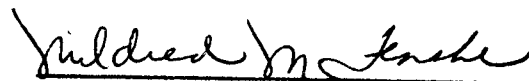


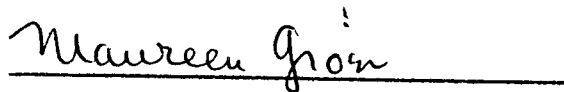
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EXPERIENCED CRITICAL CARE NURSES' ABILITY TO
INTERPRET PULMONARY CAPILLARY WEDGE PRESSURE
(PCWP) VALUES: COMPARISON OF SUBJECTS USING A
TEACHING-LEARNING PACKET AND SUBJECTS NOT
USING A TEACHING PACKET

A Thesis

Presented for the

Master of Science in Nursing

Degree

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James L. Cathelyn

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ABSTRACT

Pulmonary capillary wedge pressure (PCWP) represents important assessment data used to guide therapeutic decisions towards assisting individuals to physiologically adapt to alterations in fluid status. Proper interpretation of this parameter becomes complicated when respiratory excursions exist.

This study examined the ability of experienced critical care nurses to properly interpret PCWP when respiratory excursions exist. The study also included evaluation of a brief self-directed learning pamphlet to improve performance.

A posttest-only control group design was used to evaluate the effect of the educational pamphlet on nurses' knowledge of PCWP interpretation with respiratory excursions. These results were used to evaluate current knowledge base. Subjects not receiving the educational review (the control group) had a score of 51.5% which fell far short of an established criterion level of 89%, indicating a knowledge deficit. A significant difference ($p = .0001$) was found between the control and the experimental group scores, indicating that the self-directed learning pamphlet significantly improved performance.

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CHAPTER I

INTRODUCTION

Pulmonary artery pressure monitoring provides important assessment data to guide therapeutic interventions for seriously ill patients hospitalized in intensive care units. Pulmonary artery catheters provide access to monitor heart function. Critical care nurses assume the responsibility to obtain accurate and reliable information from these monitoring systems to aid in patient assessment (Dolter, 1989; Nemens & Woods, 1982; Shinn, Woods, & Huseby, 1979). The pulmonary capillary wedge pressure (PCWP) obtained via a pulmonary artery catheter indirectly reflects the left atrial pressure (LAP) and serves as an index of the preload of the left ventricle (Gershan, 1983; O'Quinn & Marini, 1983). As an index of preload, the PCWP may indicate a need for volume or diuretic therapy (Bolognini, 1974). The critical care nurse routinely accepts responsibility for obtaining and accurately interpreting the PCWP (Campbell & Greenberg, 1988; Gershan, 1983; Wild & Woods, 1985).

Normally, obtaining and interpreting the PCWP value is a simple procedure with little chance of error. However, when a patient's PCWP waveform exhibits excessive variation concurrent with their respiratory pattern, a phenomenon

called respiratory excursions, accurate interpretation of the PCWP value can become difficult. The respiratory pattern for mechanically ventilated patients opposes that of spontaneously breathing persons. Thus, nurses must obtain the PCWP value at a different point on the pressure wave, further complicating the process.

Accurate interpretation of the PCWP value is an important responsibility of critical care nurses. To properly perform this assessment technique, each nurse must be aware of the effects of respiratory excursions and the point at which to "read" the pressure value on the PCWP waveform in both spontaneously breathing and mechanically ventilated patients.

PURPOSE

The purpose of this study was to evaluate the ability of experienced critical care nurses to accurately interpret pulmonary capillary wedge pressures in both spontaneously breathing and mechanically ventilated individuals. Additionally, the effect of an educational intervention on nurses' interpretation knowledge was examined.

BACKGROUND AND SIGNIFICANCE

The PCWP value serves as an important indicator of the volume status of an individual. Critical care nurses frequently use PCWP values to manage a patient's fluid therapy. A typical physician's order might state "maintain the PCWP value between 12-18mmHg; give 40mg of Lasix if the PCWP value exceeds 18mmHg; increase intravenous fluid infusion rate if the PCWP value falls below 12mmHg." The literature reports frequent technical and interpretive problems related to the use of pulmonary artery catheters in the intensive care unit (Dolter, 1989; Morris, Chapman, & Gardner, 1985).

The PCWP value must be interpreted reliably and consistently, or improper therapy decisions may result from erroneous data (Campbell & Greenberg, 1988; Cengiz, Crapo, & Gardner, 1983; Dolter, 1989; O'Quinn & Marini, 1988; Riedinger, Shellock, & Swan, 1981; Wild & Woods, 1985). When a patient's PCWP waveform exhibits significant respiratory excursions, the possibility of making an interpretive error increases and could result in improper intervention. If the nurse "reads" the pressure value at an incorrect point of a waveform with respiratory excursions and implements the orders previously mentioned, a pressure could be recorded as less than 12mmHg when it actually

exceeds 18mmHg; consequently, the patient would receive the additional fluid instead of the correct intervention, a diuretic. Although respiratory excursions complicate the interpretation of PCWP value, the data guides the choice of two contrasting therapies and requires accurate interpretation.

THEORETICAL FRAMEWORK

Sister Callista Roy developed her adaptation model of nursing in the early 1960's during graduate studies at the University of California (Giger, Bower, & Miller, 1987). She based her conceptual model on the work of Helson, a physiological psychologist, who described man as attempting to achieve physiological and behavioral equilibrium through adaptation. He defined adaptation as positive responses to environmental changes which decrease the responses necessary to cope, freeing energy to respond to other stimuli (Roy, 1970, 1984).

The Roy Adaptation Model (RAM) presents a nursing model emphasizing assessment process which can be applied to a variety of settings (Sato, 1986; Tiedeman, 1989). This study applies the RAM to the intensive care unit (ICU) setting and assesses the ability of critical care nurses to correctly interpret pulmonary capillary wedge pressure (PCWP) in the presence of respiratory excursions. Nurses

must use this important assessment skill to assist patients to physiologically adapt to a changing fluid status.

Roy describes man as a biopsychosocial being in constant interaction with a changing environment, with adaptation being a crucial activity of life (Aggleton & Chambers, 1984; Roy, 1970, 1971; Sato, 1986). According to Roy, a continuum exists ranging from peak wellness to death where positive responses to the environment result in movement towards health (Mastal & Hammond, 1980; Roy, 1970, 1987). Nursing interventions are indicated when individuals encounter unusual or extreme stressors or have weak coping mechanisms resulting in ineffective adaptation (Roy, 1984; Tiedeman, 1987). The goal of nursing is to manage stimuli to promote adaptation when individuals lack the ability to do so themselves (Galbreath, 1985; Hamner, 1989; Roy, 1970, 1971, 1984).

The RAM guides nurses' responses when patients display ineffective physiologic adaptation to fluid volume. Ineffective coping may occur in response to an extreme change in volume status or poor compensation by the person. It often requires invasive monitoring to more precisely assess volume status and guide interventions. Critical care nurses must be able to accurately determine the PCWP value to choose appropriate interventions to promote adaptation. The presence of respiratory excursions on patient's PCWP waveforms complicates the interpretation of the PCWP value.

Incorrect interpretation of the PCWP value by the nurse may result in incorrect interventions.

The RAM, a systems model, defines a system as an individual or group affected by stimuli which are focal, contextual, and residual in nature. Stimuli, input to the system, activate coping mechanisms. The output of the system, behavioral responses, occur in four modes of adaptation: physiological, self-concept, role function, and interdependence. These behavioral responses are observable or measurable (Hamner, 1989; Randell, Tedrow, & van Landingham, 1982; Sato, 1986).

There are two adaptation subsystems within the RAM, the regulator and the cognator. The regulator subsystem is closely linked with physiological adaptive mechanisms and primarily operates through the autonomic nervous system. Regulator measurements include the heart rate and blood pressure. The cognator subsystem represents the person's conscious and unconscious adaptive mechanisms. The cognator uses learning, judgment, and emotion to identify, store, and relate stimuli. It makes an experience unique for an individual (Huch, 1987; Mastal & Hammond, 1980; Randell, Tedrow, & van Landingham, 1982; Roy, 1984, 1987; Tiedeman, 1989).

