolic state related to lack of adequate nutrition. The fluid balance and weight data were not helpful in predicting the development of fluid excess, most particularly acute congestive heart failure.

Comparison of Patient Variables

Data analysis thus far has included a discussion of the recorded changes in selected variables which occurred prior to an increase in pulmonary capillary wedge pressure (PCWP) suggesting an onset of, or worsening trend toward fluid volume excess. The factors surrounding each patient's surgical procedure and the fact that the majority of patients had pre-existing cardiovascular and/or pulmonary disease may have had an impact on the post-operative recovery period and the ability of the critical care nurses to identify changes in patient status that would indicate the development of fluid excess. This section of data analysis will relate demographic data and prior medical history to changes in the six defined variables of breath sounds (BS-1 and BS-2), cardiac rhythm and rate, blood pressure (B/P), central venous pressure (CVP) and neurological status (NS). Comparisons were made using percentages of possible prediction calculated for each based on the total number of responses recorded in the patient's medical record.

Sex

Table 9 displays the percentage of data tallied predicting fluid excess for each of the six variables previously described. For descriptive purposes, males and females in this study are compared with the six variables.

Table 9

Comparison of Males to Females on Predictors of Fluid Excess[1]

SEX	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Male	9.8%	12.8%	10%	25%	50%	28%
Female	13.0%	9.2%	2.9%	20%	0%	11%

[1] Tallies of no abnormality and no measurements were deleted.

The data suggest that the central venous pressure measurement may be able to predict fluid excess in males 50% of the time, and not at all in females. The amount of data is small, however. Blood pressure had a possible predictive rate of 25% for males and 20% for females. The neurological status changes may be predictive 28% of the time for males and 11% for females. The cardiac rhythm and rate tended to be less predictive for females than for males, based on the amount of data available for analysis. The breath sounds variables 1 and 2 showed minimal differences between the two groups.

Elective vs. Emergency Surgery

Health care professionals tend to think of a patient as being more prepared for surgery when an elective operation is scheduled. The patient may not be in an optimal hemodynamic state when surgery is done on an emergency basis. Table 10 compares the patient data post-operatively for elective versus emergency surgery.

Table 10

Comparison of Elective vs. Emergency Surgery on Predictors of Fluid Excess[1]

	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Elective	11.7%	11.9%	8%	24.7%	26.7%	20%
Emergency	0.0%	7.0%	9.1%	20%	0%	33%

[1] Tallies of no abnormality and no measurement were deleted.

The data show that blood pressure, CVP and changes in neurological status were more predictive of fluid volume excess in the elective surgical patients 24.7%, 26.7% and 20% of the time respectively. The emergency patients had a suggested predictive change in neurological status 33% of the time prior to the increase in PCWP as per the selected criteria. The first documented change in breath sounds and the CVP were not predictive of a change in the emergency patients based on the data.

Cardiac History

Table 11 provides the data comparing prior cardiac history with the six variables identified for data analysis.

Table 11

Comparison of Cardiac History vs. Non-Cardiac History on Predictors of Fluid Excess

	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Cardiac History	12.8%	11.8%	6.2%	27%	25%	20%
Non-Cardiac History	6.4	10.5%	10%	16%	14%	7.7%

In patients with a cardiac history, the blood pressure change to hypertension preceded the change in pulmonary capillary wedge pressure 27% of the time, the CVP measurement 25% of the time and a neurological change occurred prior to a change in PCWP 20% of the time. Blood pressure and CVP changes appeared also to be predictive in the non-cardiac patients 16% and 14% of the time respectively. Overall, patients with a cardiac history had a slightly more predictable trend to fluid volume excess in 5 of the 6 variables identified. It is important to note that the amount of data is small.

Respiratory History

Table 12 identifies the results of the data for patients with and without prior respiratory system disease.

Table 12

Comparison of Patients with Respiratory History vs. No Respiratory History on the Prediction of Fluid Excess

	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Respiratory History	10.8%	11.8%	8.6%	24%	25%	23.5%
Non-Respiratory History	12.5%	9.5%	5.3%	24%	0%[1]	0%[2]

[1]One chart results.
[2]No abnormalities noted.

There is little difference between patients with and without respiratory disease in relationship to the variables of breath sounds and cardiac rhythm and rate. There was no difference in the blood pressure variable between the two groups. It is interesting to note that the central venous pressure measurements predicted the trend to fluid excess in patients with respiratory disease 25% of the time prior to the change in PCWP. The tally of patients without respiratory disease did not appear to be predictive of fluid excess. The change in neurological status suggesting a trend to fluid excess occurred 23.5% of the time. There were no abnormalities in neurological status among the patients without respiratory history. One must question the impact of long-term right-sided heart failure seen in respiratory patients on the development of an increase in central venous pressure identified in this study. Patients with long term respiratory disease, i.e., chronic obstructive pulmonary disease, tend to have a central venous pressure above normal ranges which can be related to some degree of right-sided heart failure in the pre-operative state.

Cardiac and Respiratory History

Table 13 compares patients with a history of both cardiac and respiratory disease with those who did not have a history of these diseases.

Table 13

Comparison of Patients with Cardiac Plus Respiratory History vs. No History of the Combination

	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Cardiac & Respiratory History	12.3%	10.4%	6.5%	27.5%	33%	33%
No History of the Combination	9.0%	14.0%	9.0%	21%	10%	7.7%

Comparisons of the data suggest that the CVP and neurological status changes are more predictive of an increase in PCWP in those patients with cardiac and respiratory diseases. In addition, the blood pressure was very slightly more predictive. Again, the impact of chronic congestive heart failure may have a role in the development of these predictive signs. The other variables suggested minimal differences between the two groups. It is important to note that the amount of data collected was small.

Hypertensive History

Table 14 separates the patients with prior history of hypertension from those without. Data showed minimal differences between the two groups with all variables except CVP and nuerological changes. The one patient on whom CVP readings and neurological changes were recorded showed a trend to fluid excess of 60% in the patients with a prior history of hypertension.

Table 14

Comparison of Patients with Hypertensive History vs. Those with No History or Predictors of Fluid Excess

	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Hypertensive History	9.0%	7.7%	6.1%	27%	60%[1]	60%[1]
No Hypertensive History	11.5%	12.9%	8.9%	22%	7.1%	17.2%

[1]One chart tallies.

Previous Vascular Surgery

Patients with and without a prior history of peripheral vascular or coronary artery surgery were compared. Table 15 displays these data.

Table 15

Comparison of Patients with Previous Vascular Surgery to Those without Prior Vascular Surgery

	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Previous Vascular Surgery	4.2%	5.6%	7.8%	28.6%	37.5%	0.0%
No Previous Vascular Surgery	12.9%	13.5%	8.3%	21.2%	9.1%	28.6%

The comparison suggests that in patients without a prior history, the variables of breath sounds (BS-1 and BS-2) and cardiac rhythm and rate were slightly more predictive of fluid excess. Neurological changes were predictive 28.6% of the time in patients without prior history of previous vascular surgery as compared with 0% of those who did. The CVP measurements appeared to be predictive in patients with previous vascular surgery when assessing for trends toward fluid volume excess. The blood pressure change was slightly more likely to predict a change toward fluid excess in those patients with a prior history than those without.

Weight Gain

Table 16 separates patients with a greater than 4 kg weight gain from those with less than a 4 kg weight gain in the first 24 hours. The 4 kg weight measurement is an arbitrary measurement, used only for descriptive purposes.

Table 16

Comparison of Weight Gain Greater Than 4 kg vs. Weight Gain Less Than 4 kg in the First Twenty-Four Hours Post-Operatively on Predictors of Fluid Excess

	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Weight Gain > 4Kg	10.2%	8.9%	7.0%	18%	25%	13%
Weight Gain < 4Kg	12.0%	14.8%	9.6%	29%	14.3%	45%

The analysis suggests that patients with a weight gain less than 4 kg in the first 24 hours had neurological status changes more predictive of fluid excess than the patients with more than a 4 kg weight gain. CVP measurements were slightly more predictive in the patients with a 4 kg or more weight gain. Patients with a weight gain of less than 4 kg had blood pressure changes more suggestive of fluid excess than did the others. Other variables were slightly more predictive of the trend to fluid excess in the patients without the weight gain in the first 24 hours.

Weight Gain and Cardiac History

Data were analyzed to separate the patients with both a greater than 4 kg weight gain in the first 24 hours and a cardiac history from those not meeting these criteria. This investigator suspected that patients with a large weight gain and a cardiac history would be more at risk for problems with fluid volume than those with minimal weight gain and no cardiac history. Table 17 displays the data.

Table 17

Comparison of Patient with a Weight Gain of Greater Than 4 kg plus a Cardiac History to Those without on Predictors of Fluid Excess

	BREATH SOUNDS-1	BREATH SOUNDS-2	CARDIAC RHYTHM & RATE	BLOOD PRESSURE	CVP	NEUROLOGICAL STATUS
Weight Gain > 4Kg & Cardiac	31.6%	9.0%	5.4%	20%	37.5%	20%
Weight Gain < 4Kg & No Cardiac	6.7%	13.7%	9.3%	26%	9.0%	26%

The initial change in breath sounds and the CVP were more suggestive of fluid excess in the patients with a weight gain of greater than 4 kg and cardiac disease than those without. All other variables assessed were slightly more suggestive of a prediction in those patients without the weight gain and cardiac history.

CHAPTER FOUR

DISCUSSION

This chapter will address the limitations of this study and the results of data analysis. The design was a major limiting factor which precluded the use of statistical techniques for data analysis and interpretation. A convenience sample was used of post-operative patients who had undergone abdominal aortic aneurysm (AAA) resection and developed signs and symptoms of fluid overload post-operatively. All study patients met pre-determined criteria. A research design utilizing a control group may have been more effective for data interpretation. During this preliminary, descriptive study, the available data was collected to identify comparisons and potential predictors of fluid volume excess. The amount of data interfered with the ability to identify suspected relationships between changes in patient clinical status with coinciding increases in pulmonary capillary wedge pressure.

The patients selected for this study may not have been a representative sample of patients who have undergone abdominal aortic aneurysm resection. The consumers of health care at the private non-profit metropolitan hospital may be from a higher socioeconomic class, may seek health care more often than others in the city area, and may be more health oriented than other patients who have had an AAA resection.

This study was designed to gather as much data as possible for evaluative purposes. It was not known from the onset which data analysis techniques would be of the most value in interpreting the findings. All data collected for study purposes were not included in data analysis because on retrospective analysis it was found that some variables were not measured consistently and thus could not be further analyzed. Several variables were identified which seemed to be predictive of a change in fluid volume status. The variables - blood pressure, central venous pressure and a change in neurological status in the absence of hypoxemia - tended to change in a potentially predictive manner as the pulmonary capillary wedge pressure increased above 11 - 14mmHg, suggesting fluid excess. The study population, and thus the amount of available data were small. No generalizations could be made based on the selected sample size.