When either internal or external stimuli stress the cognator/regulator subsystem, persons manifest coping mechanisms via the four adaptive modes (Mastal & Hammond,

1980; Roy, 1984). The physiological mode encompasses a five basic need hierarchy: oxygenation, nutrition, elimination, activity and rest, and protection (Roy, 1987). The self-concept mode is composed of the physical self which includes body sensations and body image and the personal self which includes moral-ethical-spiritual self, self-consistency, and self-ideal. The role function mode includes primary roles such as age or sex, secondary roles such as husband or daughter, and tertiary roles which are usually chosen and temporary roles. The interdependence mode concerns behaviors related to significant others and support systems (Sato, 1986).

Nurses must deal with each mode of adaptation based on the individual's current position on the health-illness continuum (Roy, 1976). In this investigation, the pinnacle of the needs hierarchy, oxygenation, includes the cardiovascular system and the transportation of oxygen. Fluid alterations commonly occur in the presence of cardiovascular disturbances (Roy, 1984). PCWP monitoring, an important nursing function, guides interventions related to fluid status and thus oxygen transport.

One's adaptation level reflects an individual's state of coping (Galbreath, 1985). The process of adaptation begins when a stimulus provokes the cognator/regulator subsystem to respond via the four adaptive modes with the impulse to respond coming from the differences between the

stimulation and the person's current adaptation level (Mastal & Hammond, 1980; Roy, 1970). The adaptation response has four goals with a priority list of survival, growth, reproduction, and mastery (Galbreath, 1985; Roy, 1984; Sato, 1986). In the RAM, a zone exists around one's adaptation level. If the stimulus falls within this zone, a positive response occurs, but if the stimulus falls outside this zone, one responds ineffectively. Positive responses free energy to respond to other stimuli and promote healing and health while ineffective responses disrupt the integrity of the individual (Roy, 1984; Tiedeman, 1989).

An individual who requires pulmonary artery pressure monitoring has experienced stimuli outside his/her zone of adaptation and needs assistance to respond to fluid alterations which lie within the physiologic mode of the regulator subsystem. The nurse must accurately interpret the PCWP value to assist adaptation to circulatory changes and promote survival.

The RAM, a problem solving approach, encourages the nurse to use observational skills to assess the level of an individual's adaptation, identify problems, and intervene to assist with adaptation where indicated (Aggleton & Chambers, 1984; Galbreath, 1985; Hamner, 1989; Roy, 1970, 1984; Sato, 1986.) This six step nursing process includes first level assessment, second level assessment, nursing diagnosis, goal setting, intervention, and evaluation (Galbreath, 1985;

Hamner, 1989; Mastal & Hammond, 1980; Roy, 1984; Sato, 1986; Tiedeman, 1989). Sato (1986) also included a seventh step of modification.

In first level assessment the nurse uses observation, measurement tools, and interviewing to assess patient internal and external behaviors (Hamner, 1989; Roy, 1970, 1984; Sato, 1986). Applying the RAM to this study, the patient's preload would be considered an internal behavior observed by the nurse who interpreted the PCWP value with an appropriate measurement tool, the pulmonary artery catheter connected to a monitor calibrated to display accurate pressure waveforms.

In second level assessment the nurse identifies factors responsible for or which influence the behavior identified in first level assessment (Roy, 1984). This includes focal stimuli (defined as that which immediately confronts the individual), contextual stimuli (defined as other influencing environmental factors), and residual stimuli (defined as beliefs, attitudes, traits, and experiences presumed to be affecting the behavior) (Galbreath, 1985; Mastal & Hammond, 1980; Sato, 1986). The patient must adapt to the focal stimuli which includes alterations in physiological functioning (Giger, Bower, & Miller, 1987; Roy, 1984). For this study, the focal stimulus which requires the patient to adapt is fluid

status, reflected by their PCWP value which indirectly indicates preload.

The remaining steps in this model, nursing diagnosis, goal setting, intervention, and evaluation, can also be applied to this setting. For example, the nursing diagnosis might read as follows: Alteration in tissue perfusion related to decreased cardiac output secondary to excessive preload. Goal setting might be to maintain the PCWP value at the optimal level for the individual, for example 18mmHg. Interventions to obtain this goal in the setting of increased preload could be the administration of diuretics and vasodilators. Evaluation would be accomplished by continued observation of the patient's PCWP value. Modification to the intervention could then be made if the interventions failed to obtain the goal.

In accordance with the RAM, the nurse intervenes to alter the relationship between the stimuli and the individual's adaptation level to place the stimuli within their range of adaptation (Appleton & Chambers, 1984). The patient adapts while the nurse manipulates the situation to promote adaptation (Roy, 1976). The nurse first attempts to manipulate the focal stimuli which may require removing, increasing, decreasing, maintaining, or altering the stimuli to effect adaptation (Appleton & Chambers, 1984; Tiedeman, 1989).

SUMMARY-PCWP INTERPRETATION AND RAM

Although in the critical care setting the patient may not always actively participate, the RAM model suits a rapidly changing environment (Giger et al., 1987; Hamner, 1989). Such a condition includes a situation where a patient experiences a problem with physiologic adaptation in the regulator subsystem due to changes in fluid status and requires pulmonary artery pressure monitoring by the nurse to guide interventions. The fluid status presents the focal stimuli to which the individual must adapt. First level assessment using PCWP identifies this internal behavioral response. For the nurse to begin the nursing process appropriately according to the RAM, he\she must accurately interpret the PCWP value. An error at this beginning stage jeopardizes successful outcome. Interpretation of the PCWP value in the presence of respiratory excursions can be difficult, but must be done accurately to guide appropriate interventions to alter focal stimuli and promote adaptation.

ADULT LEARNERS

The knowledge and skills of the practitioner greatly influence the quality of health care provided (Brunt & Scott, 1986). The critical care nurse must be able to

properly interpret the PCWP value to make appropriate clinical decisions. Considering the abundance of technology confronting the practitioner, educators must assist nurses with self-directed learning; traditional classes, workshops, and conferences cannot meet all these educational needs (Cooper, 1983; Hamilton & Gregor, 1986).

Adult learners generally view themselves as responsible and self-directed, preferring productive, independent learning experiences (Brunt & Scott, 1986; Hamilton & Gregor, 1986). Application of the information to practice with a problem-solving focus provides a strong motivator for adults to learn (Mast & Van Atta, 1986). Consequently, most nurses responsible for PCWP monitoring would accept a self-directed education package regarding PCWP value interpretation.

Educational agents continue to play an important role by supporting and facilitating self-directed learning activities (Clark, 1986). Educators promote self-directed learning by designing educational programs that require independent action; such "other-designed" learning may include self-contained learning packages, directed reading, programmed instruction, or computer-assisted instruction (Cooper, 1983). Nurses have indicated that their participation in self-study would increase if more resources and assistance were provided and easily accessible (Clark, 1986; Cooper, 1983).

Adult learners seek educational opportunities with career objectives in mind, being highly motivated by a desire to improve performance by increasing knowledge and skills related to their profession (Brunner, 1983; Brunt & Scott, 1986; Clark, 1986). The learning activity must be relevant, applicable, and challenging to stimulate the participant. Also, the learning package will be more effective if it proceeds in a logical sequence with concepts visualized through illustration as much as possible. Since adult learners emphasize practical applications, learning modules should link the learning experience to clinical problem-solving (Brunt & Scott, 1986; Mast & Van Atta, 1986). Recall of material improves when the learner immediately incorporates "new" learning into practice; therefore, opportunities for immediate application should be provided (Brunner, 1983).

Brunt and Scott (1986) emphasize the importance of measuring performance when the goal of an educational program is change in job performance. A post-test requiring the use of psychomotor skills helps evaluate the knowledge and competence of the individual, the validity of the questions, and the degree to which learning objectives were met. Also, an evaluation of the learning package may provide feedback to help improve the learning material.