Patients with pre-existing respiratory disease were included in this study. Since these patients usually have a wide variety of pre-existing adventitious breath sounds, the post-operative respiratory nursing assessment may have been affected. The interpretation of the data for these patients seems limited.

All time limits and degrees of change in the variables used for data analysis were arbitrarily set. These limits were based on this investigator's clinical impression of what might be predictive of fluid volume excess. Research data was not present to support or refute these arbitrary limits set. The limitations identified support the conclusion that the results of this study not be generalized, and that further refinement in the study design is indicated.

Conceptual Framework

The conceptual framework may not have been appropriate to identify the suspected relationships between changes in clinical status and an increase in pulmonary capillary wedge pressure suggesting fluid volume excess. This study centered on the concept of fluid volume excess and the implication for patient care. Figure 1 displays a linear relationship of what this investigator conceptualized as a possible relationship of fluid volume excess to fluid balance and circulatory overload leading to congestive heart failure and acute pulmonary edema. The literature describes acute pulmonary edema as a catastrophic complication of fluid overload, especially in the setting of a cardiac compromised patient (Trunkey, 1975; Valtin, 1979; Schwartz, 1984). This investigator's conceptualization of the state of fluid excess was developed from the physiology and pathophysiology of congestive heart failure (Kinney et al., 1981; Michaelson, 1983; Vander, 1985), and clinical practice experiences. Congestive heart failure as a type of fluid volume excess may not produce early indications which may be used in this population. This possibility must be considered when establishing the importance of the findings of this study. It is recommended that the conceptual framework be modified for further use.

Interpretation of the Findings

The findings of this study must be interpreted with the limitations and discussion of the appropriateness of the conceptual framework in mind. Six variables were identified by preliminary data analysis to most likely occur prior to a change in pulmonary capillary wedge pressure suggesting fluid volume excess. These six variables have been identified as: breath sounds-1; breath sounds-2; cardiac rhythm and rate; blood pressure; and, change in neurological status. The frequencies of recordings for each variable have been discussed and percentages of recordings suggesting a possible prediction were identified. Now the essential question is: What constitutes a significant percentage of predicting fluid excess in these post-operative AAA resection patients? If a variable was predictive more than 50% of the time, it would be considered by most practitioners as an important variable to evaluate post-operatively. The question that must be raised when caring for patients in an intensive care unit is: How important is a predictive value of even 10%? Should the critical care nurse monitor those variables closely assuming that they might be predictive of fluid volume excess? This study does not provide answers to these questions; however, the data should be reviewed with these questions in mind.

Breath Sounds

The breath sounds variables 1 and 2 seemed to be predictive of fluid excess in patients 3 and 12 50% of the time. However, the results must be considered inconclusive since the amount of data is small. Of interest was the finding that patient 3 also had the highest prediction for cardiac rhythm and rate (20%), and a 40% prediction for neurological status changes suggesting the development or worsening of fluid excess.

Data collected for patient 15 suggested a trend toward fluid volume excess with regard to variables on breath sounds 1 and 2 (29% and 27%), blood pressure (80%), and a neurological change (100%). Unfortunately, there is not enough data on this patient to make any generalizations.

The evaluation of the breath sound variables did not provide the data suggesting fluid excess based on changes in breath sounds that this investigator expected. The review of the literature identified the cardiovascular and respiratory systems as most sensitive to changes in body fluids post-operatively (Dudrick et al., 1983). During the period of fluid replacement peri-operatively, the patient may rapidly develop signs and symptoms of fluid overload (Hardy, 1980), such as those associated with congestive heart failure or pulmonary edema (Michaelson, 1983). One of the most significant clinical findings in congestive heart failure and pulmonary edema is the presence of adventitious breath sounds - fine moist rales and/or wheezes (Kinney et al., 1981; Michaelson, 1983). This investigator suspected a change in breath sounds might have preceded all other clinical findings related to fluid overload. Such factors as the frequency with which the breath sounds were recorded and the presence of pre-existing diseases may have interfered with this assumption. The usual approach to patient assessment in terms of breath sounds evaluation is essential and further study is indicated.

Cardiac Rhythm and Rate

The cardiac rhythm and rate changes were predictive 6% to 20% of the time for the responses tallied. The changes in cardiac rhythm were related to the patient's activity level, tolerance to mechanical ventilation or pre-existing disease entities. Patients that had cardiac rhythm and rate changes also tended to have post-operative complications.

Blood Pressure

Blood pressure changes seemed to predict fluid and volume excess in more patients than did any of the other variables measured. This occurred in 14.3% to 80% of the time which is a much higher overall rate than for other variables. Even though blood pressure can be influenced by a number of factors, this finding was interesting and suggests further investigation.

Central Venous Pressure

The number of times the central venous pressure (CVP) was measured in patients was minimal. Two patients had CVP measurements which tended toward a prediction before the pulmonary capillary wedge pressure (PCWP) increased. The patient with renal failure had 60% and patient 2, 33%. No generalizations should be made about fluid excess from the limited amount of data or this variable. It is possible that critical care nurses identified the PCWP as indicative of the patient's fluid status and saw no need for an additional measurement of fluid pressure.

Neurological Status

Seven patients had no alteration from normal neurological functioning. Predictions ranged from 10% to 100% for those patients with a change suggesting a trend or worsening of fluid excess. No generalizations should be made based on the scant amount of data.

Intake and Output and Daily Weights

The intake and output and daily weight measurements added little to the identification of early predictors of fluid excess. Many other variables changed (blood pressure, CVP and neurological status) before the intake and output measures were totaled. The changes in daily weight supported what was suspected based on other data suggesting fluid excess. This study provided the opportunity to compare differences in the intake and output with the change in daily weight. Days 1 and 3 did not suggest a correlation of intake and output with changes in daily weight for the majority of the study sample. Day 2, however, showed 7 to 9 patients had differences between the intake and output within 400 to 900cc of the change in daily weight based on

1 kilogram being equal to 1000cc of body fluid. No statistical comparisons were made on this data. It does seem within the realm of possibilities that errors in measurement and estimations of insensible loss could account for the discrepancy between the intake and output and change in daily weight in these post-operative patients, despite the findings to the contrary by Pflaum (1979), Oveson (1981) and Beck (1982). Intake and output and daily weights should continue to be included in the fluid balance assessment of the post-operative patient.

Patient 19 had an emergency abdominal aortic aneurysm resection and received approximately 11 liters of crystalloid and colloid upon completion of Day 1. The patient's weight increased 10.4 kg from admission to the hospital to Day 1. These were minimal changes in the variables selected to predict fluid excess. The patient had an elevated PCWP, suggestive of fluid excess, yet, did not demonstrate maladaptive clinical changes. The critical care nurse must, based on this type of retrospective case study, continue to monitor the patient's intake and output and daily weight changes for indications of an intolerance to the fluid volume load. This patient's clinical presentation points out a problem in the way the variables were defined to describe as trend toward or worsening of fluid volume excess. The variables could predict a change toward fluid volume excess if the change were more than 5 - 6mmHg, but would not necessarily indicate a patient already had a fluid volume excess. An acute change in fluid status might be predicted, but a gradual one may not.

Post-Operative Characteristics

The primary demographic characteristic to be identified was the sex of the patients. Age was not used when the data were examined because pre-existing disease entities and quality of life appeared to be more significant in identifying fluid overload predictors.

The data separating the sexes showed differences in the cardiac rhythm and rate, CVP and neurological status changes indicating that fluid excess may have been more predictable in the male population of this study. The lack of a sizeable population limits the investigator's ability in interpreting this data. Interpretation may also be skewed as one female patient spent the longest amount of time in the ICU post-operatively suggesting the interference of unusual complications. These complications included pneumonia and adult respiratory distress syndrome. Adult respiratory distress syndrome and its treatment may have raised the PCWP and obscured increases caused by fluid excess. Such an explanation would be consistent with the observation that there were no variables which predicted fluid excess in this patient. Deleting this patient from the analysis of male versus female differences prohibits any generalizations of the data.

Elective or emergency surgery in this study showed some differences in the study groups. No generalizations should be made, however, based on the small number of patients undergoing the emergency procedure and the relative lack of magnitude in the differences.

As mentioned previously, prior medical history was shown to be important in the post-operative patient's recovery. There was a higher percentage of predictability in the CVP variable for patients with pre-existing cardiovascular and pulmonary diseases. This finding was difficult to interpret based on the probability that these patients had a CVP above the normal ranges pre-operatively. Right-sided heart pressures become much less reliable as indicators of left heart pressures in patients with respiratory disease (Kinney et al., 1981).

Neurological status changes showed a higher predictive rate in the two emergency surgery patients, in those with prior cardiac disease, those with cardiac and respiratory disease, those with a history of hypertension, and in those without prior vascular surgery. This finding does suggest further investigation. It should be noted that it is difficult to determine which occurs first, restlessness or agitation associated with impending fluid excess or the agitation and suffocation, or hypoxia which occur with hypoxemia associated with an already existing fluid overload state. Each of the disease states suggests a condition of vascular disease of long standing duration, whether restorative surgery had been performed or not. These patients probably had inelastic blood vessels and little myocardial reserve which could account for the high percentage of possible prediction seen.

The final area of data analysis is the patient's response to changes in body weight. Previous studies have failed to demonstrate a correlation between intake and output records and changes in daily weights (Pflaum, 1979; Oveson, 1981; Beck, 1982). This study did not attempt to make these types of correlations. The data on intake and output and daily weights were tabulated for descriptive purposes. Most patients gained water weight during the intra-operative and early post-operative hours. The most interesting case study in this descriptive study was Patient 17. This patient was a 59 year old male who had elective surgery and was in the ICU 2.5 days post-operatively. The patient had a history of coronary artery bypass grafting 12 years and 4 years prior to admission, was obese, had arthritis, no angina and a negative stress test. The graphic flow sheet of this patient's post-operative pulmonary artery wedge pressures (Appendix D) was basically a straight line of a range of 15 - 16mmHg. The patient had a cumulative weight difference of +5.4 kg on discharge from the ICU with no noted post-operative secondary diagnoses other than fluid overload, and did not receive lasix in the ICU. There were six instances of breath sounds changes without change in PCWP predicting fluid excess as described, four instances of a new diagnosis of hypertension, three instances of premature atrial contractions and a one time period of agitation when the nurses were suctioning a small amount of thin frothy secretions from his lungs, all without more than 1 - 2mmHg change in PCWP recordings. This patient apparently had the myocardial reserve to manage the 5 kg water weight gain on Day 1. His then stable cardiac condition may suggest that he was not as at risk for post-operative complications as some other patients with active disease may have been.

In separating the patients with a greater than 4 kg weight gain and cardiac history from those without, the first change in breath sounds showed a more predictive value. The CVP percentage was also higher in those with the weight gain and cardiac history. Again the amount of data proves to be a hindering factor on the ability to make generalizations overall.