STATEMENT OF THE PROBLEM

How accurately do experienced critical care nurses interpret PCWP with respiratory excursions in both spontaneously breathing and mechanically ventilated patients? Does independent study of a brief review of methods for proper interpretation of PCWP values in the presence of respiratory excursions improve performance?

DEFINITION OF TERMS

Experienced critical care nurses. Registered nurses who have worked in a critical care unit for one or more years.

Mechanically ventilated patients. Intubated patients who receive positive pressure ventilation in the control mode.

Independent review. Examination of information regarding interpretation of PCWP values requiring no more than 15 minutes to examine without having a "teacher" present.

Respiratory excursions. Pressure value variations greater than 10mmHg in the PCWP waveform related to the ventilatory pattern.

Spontaneous breathing. Any respiratory pattern exhibited by an individual without the aid of a mechanical device. Supplemental oxygen may be used.

Preload. The volume of blood in the left ventricle at the end of diastole which is indicated by the PCWP value and which along with the afterload and contractility, influences stroke volume.

PCWP value. The pressure measured via the distal port of a pulmonary artery catheter with the balloon inflated and a left atrial pressure tracing recorded assuming the tip of the pulmonary artery catheter is located in lung zone three and normal mitral valve function exists.

ASSUMPTIONS

It is assumed that:

1. Subjects will follow the directions.
2. Subjects will answer the questions honestly.
3. Subjects will answer the questions independently.

SUMMARY

Pulmonary artery catheters provide the route to obtain PCWP measurements. Critical care nurses frequently interpret PCWP values, an assessment skill, to guide interventions with the potential of assisting patients to adapt physiologically to altered fluid status. Accurately determining accurate PCWP values becomes more complicated when patients' PCWP waveforms exhibit respiratory

excursions. This study assessed the ability of experienced critical care nurses to accurately interpret the PCWP value in the presence of respiratory excursions and examined the effect of an independent review on performance.

CHAPTER II

REVIEW OF RESEARCH/LITERATURE

OVERVIEW

The appearance of respiratory excursions on PCWP waveforms are associated with changes in intrathoracic pressure with inspiration and expiration (Riedinger et al., 1981; O'Quinn & Marini, 1983). The amount of variation exhibited depends on such factors as depth of inspiration, compliance of the lungs, intravascular volume, and myocardial performance (Gooding & Laws, 1977). Nurses must consider this respiratory effect to accurately interpret the PCWP.

Various methods have been proposed to accurately interpret PCWP values in the presence of respiratory excursions, including breath holding, removal of mechanical ventilation, recording mean pressure, pressure averaging, and recording at end-expiration (Riedinger et al., 1981). However, interpretation of PCWP values at end-expiration assures the most accurate data (Berryhill, Benumot, & Rauscher, 1978; Cengiz et al., 1983; Dolter, 1989; Gooding & Laws, 1977; Maran, 1980; O'Quinn & Marini, 1983).

End-expiration is considered the period of the respiratory cycle preceding the beginning of inspiration (Riedinger et al., 1981). During this phase of the respiratory cycle intrathoracic pressure and atmospheric pressure tend to equilibrate and provide a baseline for interpretation of PCWP with minimal influence from intrathoracic pressure changes (Berryhill et al., 1978; Cengiz et al., 1983; Gooding & Laws, 1977; O'Quinn & Marini, 1983; Riedinger et al., 1981).

Wild and Woods (1985) compared three methods for interpreting PCWP values in the presence of respiratory excursions in 23 mechanically ventilated patients. Method I involved computerization of the area under the curve. Method II calculated an arithmetical estimate of the pressure where $PCWP = 1/3 (\text{systole-diastole}) + \text{diastole}$, and Method III involved reading the pressure at end-expiration. A clinically and statistically significant difference ($p < 0.05$) was found between Methods I and II versus Method III. The investigators concluded that for consistent and accurate data, PCWP should be read at end-respiration.

Davison, Parker, and Harrison (1978) compared the effect of mechanical ventilation on PCWP. They recorded PCWP values on 29 patients during mechanical ventilation and during temporary removal of the ventilator to assess the effects of the ventilator on the pressure. The investigators concluded that there was no statistical

difference ($p > 0.05$) in the measurement of PCWP during end-expiration whether connected or disconnected from the ventilator.

Determining end-respiration on a PCWP waveform in the presence of respiratory excursions requires nurses to know the differences between respiratory patterns of mechanically ventilated patients and spontaneously breathing patients. Spontaneous ventilation tends to lower the PCWP waveform toward more negative values and mechanical ventilation tends to raise the PCWP waveform toward more positive values (Campbell & Greenberg, 1988; Gooding & Laws, 1977). Although changes with mechanical ventilation seem to be more often considered, respiratory variation with spontaneous ventilation can cause significant changes in the PCWP waveform (Morris, 1988). When assessing waveforms of spontaneously breathing patients, end-expiration is the higher portion of the waveform. In contrast, when assessing waveforms of mechanically ventilated patients, end-expiration is the lower portion of the waveform (Dolter, 1989). Nurses must be aware of this difference in respiratory patterns to appropriately interpret the pressure value and record accurate assessment data.

The equipment used to measure PCWP in the presence of respiratory excursions also influences accuracy. Modern bedside computers provide automated digital displays of pressures from invasive monitoring systems. In the presence

of respiratory excursions, the difference between the digitally recorded PCWP value and the PCWP value properly interpreted from a graphic recording of the waveform can be substantial (Maran, 1980).

Digital recordings average values the computer considers systolic and diastolic pressures without regard to the respiratory cycle (Dolter, 1989; Maran, 1980). This unselective sampling and averaging method can report inaccurate data leading to the selection of inappropriate therapy (O'Quinn & Marini, 1983). Thus, nurses required to monitor PCWPs must know how to properly interpret the pressure value by observing the recorded waveform; failing to critically analyze the PCWP waveform and accepting the value digitally displayed can result in errors leading to poor treatment decisions and failure to assist patient adaptation (Dolton, 1989; Pierpont, 1987).

Cengiz and associates (1983) studied the differences between automated digital recordings of PCWP values and manually interpreted pressure values from the graphic recordings of 40 patients admitted to critical care units. The sample included both spontaneous breathing patients and mechanically ventilated patients. In spontaneously breathing patients, the automated method resulted in a statistically significant ($p < 0.001$) underestimation of the PCWP value. In mechanically ventilated patients, the automated method resulted in a statistically significant

overestimation of the PCWP, ($p < 0.001$). These investigators found spontaneously breathing patients had the largest measurement errors; 42% had clinically important errors. Assuming they properly interpreted the graphic recordings, the study supports the importance of nurses' correctly interpreting PCWP waveforms.

Maran (1980) examined the variations between digitally reported PCWP values and graphic analysis of the pressure waveform in a study of three patients with Adult Respiratory Distress Syndrome (ARDS). He reported an unpredictable variation sufficient to deem the use of digital data unreliable. This study also supports the importance of accurately interpreting PCWP values.

Critical care nurses' knowledge of thermodilution cardiac output measurement, a related assessment skill, was examined by Loveys, Straw, and Woods (1987). They distributed a 20-item multiple-choice questionnaire to 1000 members of the American Association of Critical Care Nurses (AACN) throughout nine geographic regions of the United States. They reported a 28% response rate and analyzed 274 responses. The mean questionnaire score was reported as 71.05% with a range from 25% to 100%. The study also examined variations in scores related to gender, age, education, additional certification, experience, employment position and clinical area, and geographic location. Few significant differences ($p > 0.05$) were found. Respondents

who had critical care certification (CCRN) and held administrative positions had statistically significant higher mean questionnaire scores (.06% to 10.5% higher, $p < 0.05$) than other respondents. The respondents' knowledge regarding thermodilution cardiac output measurement did not meet the criterion level established for the study. Findings from the study suggest that critical care nurses may not have the necessary knowledge to properly interpret pulmonary artery pressure values. However, results of the study should be interpreted with caution due to the poor response rate.