CHAPTER FIVE

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

This study was intended to add to the current nursing knowledge of predictors of fluid overload in the post-operative critically ill patient. A sample population of patients that had undergone abdominal aortic aneurysm resection were selected for retrospective study because these patients usually require relatively large volumes of fluid in the peri-operative period to achieve hemodynamic stability. A review of the literature provided minimal rationale to identify the most important nursing assessment areas, hemodynamic measurements and laboratory data in the early post-operative period to indicate early signs of volume excess in the critically ill patient.

Summary

The charts of 14 patients were reviewed to identify data suggesting impending fluid volume excess as conceptualized by this investigator using knowledge of the pathophysiologic changes occurring in congestive heart failure. The review of the literature suggested that patients who have major surgical procedures may have complications associated with intravascular volume overload on Day 3 to 5 post-operatively. This occurs when fluid which has been sequestered in the "third space" begins to mobilize back into the vascular system as the stress response resolves. Periods of fluid overload as early as 16 to 32 hours post-operatively were identified in a majority of patients. Several patients were admitted to the ICU post-operatively in what this investigator would describe as a state of fluid overload. However, there are several factors which must be considered before making the clinical judgement that a state of fluid overload exists. Factors to be considered during the first few hours post-operatively were: the amount of fluid received intra-operatively, the patient's temperature on admission to the ICU, the cardiac output and index and the assessment of the peripheral tissue perfusion. These assessments, in addition to routine vital signs suggested that the majority of the patients included in this study were hypothermic and vasoconstricted. It seemed that a period of time for intracompartmental fluid shifts and body rewarming would be required during the initial few hours post-operatively for patient stabilization as the patient emerged from anesthesia. Therefore, all patients were given an arbitrary first four hours post-operatively for stabilization. Data collection was initiated on the post-operative abdominal aortic aneurysm resection patients after the first four hours in the ICU.

Certain variables were extracted from the graphs of each patient's post-operative course (Appendix D) and related to the pulmonary capillary wedge pressure with time and degree of change criteria established to allow a prediction of a possible relationship among variables (Table 4). Data were tallied and placed into frequency and contingency tables. No statistical analysis procedures were used with this data because of the small sample size and descriptive nature of the study. It was clear as the tallies of frequencies were made that no generalizations would be possible as a control group was not established, though the data provides a descriptive base from which individual factors may be more completely investigated.

Conclusions

Early indications of fluid excess were identified in this study. However, no generalizations can be made based on the limitations of the study. Nursing assessment findings appeared to be related to changes suggesting fluid excess, specifically with regard to the blood pressure, central venous pressure and changes in neurologic status in those patients with prior cardiac, cardiovascular and pulmonary disease. In this study, breath sound changes did not predict the high percentage of the changes in pulmonary capillary wedge pressure that this investigator expected. In addition, laboratory data did not assist in an early prediction of fluid excess. The intake and output and changes in daily weight data were not helpful in predicting fluid volume excess. The fluid balance data did confirm that patients had periods of positive fluid balance with an increase in daily weight coinciding with variables which seemed to suggest fluid excess.

The research question posed for this study:

> What is the relationship between nursing assessment parameters, hemodynamic measurements, intake and output records, and daily weights in the development of fluid overload in a sample of patients who have undergone abdominal aortic aneurysm resection?

cannot be answered based on the limitations described. There are variables which should be studied in more depth based on suggested relationships to changes in pulmonary capillary wedge pressure identified in this study. This study has explored at an introductory level the importance of the nursing assessment in the early post-operative phase of the abdominal aortic aneurysm resection patient. This study has identified adventitious breath sounds, cardiac rhythm and rate, blood pressure, central venous pressure and changes in neurologic status as important variables to monitor in the patients selected for this study based on the amount and frequency of data documented. This finding may save time and money as larger patient populations are studied. As mentioned previously, there was an overwhelming amount of data which did not predict fluid overload. An experimental study of the importance of the nursing assessment, including a control group, will be practical and feasible now that this descriptive study has suggested important variables to monitor in the post-operative abdominal aortic aneurysm resection patient. It may be that certain variables will predict fluid excess in patients with particular pre-existing disease entities and others will not. Further study is needed.

Recommendations

This retrospective descriptive study lacked the strength that a control group might have provided. For further study on the relationship of nursing assessment parameters, hemodynamic measurements and laboratory data, a larger sample of patients with a control group meeting all of the criteria established for inclusion in this study may be of value. Consistent measurement of central venous pressure throughout the study period could add significance to the results of the study. The blood pressure and changes in neurologic status as described in this study appeared to be possibly predictive of pulmonary capillary wedge pressure changes and need further study. This investigator would place emphasis on further study evaluating the blood pressure and changes in neurological status on the development of fluid excess.

It is also recommended that data be collected on the hourly urine output and the relationship to the pulmonary capillary wedge pressure as an early indication of a fluid imbalance. Critical care nurses monitor the urine output hourly on post-operative patients in the ICU and notify the physician if the hourly urine output is below a predetermined level suggesting an alteration in tissue perfusion and/or fluid volume status. The hourly urine outputs were not a part of this study, but may have added a valuable dimension to the evaluation and ability to predict a patient developing a fluid volume excess at the earliest time post-operatively.

Study of the nursing assessment merits more attention as it relates to the critically ill patient. Nursing diagnoses are assisting nurses in defining and describing clinical manifestations of potential or actual patient problems. Further study of nursing diagnoses which can be applied to the critically ill patient is needed.

Documentation is always a critical consideration when reviewing patient charts. A retrospective chart review is useful because it allows the reviewer to evaluate care provided and predicy early patient problems. A question which was difficult to interpret from the review of the selected for this study was: Were the nurses aware of the patient's trends with regard to fluid excess, intake and output, daily weights and pulmonary capillary wedge pressure? This investigator is not sure this type of data would be found in the summary type charting used in this institution. A recommendation for the study hospital might be a trial with the SOAPE format of charting which allows the critical care nursing staff the opportunity to document according to patient problems their analysis of the data and plans for predictive monitoring. Evaluation of the patient's response to nursing and medical interventions could be more clearly delineated. This format of charting would provide retrievable data suitable for the complexities of problems found in an ICU patient and offer more data for the development of a comprehensive plan of care.

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APPENDIX A

CHART REVIEW

Data Collection Sheet #1

Patient Profile

AGE________________________

SEX________________________

HEIGHT_____________________

ADMISSION WEIGHT___________________

ADMITTING DIAGNOSIS

A. Abdominal Aortic Aneurysm Resection

Elective Emergency

B. Other

C. Documented Complications/Additional Diagnoses

PAST MEDICAL HISTORY

A. Cardiac History: YES NO

specify____

B. Respiratory History YES NO

specify____

C. Other Systems YES NO

specify____

APPENDIX B

DATA COLLECTION SHEET #2

Clinical Data

		Breath Sounds	Respiratory Rate	CXR Results	Heart Sounds	Cardiac Rhythm	Heart Rate	Blood Pressure	PCWP	CVP	Cardiac Output	Cardiac Index	Presence of Edema	Skin Color Moisture Temperature	Neurological Status	ABG's	Serium Sodium	BUN	Hct	Oxygen Therapy	Urine - Sp. Gravity	Temperature
Change of Shift	2300																					
	2400																					
	0100																					
	0200																					
Night Shift	0300																					
	0400																					
	0500																					
	0600																					
Change of Shift	0700																					
	0800																					
	0900																					
	1000																					
Day Shift	1100																					
	1200																					
	1300																					
	1400																					
Change of Shift	1500																					
	1600																					
	1700																					
Evening	1800																					
Shift	1900																					
	2000																					
	2100																					
	2200																					

APPENDIX C

DATA COLLECTION SHEET #3

Fluid Analysis

INTAKE	Includes OR Date ________	Date ________	Date ________
IV			
Colloid			
Water of Oxidation (300cc/day adult; Valtin, 1979)			
TOTAL			

OUTPUT

Urine			
N/G Drainage			
Insensible Loss: A. Skin Water Loss (500cc/day adult; Valtin, 1979)			
B. Lung Water Loss* (400cc/day adult; Valtin, 1979)			
C. Temperature 38^{4} - 39^{4} or RR >35, add 500cc/day (Dudrick et al., 1983)			
Stool			
Estimated Blood Loss/ Wound Drainage			
TOTAL			
Cummulative + or -			
Daily Weight			
Mean Daily Temperature			
Body Surface Area			

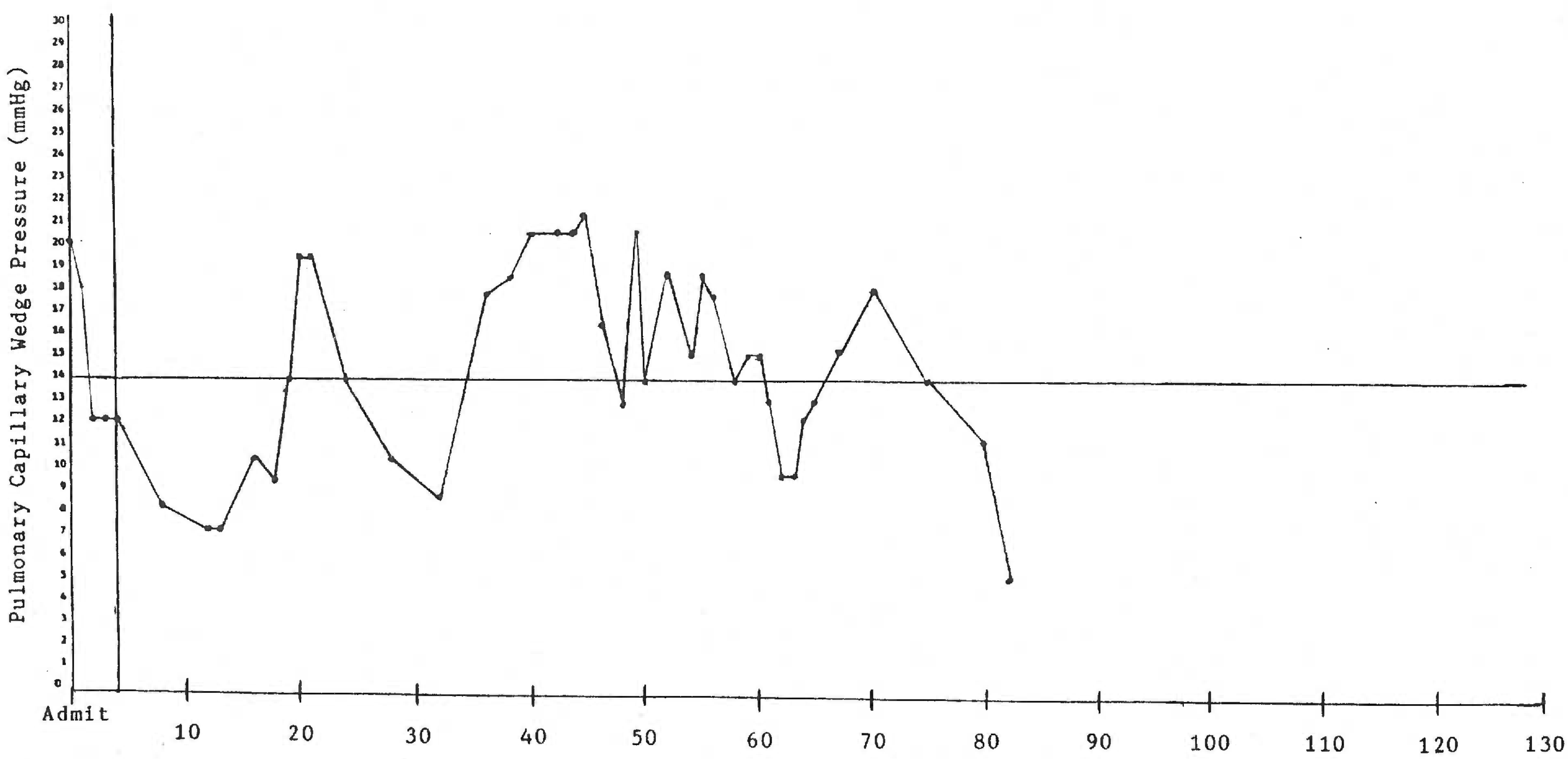
*No value while patient receiving humidified oxygen.