SUMMARY

The PCWP waveform in the presence of respiratory excursions may vary significantly in both spontaneously breathing and mechanically ventilated patients. To accurately interpret the PCWP value, the pressure must be read at end-expiration. End-expiration occurs on opposite portions of the PCWP waveform depending on whether the person is being mechanically ventilated or not. Automated digital measurements of PCWP value can result in significant errors due to the unselective nature of the sampling method. To accurately interpret the PCWP value in the presence of respiratory excursions, nurses must have adequate knowledge and skill to interpret the proper end-

expiration point on a graphic recording of the pressure.

Critical care nurses may not have the necessary knowledge to accurately select appropriate interventions to promote adaptation of the patients.

CHAPTER III

DESIGN OF STUDY

A posttest-only control group design was used. Subjects were randomly assigned to either the experimental or the control group. The control group received a questionnaire (see Appendix A) to assess the subjects' individual knowledge and skill related to interpretation of PCWP values in the presence of respiratory excursions. An independent educational review packet related to accurate assessment of PCWP values was provided prior to completing the same questionnaire to subjects in the experimental group.

INSTRUMENTATION

Responses from a 16 item investigator designed questionnaire were analyzed. The first eight items of the questionnaire addressed demographic data and the remainder assessed nurses' knowledge of interpreting PCWP values in the presence of respiratory excursions. The instrument was reviewed by experts in critical care to assure validity.

Subjects in the control group received the questionnaire only. Subjects in the experimental group

first received an independent educational review titled "Guidelines for Interpretating PCWP Values with Respiratory Excursions" (see Appendix B). This review included a written explanation of proper PCWP value interpretation when respiratory excursions exist, waveform examples, illustrations, and a catch phrase to assist recall of proper interpretation points. A Likert-type evaluation scale was used to assess perceived benefits of the educational review (see Appendix C).

SUBJECTS

Subjects were randomly drawn from a convenience group of nurses working in critical care units in East Tennessee and Southwest Virginia. To be included in the study, each subject was required to be a registered nurse with at least one year of experience in a critical care area. The sample size of 75 nurses was randomly assigned to one of the groups with 42 subjects in the control group and 33 subjects in the experimental group.

RESEARCH HYPOTHESIS

The following research hypotheses were tested:

1. Critical care nurses within the control group will have scores less than an established

criterion level of 89% on a questionnaire assessing PCWP interpretation.

2. Critical care nurses completing a brief independent review on interpreting PCWP values will score higher ($p < .05$) on the questionnaire items than nurses not receiving the independent review.

DATA ANALYSIS

A mean score from the control group was compared to the established criterion level of 89%. This criterion level was selected after discussion with experts in critical care and review of the certification standard for the ACLS examination. A criterion level of 100% was first considered, but subjects answering one question incorrectly and/or scoring 89% could still demonstrate competence (ACLS certification requires a score of 84% on the written examination). Support for the first research hypothesis was assumed if the control group mean score fell below the 89% criterion level.

The second research hypothesis was evaluated using a t -test for independent sample means comparing the scores of subjects provided with the brief independent review (experimental group) with the scores of subjects not

receiving the review (control group) to determine if a significant difference ($p = .05$) existed.

PROCEDURE

Critical care nurses within the East Tennessee and Southwest Virginia region were invited to participate in the study. After the investigator received administrative approval, potential subjects in four hospitals were approached and asked if they were willing to devote approximately 30 minutes of their time after work to participate in the study. A majority of those approached were willing to participate. They were instructed to report to a predetermined conference room within the facility at a specified time. After reporting to the conference room, subjects were randomly assigned to either the control or the experimental group. A flip of the coin determined group placement with heads being the control group and tails the experimental group. Experimental group subjects then moved to an alternate conference room.

Control group subjects were first asked to read the information sheet titled "PCWP Value Interpretation Questionnaire" (see Appendix E) and asked to sign and date the consent form (see Appendix D) if they desired to participate in the study. No subjects declined to

participate at this point. After collecting the consent forms, the subjects were given the questionnaire and instructed to answer all the questions to the best of their ability and return it to the data collector. These questionnaires were identified only with a black "C" printed on page 1 to indicate control group. The entire process for the control group required 15 minutes or less.

Experimental group subjects were first asked to read the information sheet titled "PCWP Value Review and Interpretation Questionnaire" (see Appendix F) and asked to sign and date the consent form if they desired to participate in the study. At this point none of the subjects declined to participate. After collecting the forms, subjects were instructed to independently review the educational pamphlet titled "Guidelines for Interpreting PCWP Values with Respiratory Excursions" (see Appendix B). Subjects returned the pamphlet to the data collector after they reviewed it. No time limit was set for completing the review, but no subject took more than 10 minutes. The subjects were then given a questionnaire and instructed to answer all of the questions to the best of their ability and return it to the data collector. These questionnaires were marked only with a red "E" printed on page 1 to indicate experimental group. The process of reviewing the pamphlet and responding to the questionnaire required approximately 30 minutes.

CHAPTER IV

RESULTS

DEMOGRAPHICS

Seventy-eight critical care nurses from four hospitals located in Northeast Tennessee and Southwest Virginia participated in the study. The questionnaires of three subjects were eliminated from the study due to the subjects' failure to meet experience requirements. Of the 75 remaining subjects, 68 (90.6%) were female and 7 (9.3%) male. The mean age of participants was 36.2 years with a range of 22-60 years. Critical care experience ranged from 1-24 years with a mean of 6.7 years. Control group subjects had a mean age of 37.2 years ranging from 22-60 years; the experimental subjects had a mean age of 34.9 years ranging from 22-52 years. The control and experimental subjects had comparable experience as employees in critical care units (see Table 1).

The majority of subjects (52%) reported their current nursing educational preparation as an associate degree, followed by those reporting a bachelor's degree (25.3%), and diploma (17.3%). A small percentage of subjects reported an initial educational preparation different from their current educational preparation. One subject failed to report

Table 1. Age and Experience of Participants

Group	Mean Age	Age Range	Mean Exp.*	Exp.* Range
All Subjects (n=75)	36.2	22-60	6.7	1-24
Control (n=42)	37.2	22-60	6.5	1-21
Experimental (n=33)	34.9	22-52	6.9	1-24

* Exp. = Experience

educational preparation. Percentages of subjects with bachelor's degrees and associate degrees were similar within both the control and experimental groups, but the experimental group had a higher percentage of diploma nurses (see Table 2).

A majority of subjects reported holding a certification. Certifications included critical care (CCRN), advanced cardiac life support (ACLS), and medical-surgical. With the exception of CCRN, certification percentages were similar within both control (57.1%) and experimental (60.6%) group subjects. The control group had a higher percentage of subjects with CCRN certification (see Table 3).

A sizable majority (90.7%) of participants described themselves as staff nurses. A small percentage (9.3)

Table 2. Educational History of Participants

	All Subjects (n=75)	Control (n=42)	Experimental (n=33)
BSN	19 (25.3%)	10 (23.8%)	9 (27.3%)
AD	39 (52%)	23 (54.7%)	16 (48.5%)
Diploma	13 (17.3%)	6 (14.3%)	7 (21.2%)
Non-Nursing BS	3 (4%)	2 (4.8%)	1 (3%)
No Response	1 (1.3%)	1 (2.4%)	0
Initial AD/ Current BSN	4 (5.3%)	4 (9.5%)	0
Initial Dip./ Current BSN	1 (1.3%)	1 (2.4%)	0
Initial AD/ Current Non-Nsg. BS	1 (1.3%)	0	1 (3%)

Table 3. Certifications

	All Subjects (n=75)	Control (n=42)	Experimental (n=33)
Any Certification	44 (58.7%)	24 (57.1%)	20 (60.6%)
CCRN	5 (6.7%)	4 (9.5%)	1 (3%)
ACLS	32 (42.7%)	17 (40.5%)	15 (45.5%)
CCRN & ACLS	6 (8%)	3 (7.1%)	3 (9.1%)
Med./Surg.	1 (1.3%)	0	1 (3%)

reported they held positions of supervisor, head nurse, and staff educator. Distributions were similar between both the control and experimental groups (see Table 4).