APPENDIX D

Graphic Representation of Study Patients' Post-Operative Course:

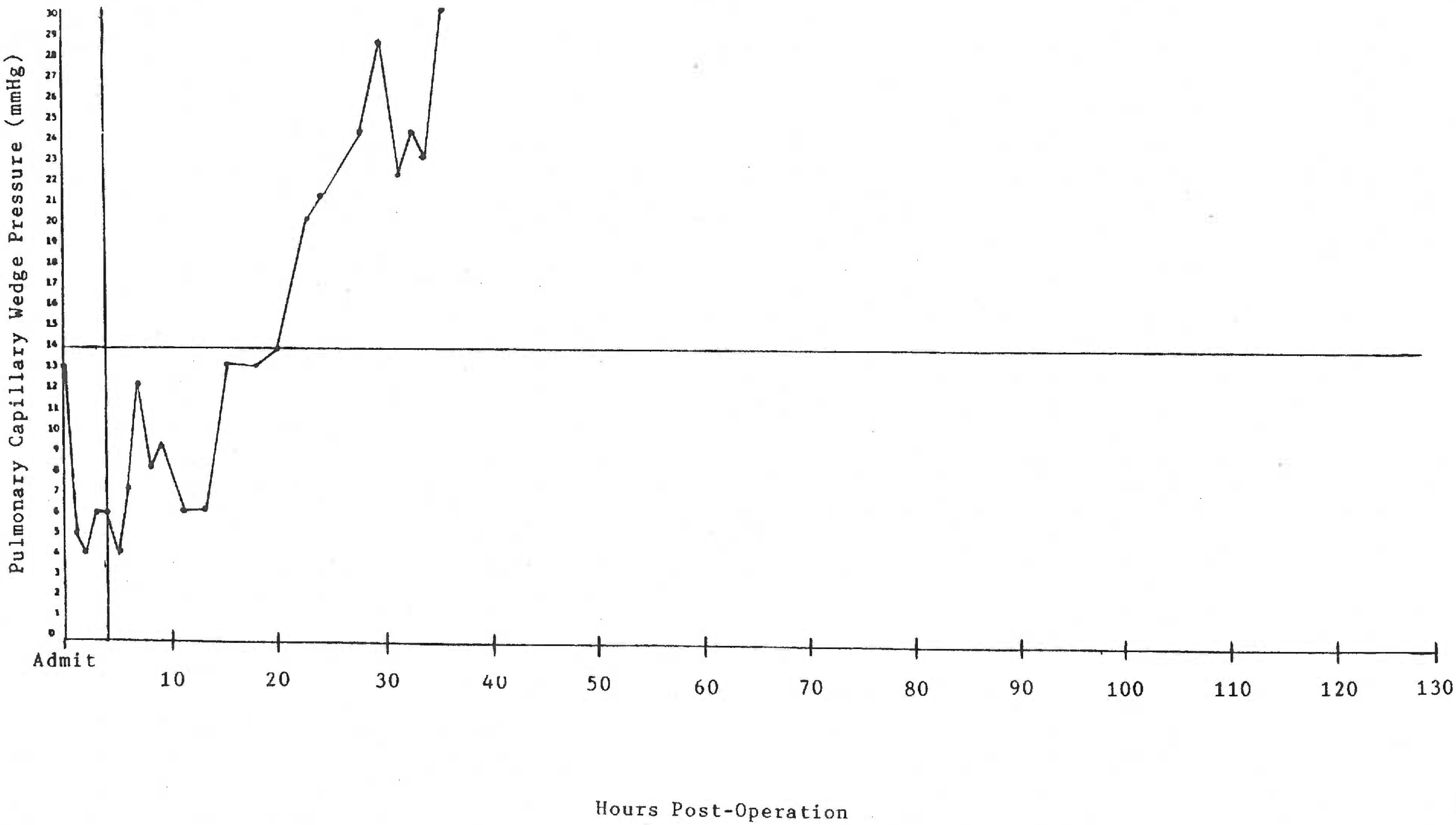
Pulmonary Capillary Wedge Pressure Versus Hour Post-Operation

Patient 2

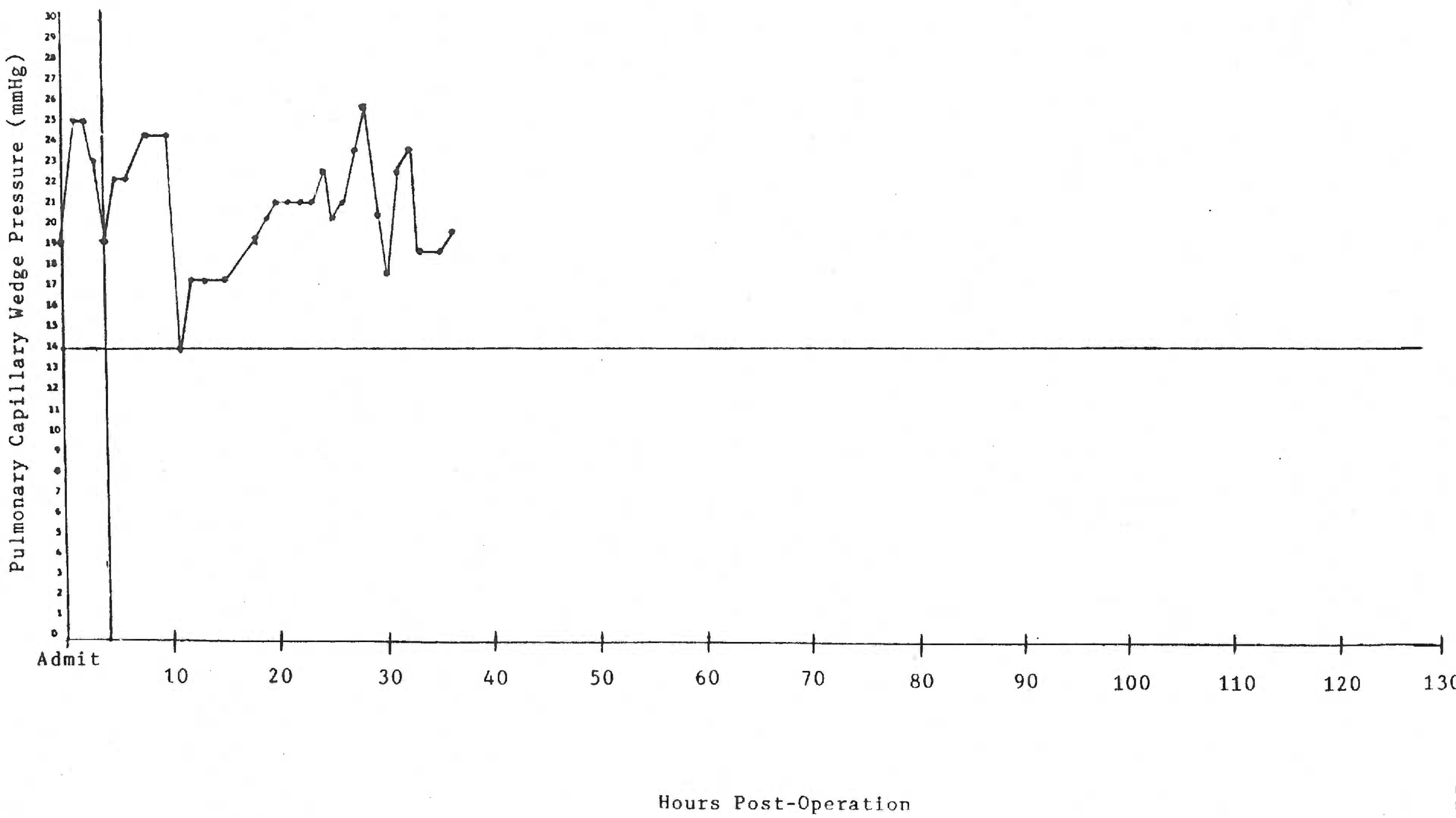


Hours Post-Operation

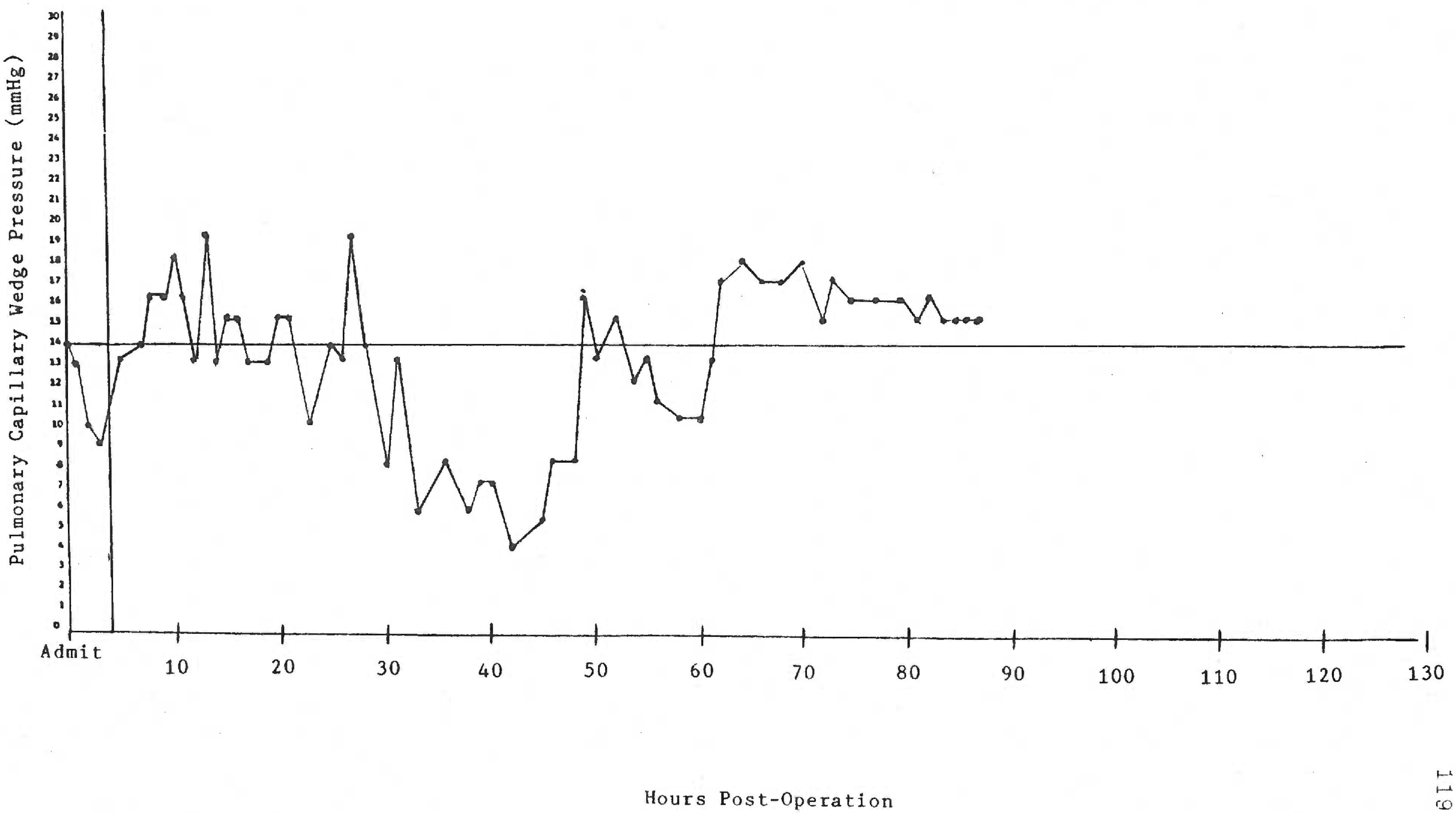
Patient 3


Pulmonary Capillary Wedge Pressure (mmHg)
Admit
10
20
30
40
50
60
70
80
90
100
110
120
130
Hours Post-Operation

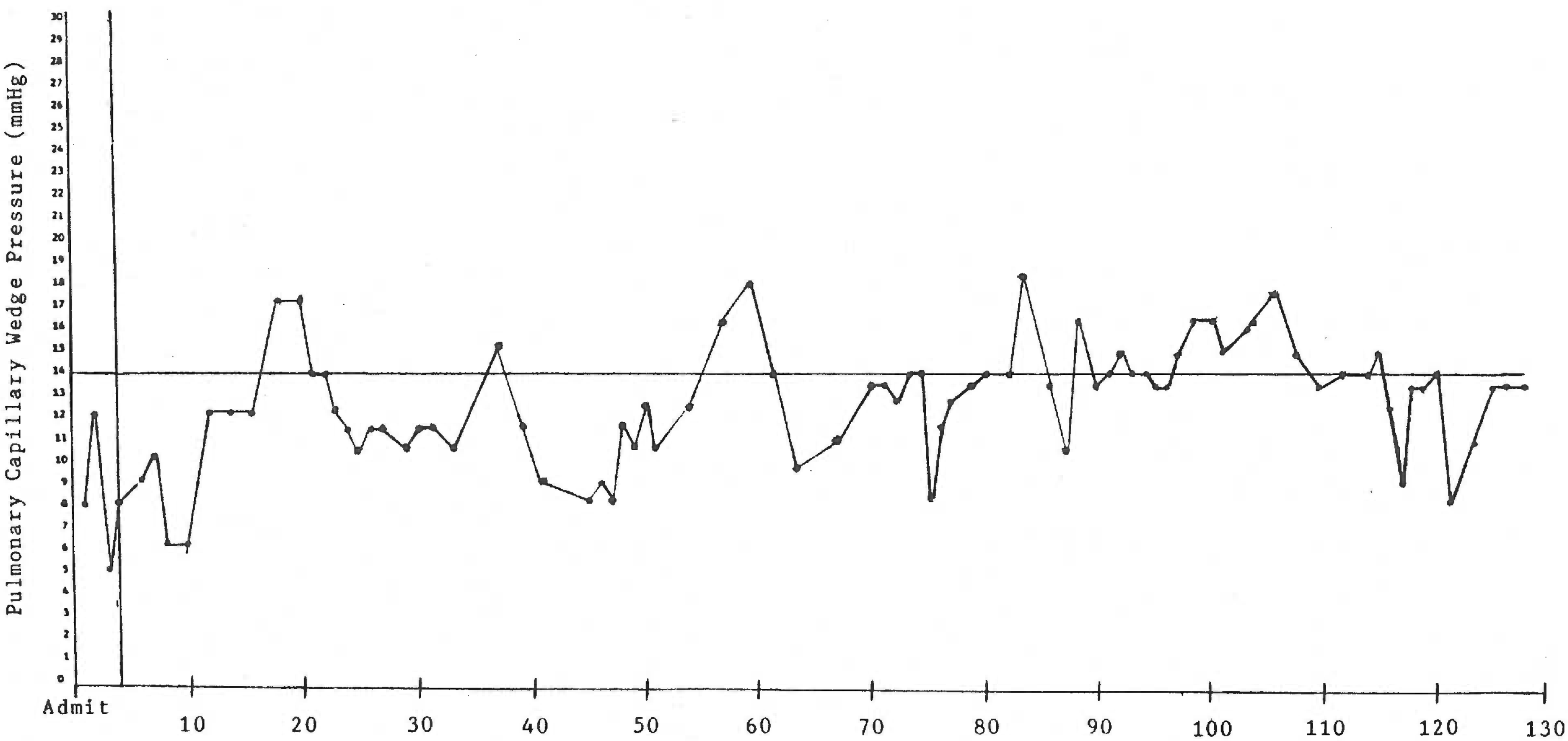
Patient 4


Pulmonary Capillary Wedge Pressure (mmHg)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Admit
10 20 30 40 50 60 70 80 90 100 110 120 130
Hours Post-Operation

Patient 6

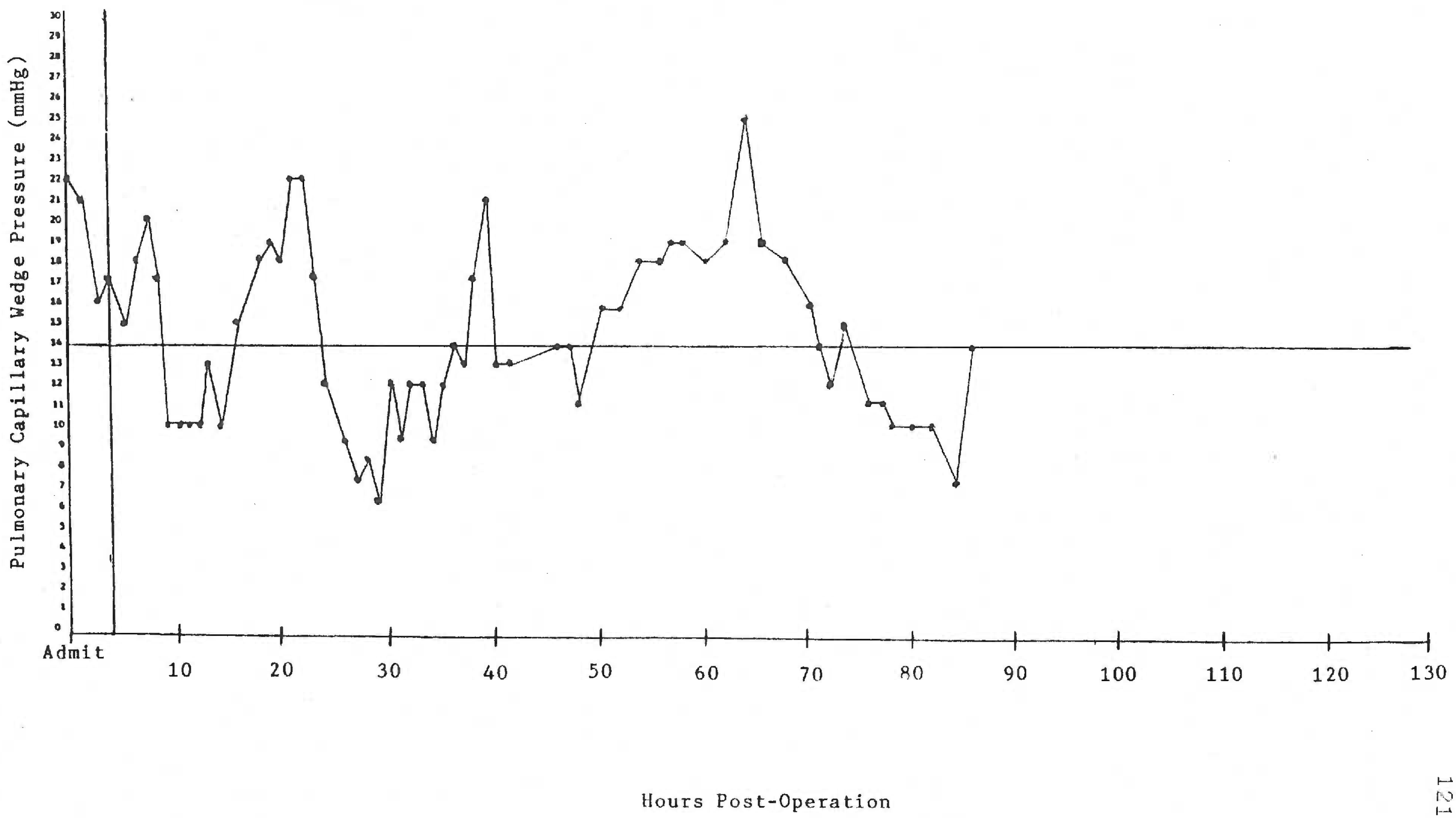

Pulmonary Capillary Wedge Pressure (mmHg)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Admit
10 20 30 40 50 60 70 80 90 100 110 120 130
Hours Post-Operation