Subjects described themselves as being drawn from six critical care practice areas. Twenty-three indicated their primary practice area as a medical intensive care unit (MICU), 14 a surgical intensive care unit (SICU), 4 a coronary care unit (CCU), 8 a cardiac surgical unit, 1 an emergency room (ER), and 25 a general intensive care unit (GICU). More subjects in the control group worked in a MICU; otherwise, distributions were similar between control

Table 4. Positions of Subjects

	All Subjects (n=75)	Control (n=42)	Experimental (n=33)
Staff Nurse	68 (90.7%)	39 (92.8%)	29 (87.9)
Supervisor	3 (4%)	1 (2.4%)	2 (6.1%)
Head Nurse	3 (4%)	2 (4.8%)	1 (3%)
Educator	1 (1.3%)	0	1 (3%)

and experimental group subjects (see Table 5).

An indication of the frequency with which participants performed pulmonary artery pressure monitoring was investigated. The majority of subjects reported they perform pulmonary artery pressure monitoring less than 50% of their work days. Distributions were similar between control and experimental group subjects (see Table 6). Table 7 demonstrates how the frequency of performance varied between areas of practice.

Table 5. Practice Areas

	All Subjects (n=75)	Control (n=42)	Experimental (n=33)
MICU	23 (30.6%)	16 (38%)	7 (21.2%)
SICU	14 (18.6%)	7 (16.6%)	7 (21.2%)
CCU	4 (5.3%)	2 (4.8%)	2 (6%)
CSU	8 (10.6%)	4 (9.5%)	4 (12.1%)
ER	1 (1.3%)	1 (2.4%)	0
GICU	25 (33.3%)	12 (28.6%)	13 (39.4%)

Table 6. Frequency of Pulmonary Artery Pressure Monitoring

	All Subjects (n=75)	Control (n=42)	Experimental (n=33)
0-9% *	25 (33.3%)	15 (35.7%)	10 (30.3%)
10-19%	12 (15.9%)	7 (16.6%)	5 (15.1%)
20-29%	14 (18.6%)	7 (16.6%)	7 (21.2%)
30-39%	8 (10.6%)	3 (7.1%)	5 (15.1%)
40-49%	5 (6.6%)	3 (7.1%)	2 (6%)
50-59%	5 (6.6%)	3 (7.1%)	2 (6%)
60-69%	1 (1.3%)	0	1 (3%)
70-79%	1 (1.3%)	1 (2.3%)	0
80-89%	3 (3.9%)	3 (7.1%)	0
90-100%	1 (1.3%)	0	1 (3%)

* Subject's estimated % of work days in which they perform pulmonary artery pressure monitoring

Table 7. Frequency of Pulmonary Artery Pressure
Monitoring within Practice Areas

	MICU	SICU	CCU	CSU	ER	GICU
0-9%*	6** 7.9%***	2 2.6%	3 3.9%	0	1 1.3%	13 17.3%
10-19%	8 10.6%	1 1.3%	0	0	0	3 3.9%
20-29%	3 3.9%	5 6.6%	1 1.3%	0	0	5 6.6%
30-39%	1 1.3%	2 2.6%	0	1 1.3%	0	4 5.3%
40-49%	4 5.3%	1 1.3%	0	0	0	0
50-59%	1 1.3%	3 3.9%	0	1 1.3%	0	0
60-69%	0	0	0	1 1.3%	0	0
70-79%	0	0	0	1 1.3%	0	0
80-89%	0	0	0	3 3.9%	0	0
90-100%	0	0	0	1 1.3%	0	0

* Subject's estimated % of work days in which they
perform pulmonary artery pressure monitoring

** No. of total subjects

*** % of total subjects

ITEM ANALYSIS

An item analysis was conducted on the nine items of the questionnaire testing knowledge of pulmonary capillary wedge pressure (PCWP) value interpretation to determine each item's ability to discriminate between the least and the most knowledgeable subjects. The difficulty index of each item ranged from 37.5-72.5 with a mean of 60. The discrimination index of each item ranged from 35-80 with a mean of 56.7 (see Table 8). This analysis suggests that overall these questionnaire items reliably discriminate between subjects.

RESEARCH HYPOTHESIS 1

The first research hypothesis was that experienced critical care nurses within the control group will have scores less than an established criterion level of 89% on a questionnaire assessing PCWP value interpretation. The findings support the hypothesis. The mean score for subjects in the control group was $51.5\% \pm 22.5$ with a range of 0-100% and a median of 56%. Test scores were normally distributed. This finding suggests that a knowledge deficit exists among the sample regarding PCWP value interpretation in the presence of respiratory excursions.

Table 8. Item Analysis

Questionnaire Item	Difficulty Index	Discrimination Index
10) Interpretation Point	72.5	55
11) Respiratory Excursion Interpretation Point	47.5	65
12) Mechanical Ventilator Effect	50	40
13) Spontaneous Breathing Effect	37.5	55
14) Spontaneous Breathing Waveform Interpretation	65	60
15) Mechanical Ventilation Waveform Interpretation	67.5	55
16) Mechanical Ventilation Interpretation Point	67.5	65
17) Spontaneous Breathing Interpretation Point	60	80
18) Interpretation Method	72.5	35
Mean	60	56.7

RESEARCH HYPOTHESIS 2

The second research hypothesis was that subjects completing the independent educational review on PCWP value interpretation (experimental group) would score significantly higher on the questionnaire items than subjects who did not receive the independent educational review (control group). Again, data supported this hypothesis. Mean score for the experimental group was 77.7% $\pm$ 15.2 with a range of 45-100% and a median of 78%. Experimental group scores also were normally distributed. A t -test for independent sample means demonstrated a statistically significant ($t = 5.7$, $p = .0001$) difference between the control group and experimental group means (see Table 9).

SUBSIDIARY QUESTION 1-WHAT ARE THE RELATIONSHIPS BETWEEN EXPERIENCE AND TEST SCORES?

To determine if a relationship existed between subjects' years of experience and test scores, correlations (Pearson r) were examined between these variables in both the experimental and control groups. Within the control group no significant relationship was found between years of experience and test scores ($r = .009$, $p = .91$). Also, no significant relationship was found within the experimental

Table 9. Differences in Mean Scores Between Control and Experimental Subjects

	Control (n=42)	Experimental (n=33)
Mean	51.5	77.7
Median	56	78
SD	22.5	15.2
Range	0-100	45-100
Skewness	-.15	-.50
$t = 5.7$		
$p = .0001$		

group between years of experience and test scores ($r = .21$, $p = .24$).

**SUBSIDIARY QUESTION 2-WHAT ARE THE RELATIONSHIPS
BETWEEN USAGE AND TEST SCORES?**

Correlations (Spearman r) between reported percentages of usage of pulmonary artery pressure monitoring and test scores were examined in both the experimental and control groups to determine if relationships existed. No significant relationships were found between reported usage and test scores within the experimental group ($r = .01$, $p = .90$). However, a significant positive correlation ($p < .05$) was found between reported usage and test scores within the control group ($r = .41$, $p = .009$).

EXAMINATION OF TEST SCORES WITHIN SUBGROUPS

Subjects reported three levels of nursing preparation and a variety of certifications and primary practice settings. The number of subjects within these subgroups was insufficient to justify the use of parametric statistics for comparisons of test scores. However, descriptive statistics were examined in both the control and experimental groups. Table 10 describes test scores of subjects and their nursing education preparation. Table 11 describes test scores of

Table 10. Educational Differences

<u>Subgroup</u>	<u>n</u>	<u>Mean</u>	<u>Median</u>	<u>SD</u>	<u>Range</u>
Control BSN	10	50.5	50.5	23.3	12-78
Control AD	23	49.2	50.5	22.4	0-89
Control Dip.	6	50.5	50.5	20.6	23-78
Exp.* BSN	9	78	78	17.4	45-100
Exp. AD	16	75.3	78	14.2	45-100
Exp. Dip.	7	82.7	83.5	16.6	56-100

* Exp. = Experience

Table 11. Certification Differences

Subgroup	n	Mean	Median	SD	Range
Control/ any certification	24	49	56	25.2	0-100
Control/ no certification	18	54.8	56	18.4	23-89
Control/CCRN	4	58.8	50.5	28.9	34-100
Control/ACLS	17	48.7	56	25.4	0-78
Experimental/ any certification	20	81.3	78	12.9	56-100
Experimental/ no certification	13	72.1	78	17.2	45-100
Experimental/ACLS	15	78	78	12.5	56-100

subjects in relation to certification diversities. Table 12 describes test scores of subjects from varied practice settings.

SUBJECTS' EVALUATION OF EDUCATIONAL MATERIAL

Subjects within the experimental group were asked to complete an evaluation of the educational pamphlet they reviewed. Responses to four questions regarding different aspects of the educational material were requested on a Likert-type scale ranging from 1-6 where 1 was considered not helpful and 6 considered very helpful. Responses to question 1 evaluating the helpfulness of the written explanation resulted in a mean of 4.9; responses to question 2 evaluating the helpfulness of the waveform examples resulted in a mean of 5.1; responses to question 3 evaluating the helpfulness of the illustration resulted in a mean of 5.3; and responses to question 4 evaluating the helpfulness of the catch phrase resulted in a mean of 5.5 (see Table 13). Totals of individual subjects' evaluations resulted in a mean of 20.8 out of a potential maximum of 24 and minimum of four (see Table 14).

Table 12. Practice Setting Differences

<u>Subgroup</u>	<u>n</u>	<u>Mean</u>	<u>Median</u>	<u>SD</u>	<u>Range</u>
Control MICU	16	51.1	45	20.3	21-78
Control SICU	7	56	45	22.9	34-89
Control CCU	2	28	28	39.6	0-56
Control CSU	4	67	56	22	56-100
Control GICU	12	51.4	56	20.7	12-78
Exp. MICU	7	79.6	78	13.4	56-100
Exp. SICU	7	90.6	89	7.6	78-100
Exp. CCU	2	89	89	0	0
Exp. CSU	4	64.3	67	16.5	45-78
Exp. GICU	13	72.1	72	14.6	45-100

Table 13. Independent Educational Review Evaluation-
Individual Question Ranks

Question	Mean	Range
1) Did the written explanation and instructions improve your understanding of PCWP value interpretation?	4.9	2-6
2) Did the waveform examples demonstrating appropriate points for interpreting PCWP values improve your understanding?	5.1	3-6
3) Did the illustration describing differences in inspiratory pressures for spontaneously breathing patients compared to those mechanically ventilated improve your understanding?	5.3	1-6
4) Did the catch phrase assist in recalling the appropriate PCWP value interpretation point?	5.5	2-6

Table 14. Independent Educational Review Evaluation-
Overall

	Mean	Range
Total Pamphlet Evaluation Rank *	20.8	12-24

* Potential maximum 24 (very helpful); Potential minimum 4 (not helpful)

SUMMARY

Seventy-five critical care nurses with a mean age of 36.2 years were included in the study. Most subjects, 52%, reported nursing educational preparation at the AD level, followed by BSN, 25%, and diploma, 17%. A vast majority, 90.7%, indicated they held staff nurse positions and 58% indicated at least one certification. Random assignment resulted in 42 subjects within the control group and 33 subjects within the experimental group.

Support for the first research hypothesis was found with the control group mean score falling short of the criterion level. Support for the second research hypothesis was also found with a statistically significant difference in scores on questionnaire items related to interpretation of PCWP value between subjects receiving an independent educational review (experimental group) and those not receiving the review (control group) ($t = 5.7$, $p = .0001$). A significant positive relationship ($p < .05$) was found in the control group when test scores were correlated with reported frequency of usage of pulmonary artery pressure monitoring ($r = .41$, $p = .009$). The positive responses to the evaluation of the independent educational review indicate that all aspects of the review helped improve understanding of PCWP value interpretation.

CHAPTER V

DISCUSSION

CONCLUSIONS AND IMPLICATIONS

Results from this study supported the hypothesis that experienced critical care nurses lack an adequate knowledge base for proper interpretation of pulmonary capillary wedge pressure (PCWP) values in the presence of respiratory excursions. The mean score of 51.5% mastery by the control group subjects fell far short of the criterion level of 89% mastery, indicating the difficulty this group experienced with regard to properly interpreting PCWP values. When PCWP values guide decisions related to fluid management, improperly interpreted values may result in inappropriate clinical interventions which fail to assist patients to adapt to an altered fluid status. This finding suggests critical care nurses need continued education to interpret PCWP values in the presence of respiratory excursions irrespective of their educational preparation or experience. Although a positive correlation ($r = .41$, $p = .009$) existed within the control group regarding frequency of performing PCWP value interpretation and test scores, the scores were still well below the criterion level of 89. Although

this finding indicates experience with the procedure improved performance on the questionnaire, a need remains to provide additional education regarding principles of proper PCWP value interpretation.

The impact of the independent educational review on performance represents another significant finding of this study. The highly significant ($p = .0001$) difference found between the mean score for the group without the independent educational review (control group) and the mean score for those receiving the review (experimental group) emphasizes the importance of continued education to maintain high standards of practice. It also lends support to the value of self-directed study designed for the continued education of adult learners. Although the independent review was limited and required 10 minutes or less, the subjects' performance dramatically improved.

Evaluation of the independent educational review by experimental subjects provided positive feedback as to the appropriateness and helpfulness of all aspects of the material. The overall mean rank of 20.8 out of a potential maximum of 24 for the entire pamphlet indicated that subjects found the material to be highly beneficial in increasing their understanding of PCWP value interpretation. The rankings of specific aspects of the review demonstrates that subjects benefited from all features of the material. The catch phrase received the highest ranking, a mean of 5.5

out of a potential maximum of 6.0, indicating that subjects found this aspect of the material most beneficial in recalling the appropriate PCWP value interpretation point. The illustrations and waveforms received high ranking also, 5.3 and 5.1 respectively, supporting the need for graphic representation of important principles in learning packets. The written explanation, although considered helpful, received the lowest rank of 4.9. Together, all aspects of the independent educational review appear to have produced a highly beneficial learning tool.

The Roy Adaptation Model aptly incorporates in first level assessment PCWP value interpretation to guide evaluation of the patient's fluid status, the focal stimulus to which the patient must adapt. Proper interpretation of the PCWP value during first level assessment allows the nurse to appropriately proceed through the nursing process by first making an accurate nursing diagnosis, then selecting correct interventions to achieve the desired goal, and finally evaluating patient responses including continued interpretation of PCWP value. Thus, physiologic adaptation to fluid status may be promoted.

LIMITATIONS

Subjects participating in this study were randomly selected from three hospitals in Northeast Tennessee and one

hospital in Southwest Virginia. Therefore, results of the study can only be applied to critical care nurses employed within this region. Critical care nurses outside this region cannot be expected to perform in a similar fashion.

The results of the study demonstrated significantly improved scores related to PCWP value interpretation in the presence of respiratory excursions for subjects receiving a brief independent educational review. The mean score (77.7%) of this experimental group, however, still falls short of the established criterion level of 89%. This finding suggests that although independent review of an educational packet greatly improves performance, it does not entirely correct a knowledge deficit related to PCWP value interpretation.

Results of this study should also be interpreted with consideration that the study only examined the ability of critical care nurses to interpret PCWP waveforms complicated by respiratory excursions. It does not analyze the ability to interpret uncomplicated PCWP waveforms or other aspects of pulmonary artery pressure monitoring. Also, the study did not assess the ability of critical care nurses to interpret PCWP values of mechanically ventilated patients in the intermittent mechanical ventilation (IMV) mode. Therefore, this study can not be generalized to evaluate the overall knowledge base of critical care nurses regarding pulmonary artery pressure monitoring.

RECOMMENDATIONS FOR FUTURE RESEARCH

This study examined the ability of critical care nurses to recall knowledge of PCWP value interpretation in the presence of respiratory excursions immediately after they had engaged in an independent educational review. A study conducted after a longer period of time has elapsed between review and testing could examine the knowledge retention of the experimental subjects. Such information would provide additional data to evaluate the effectiveness of independent review and may also indicate the required frequency of such a review.