Patient 8



Hours Post-Operation

Patient 9



Pulmonary Capillary Wedge Pressure (mmHg)
Admit
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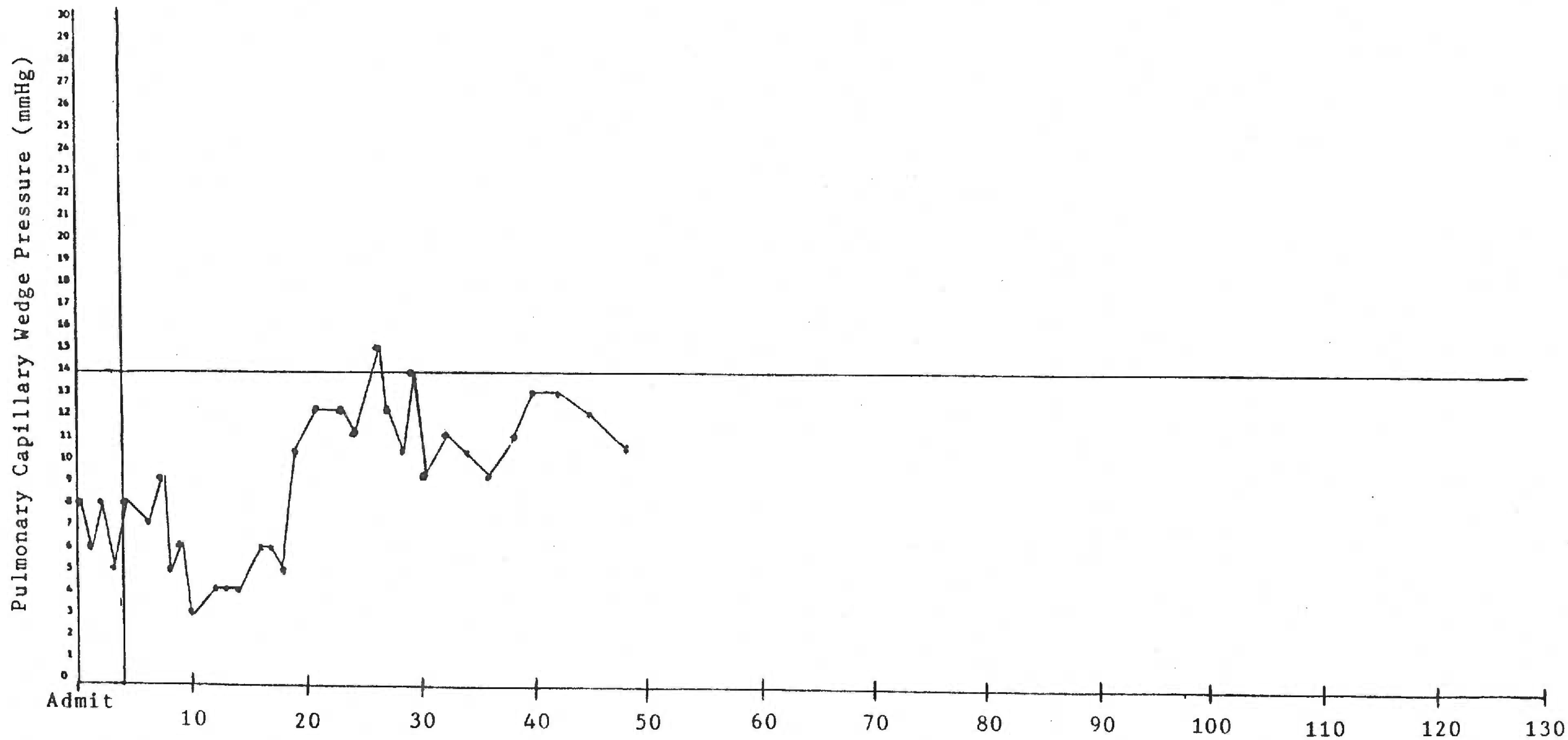
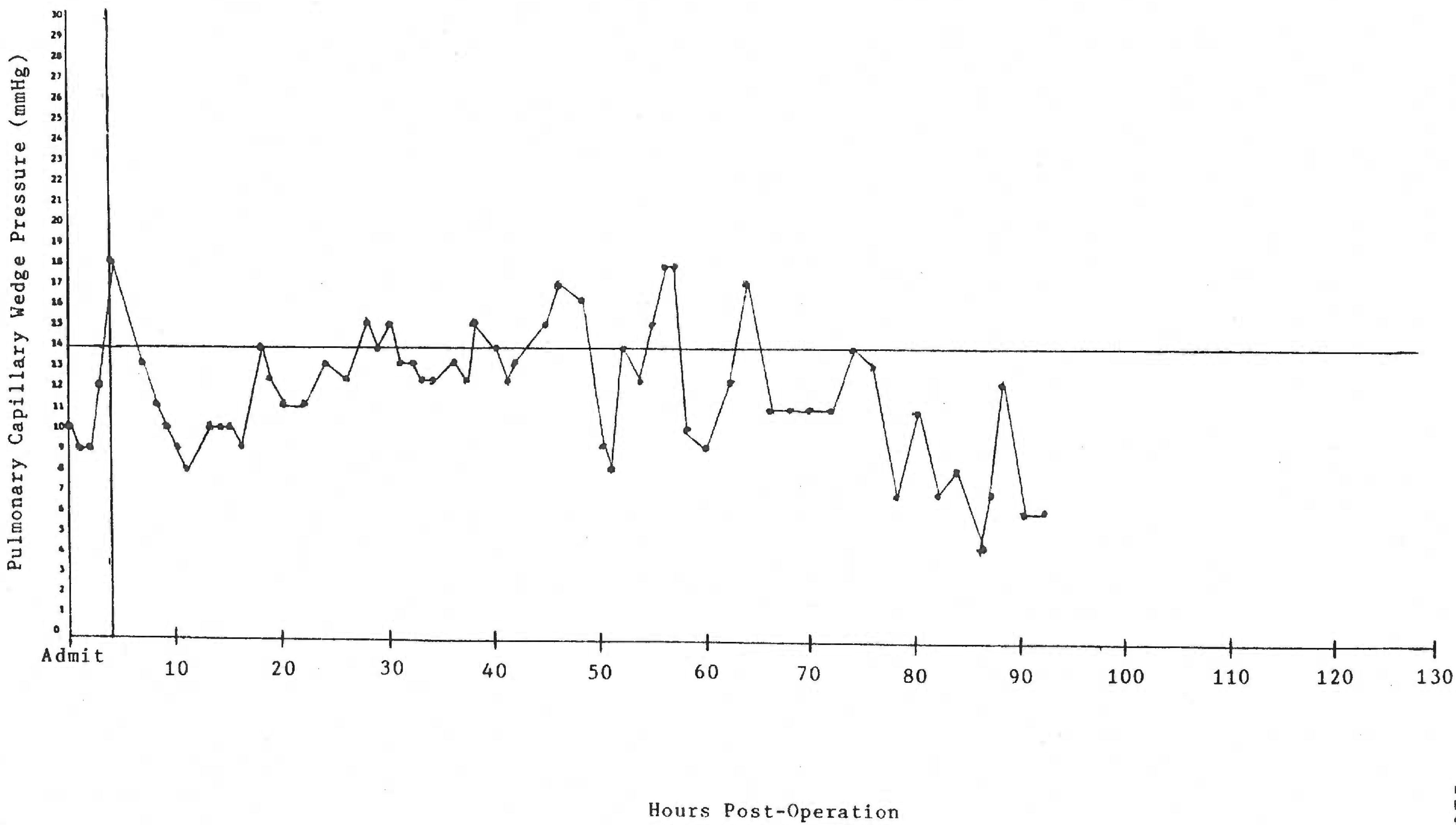
130
Hours Post-Operation

Patient 10

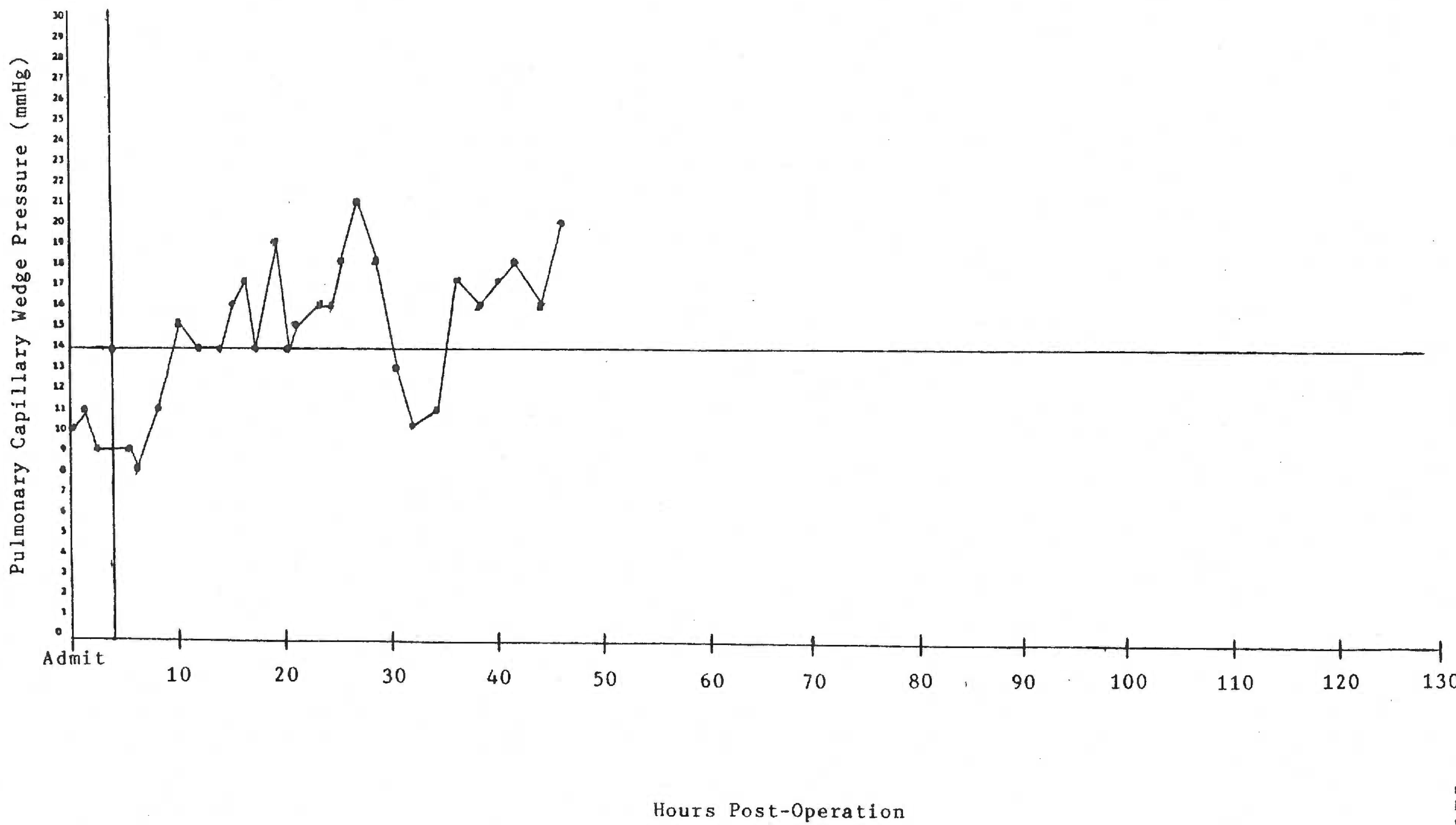


Hours Post-Operation

Patient 11


Pulmonary Capillary Wedge Pressure (mmHg)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Admit
10 20 30 40 50 60 70 80 90 100 110 120 130
Hours Post-Operation

Patient 12



Pulmonary Capillary Wedge Pressure (mmHg)
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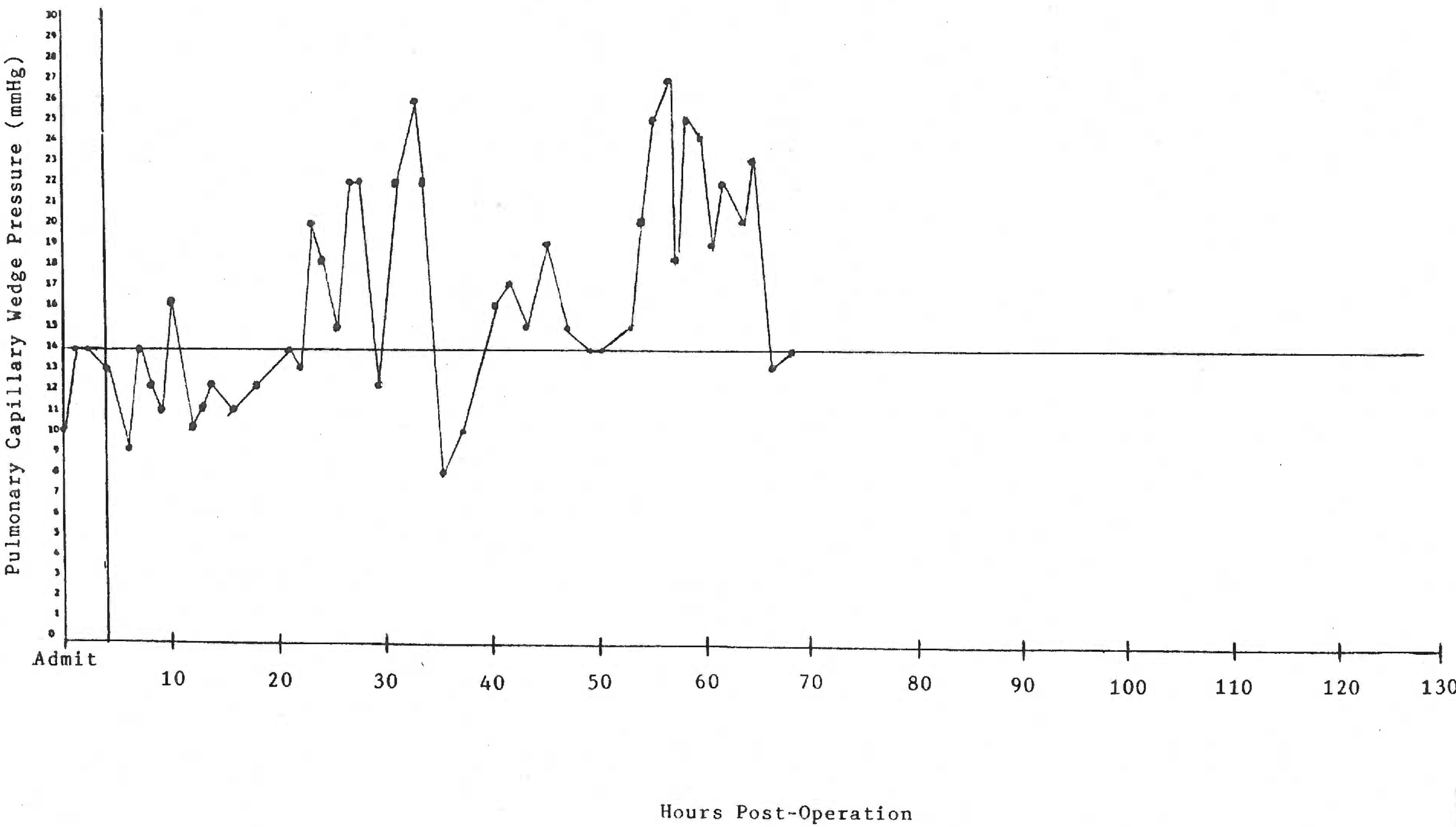
Hours Post-Operation

Patient 15


Pulmonary Capillary Wedge Pressure (mmHg)
Hours Post-Operation
Admit
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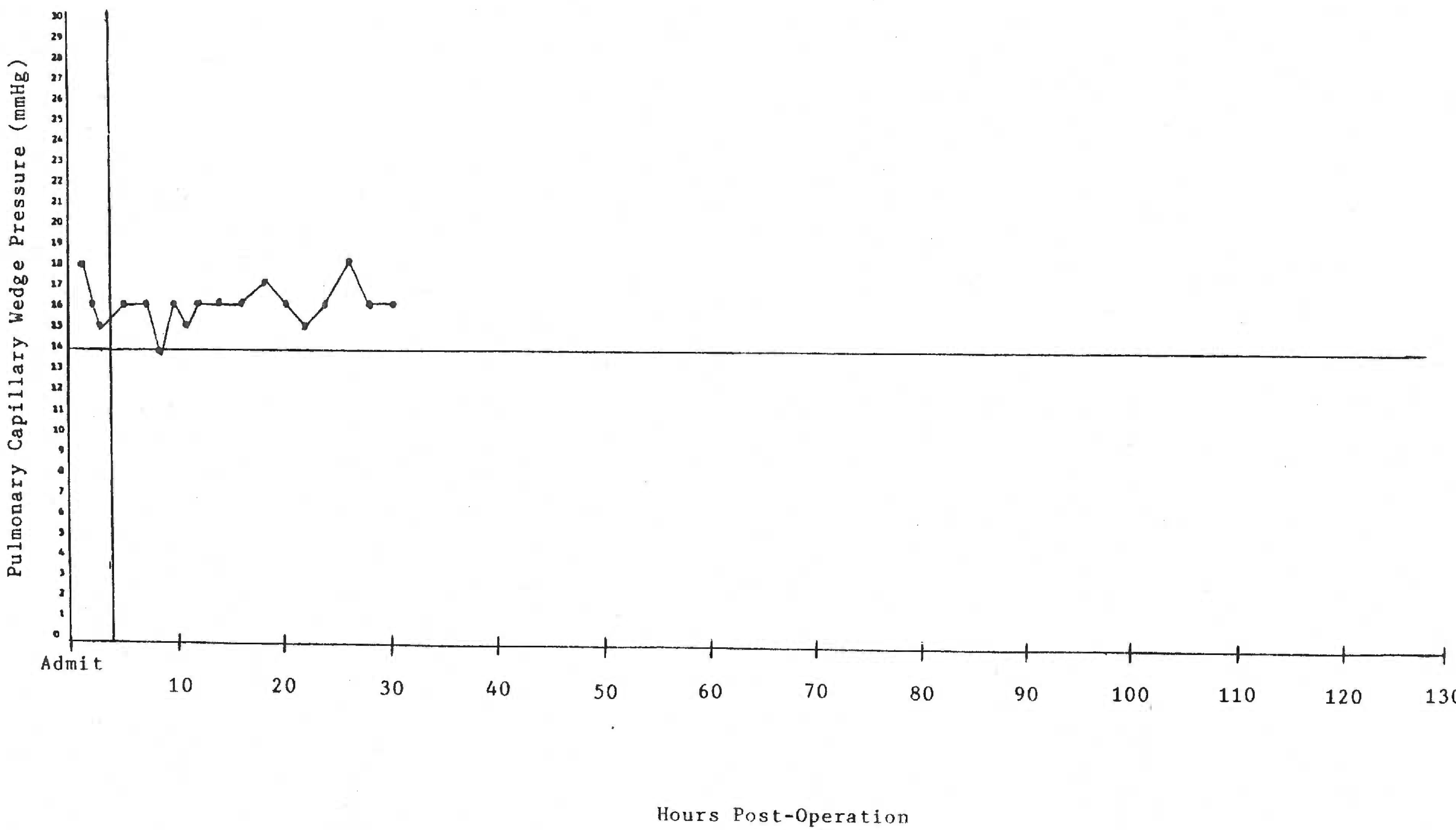
Patient 17