Examination of nursing knowledge and performance of other aspects related to hemodynamic monitoring may also be beneficial. Such studies might examine knowledge related to proper leveling of transducers, determination cardiac output via thermodilution technique, calculating components of cardiac output (preload, afterload, contractility), and implementing appropriate therapy related to such data.

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APPENDIXES

APPENDIX A

PCWP VALUE INTERPRETATION QUESTIONNAIRE

PCWP Value Interpretation Questionnaire

Please answer the following questions by either filling in the blank with the appropriate information or circle the letter corresponding to your choice.

DO NOT WRITE YOUR NAME ON THIS QUESTIONNAIRE.

1. Age
2. Gender
3. How many years have you worked in critical care settings?
4. Circle the choice which most appropriately describes your initial level of nursing preparation.
 - a. Diploma
 - b. Associate Degree in Nursing
 - c. Bachelors Degree in Nursing
 - d. Bachelors Degree other than nursing
 - e. Master's Degree in Nursing
5. Circle the choice which most appropriately describes your current level of educational preparation.
 - a. Diploma
 - b. Associate Degree in Nursing
 - c. Bachelors Degree in Nursing
 - d. Bachelors Degree other than nursing
 - e. Master's Degree in Nursing

- f. Master's Degree other than nursing
 - g. Doctorate
6. List any specialty certifications you currently hold:
7. Circle the title which best describes your practice position.
- a. Staff Nurse
 - b. Head Nurse
 - c. Supervisor
 - d. Clinical Specialist
 - e. Staff Educator
8. Circle the setting which best describes your area of practice.
- a. Medical Intensive Care Unit
 - b. Surgical Intensive Care Unit
 - c. Coronary Care Unit
 - d. Neurosurgical Unit
 - e. Trauma
 - f. Cardiac Surgery Unit
 - g. Burn Unit
 - h. Post Anesthesia Recovery Unit
 - i. Emergency Room
 - j. Other

9. Circle the choice which best approximates the percentage of work days you perform pulmonary artery pressure monitoring.

- | | |
|------------|-----------|
| a. 90-100% | f. 40-49% |
| b. 80-89% | g. 30-39% |
| c. 70-79% | h. 20-29% |
| d. 60-69% | i. 10-19% |
| e. 50-59% | j. 0-9% |

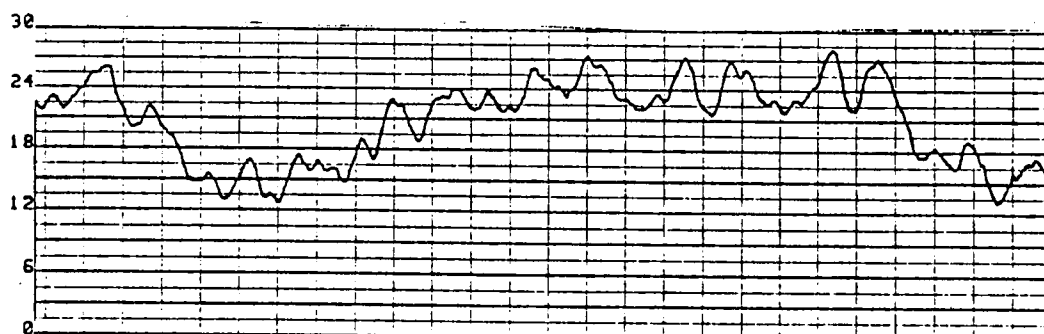
Comments:

10. Pulmonary Capillary Wedge Pressure waveforms should be interpreted by:

- a. Calculating Mean Pressure
- b. Pressure averaging over several respiratory cycles
- c. Reading the pressure at the highest point of the waveform
- d. Reading the pressure at end-expiration
- e. Reading the pressure at the lowest point on the waveform
- f. Digital Readout

11. Pulmonary Capillary Wedge Pressure waveforms which exhibit respiratory excursions should be interpreted by:
 - a. Calculating Mean Pressure
 - b. Pressure averaging over several respiratory cycles
 - c. Reading the pressure at the highest point of the waveform
 - d. Reading the pressure at end-expiration
 - e. Reading the pressure at the lowest point on the waveform
 - f. Digital Readout
12. Mechanical ventilation in the assist/control mode tends to:
 - a. Depress the PCWP waveform
 - b. Elevate the PCWP waveform
 - c. Have no effect on the PCWP waveform
13. Spontaneous breathing tends to:
 - a. Depress the PCWP waveform
 - b. Elevate the PCWP waveform
 - c. Have no effect on the PCWP waveform

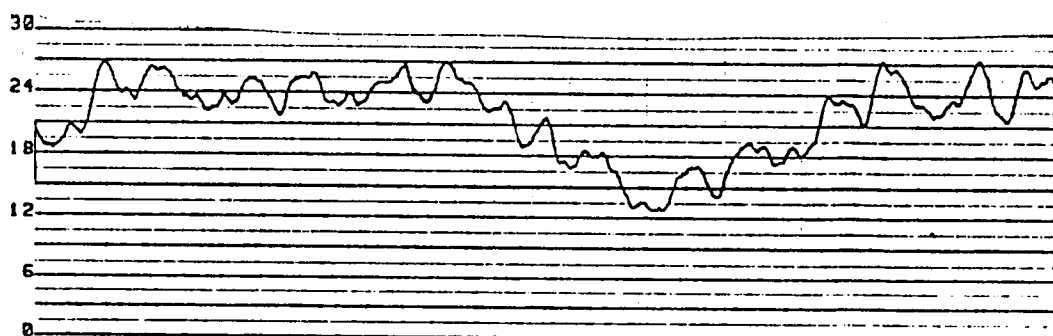
14. The following is a graphic recording of a spontaneously breathing patient's PCWP waveform:



The pressure closest to the appropriate point of interpretation is:

- a. 13 mmHg
- b. 18 mmHg
- c. 25 mmHg

15. The following is a graphic recording of a mechanically ventilated patient's PCWP waveform:



The ventilation is in the assist/control mode.
The pressure closest to the appropriate point of interpretation is:

- a. 13 mmHg
- b. 18 mmHg
- c. 25 mmHg

16. A PCWP waveform with respiratory excursions of a mechanically ventilated patient should be interpreted:
 - a. Towards the upper (more positive) portion of the waveform
 - b. At the midpoint of the waveform
 - c. Towards the lower (more negative) portion of the waveform
17. A PCWP waveform with respiratory excursions of a spontaneously breathing patient should be interpreted:
 - a. Towards the upper (more positive) portion of the waveform
 - b. At the midpoint of the waveform
 - c. Towards the lower (more negative) portion of the waveform
18. The most accurate method of determining a PCWP with respiratory excursions should be:
 - a. Automated digital recording
 - b. Manual interpretation

APPENDIX B

INDEPENDENT EDUCATIONAL REVIEW

**GUIDELINES FOR INTERPRETING PCWP VALUES
WITH RESPIRATORY EXCURSIONS**

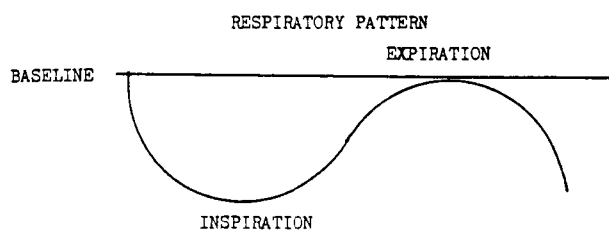
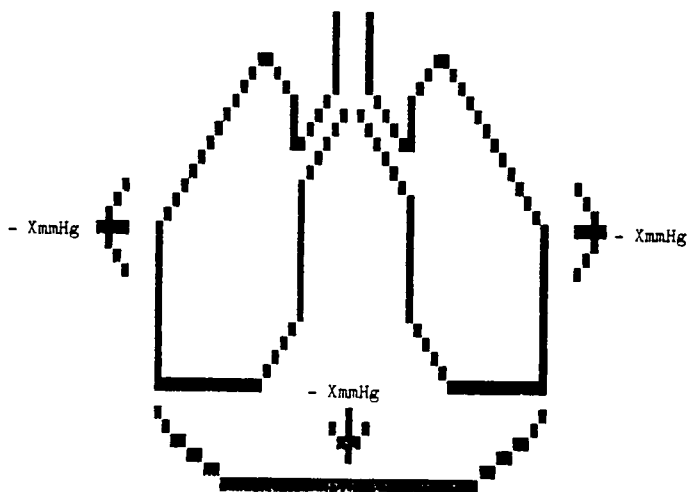
Guidelines for Interpreting PCWP values with Respiratory Excursions

The pulmonary capillary wedge pressure (PCWP) value provides important data to guide therapeutic interventions regarding volume status. Critical care nurses assume responsibility for properly interpreting PCWP waveforms. This procedure becomes more complex when the waveform exhibits respiratory excursions.