Pulmonary Capillary Wedge Pressure (mmHg)
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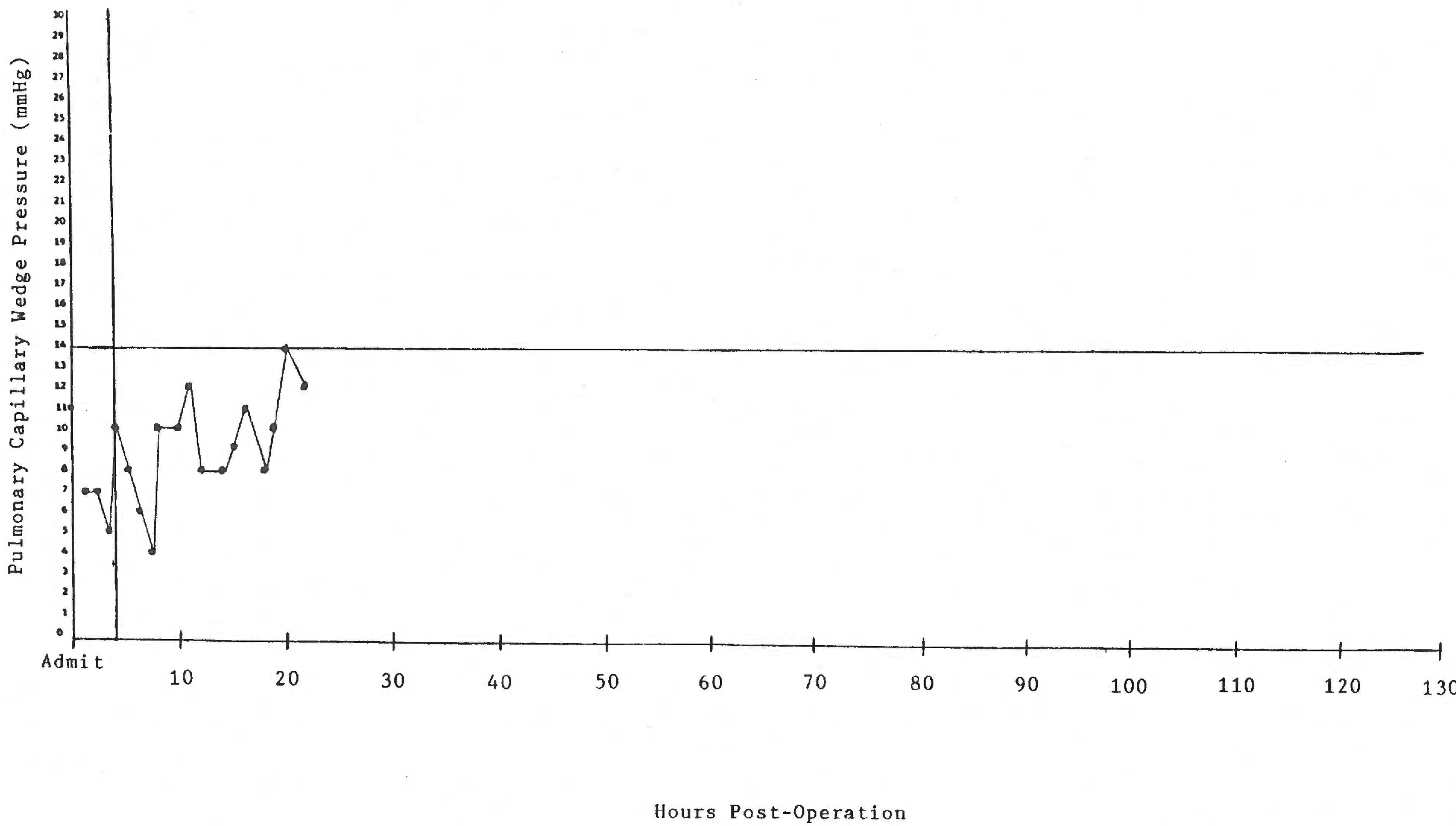
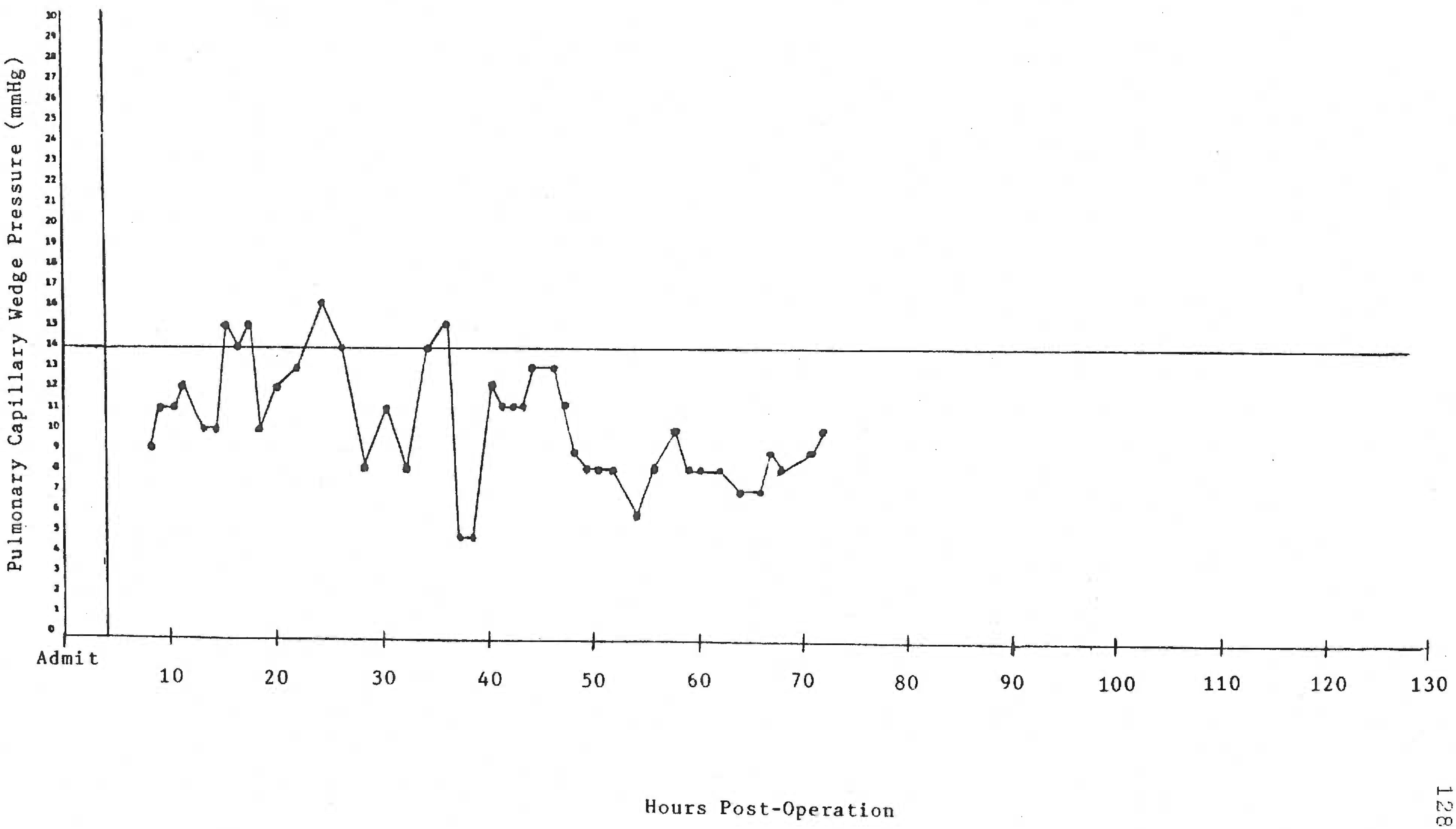
Hours Post-Operation

Patient 18


Pulmonary Capillary Wedge Pressure (mmHg)
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30
Admit
10 20 30 40 50 60 70 80 90 100 110 120 130
Hours Post-Operation

Patient 19



Pulmonary Capillary Wedge Pressure (mmHg)
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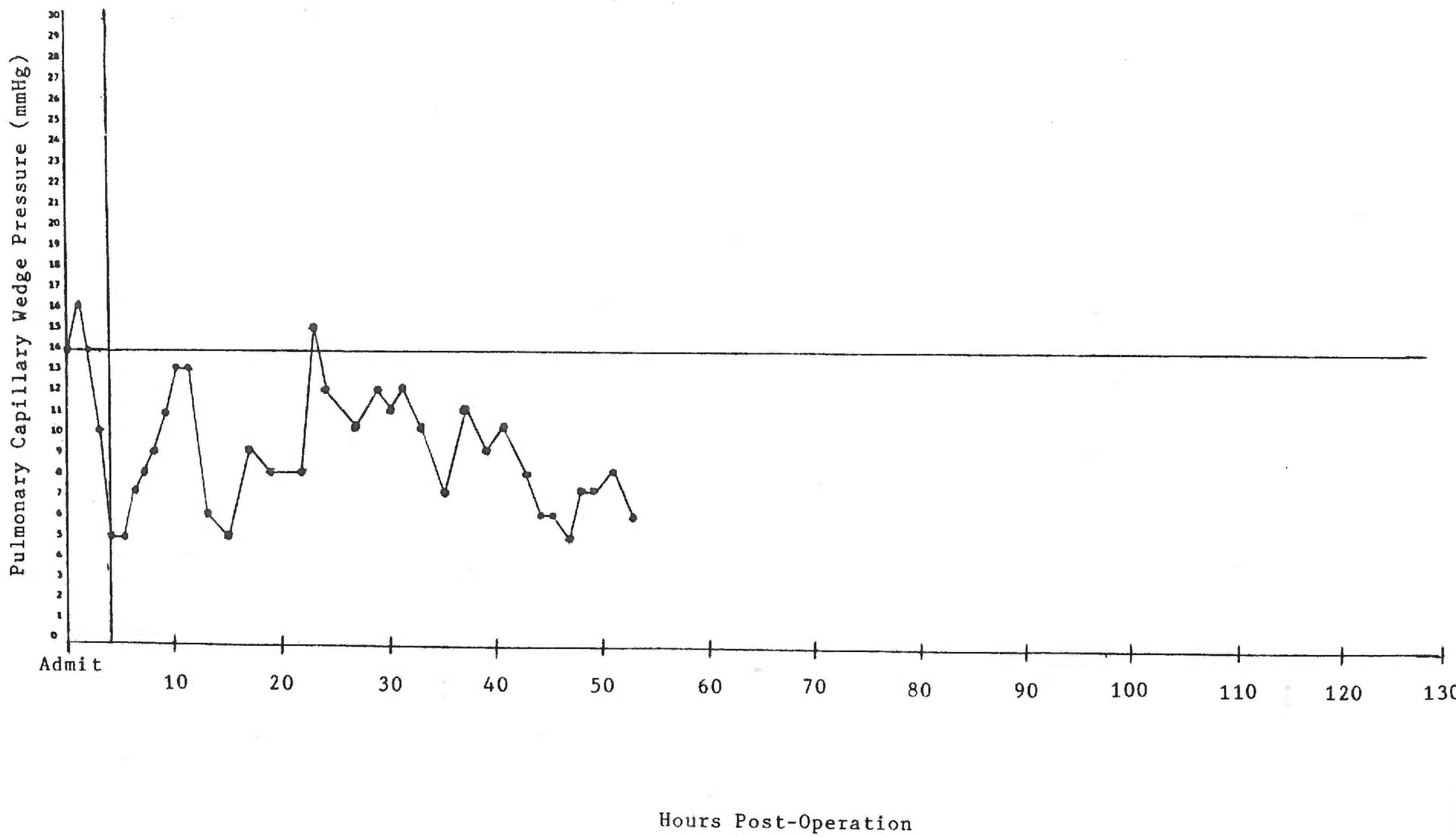
Hours Post-Operation

Patient 21


Pulmonary Capillary Wedge Pressure (mmHg)
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27
28
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Admit
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110
120
130
Hours Post-Operation

AN ABSTRACT OF THE THESIS OF

KATHLEEN ANN SKIPPER

for the MASTER OF NURSING

Date receiving this degree: JANUARY 12, 1987

Title: THE NURSING ASSESSMENT AND PREDICTORS OF FLUID EXCESS IN THE POST-OPERATIVE CRITICALLY ILL PATIENT - A RETROSPECTIVE STUDY.

APPROVED: ______________________________
Mary McFarland, R.N., M.S.N., Thesis Advisor

The purpose of this retrospective, descriptive study was to add to the current nursing knowledge of fluid volume excess. This investigator sought to identify early indicators of fluid volume excess from the medical records of fourteen critically ill post-operative abdominal aortic aneurysm resection patients in the intensive care unit of a large metropolitan hospital. It is generally accepted that early identification of potential post-operative problems may avoid life threatening complications.

A review of the nursing and medical literature provided little more than lists of patient data to be collected. The rationale for the monitoring of particular parameters was not available.

Data were collected to identify nursing assessments, hemodynamic measurements and laboratory values most commonly collected in the post-operative patients selected for this

study. Patient records selected for inclusion in this study met predetermined criteria.

For descriptive purposes, six patient assessment variables were identified from the large amount of data collected. These variables: breath sounds 1 and 2, cardiac rhythm and rate, blood pressure, central venous pressure and a change in neurological status, were related to what was thought by this investigator to be the best representation of fluid excess based on the review of the literature, pulmonary capillary wedge pressure increasing above the normal ranges. Tallies of the frequencies of changes in patient status suggesting fluid excess identified the blood pressure, central venous pressure and a change in neurologic status as tending to occur prior to the increase in pulmonary capillary wedge pressure. The breath sounds variables did not appear to be as predictive of a change toward fluid excess as initially suspected. However, the amount of data was small.

Data were also related to various combinations of prior medical conditions present among patients on admission. The results again suggested the blood pressure, central venous pressure and a change in neurologic status tended to precede an increase in pulmonary capillary wedge pressure suggesting fluid excess. No generalizations can be made based on the amount of data.

The intake and output and daily weight data as used in this study added little to the identification of early predictors of fluid volume excess in the selected patient population. Further study is indicated.