When respiratory excursions are present, the pressure must be interpreted at end-expiration. To properly interpret the PCWP value in this situation, the nurse must have knowledge of the differences in the respiratory pattern for both spontaneously breathing and mechanically ventilated patients.

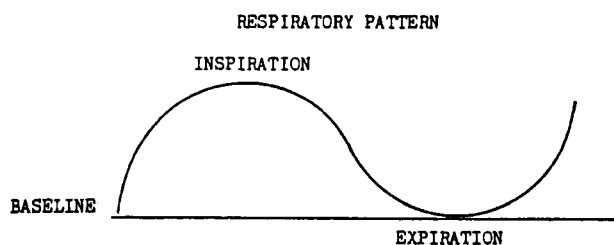
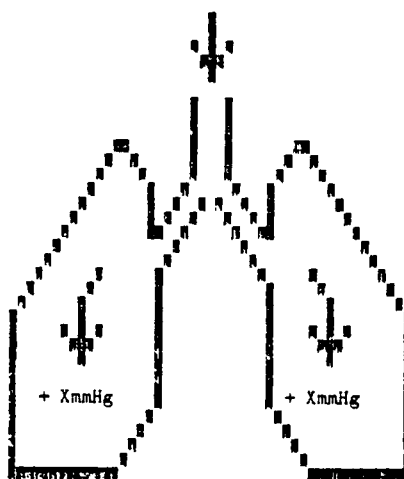
Respiratory excursions appear on the PCWP waveform as a result of changes in intrathoracic pressure during inspiration and expiration. When a person breathes spontaneously, inspiration results from contraction of the diaphragm and other muscles of inspiration causing expansion of the rib cage which creates negative intrathoracic pressure compared to atmospheric pressure and air flows into the lungs. During expiration, intrathoracic pressures rises and air moves out of the lungs.

SPONTANEOUS RESPIRATION



In contrast, when a person receives mechanical ventilation, inspiration results from positive pressure driving air into the lungs and increasing intrathoracic pressure. During expiration in this situation, intrathoracic pressure falls as air moves out of the lungs.

MECHANICAL VENTILATION



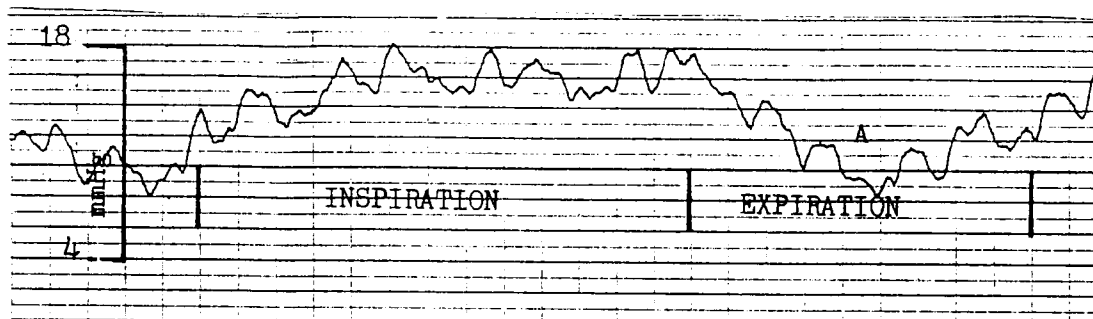
To Summarize:

Based on this physiology, when a patient breathes spontaneously, the lower portion of the waveform represents inspiration and the upper portion represents expiration. Therefore, the PCWP value must be interpreted on the upper portion or erroneous low pressures will be recorded. However, if the patient is receiving mechanical ventilation, the upper portion of the waveform represents inspiration and the lower portion represents expiration. Thus, the PCWP value must be interpreted on the lower portion or erroneous high pressure will be recorded.

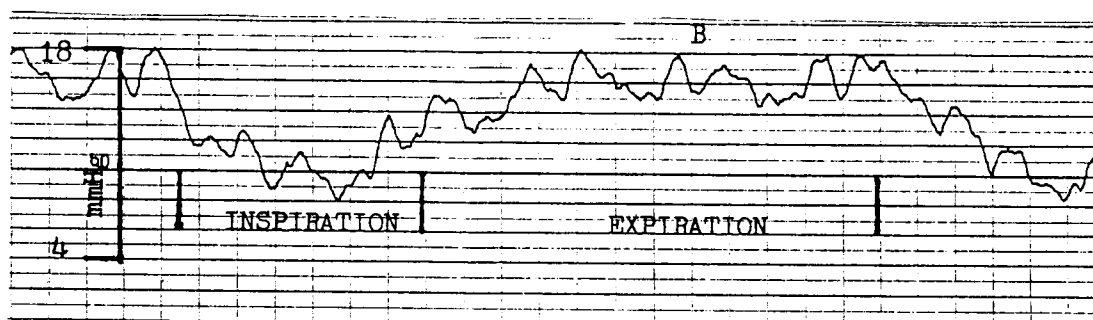
Some nurses benefit from the use of a catch phrase to remember the proper point of interpretation. One that has been used states:

"When on the ventilator health is down, so read PCWP at the bottom; when breathing unassisted, health is up, so read PCWP at the top."

Examine the waveforms below noting the proper interpretation points for the spontaneously breathing and the mechanically ventilated patient.



Mechanically ventilated patient. Read PCWP at point A



Spontaneously breathing patient. Read PCWP at point B.

APPENDIX C

INDEPENDENT EDUCATIONAL REVIEW EVALUATION

Please respond to the following questions regarding "Guidelines for Interpretation of PCWP Values with Respiratory Excursions" by circling the most appropriate number on the scale to the right of the question.

- | | Very
Helpful | | | | | Not
Helpful |
|--|-----------------|---|---|---|---|----------------|
| | | | | | | |
| 1. Did the written explanation and instructions improve your understanding of PCWP value interpretation? | 6 | 5 | 4 | 3 | 2 | 1 |
| 2. Did the waveform examples demonstrating appropriate points for interpreting PCWP values improve your understanding? | 6 | 5 | 4 | 3 | 2 | 1 |
| 3. Did the illustration describing differences in inspiratory pressures for spontaneously breathing patients compared to those mechanically ventilated improve your understanding? | 6 | 5 | 4 | 3 | 2 | 1 |
| 4. Did the catch phrase assist in recalling the appropriate PCWP value interpretation point. | 6 | 5 | 4 | 3 | 2 | 1 |

APPENDIX D
CONSENT FORM

CONSENT FORM

I consent to participate in the PCWP value interpretation study assessing the ability of critical care nurses to interpret pulmonary capillary wedge pressure values with respiratory excursions.

I understand that my participation in this study is strictly voluntary and that I have the right to withdraw at any time without any penalties.

Date: _____

Signature: _____

APPENDIX E

**PCWP VALUE INTERPRETATION QUESTIONNAIRE-
INFORMATION SHEET**

PCWP Value Interpretation Questionnaire

Dear Potential Participant:

I would like to inform you of a study I am conducting as part of my requirements for a Master's degree in Nursing at the University of Tennessee, Knoxville and request your assistance as a participant. The purpose of this study is to examine the ability of critical care nurses to interpret pulmonary capillary wedge pressure (PCWP) values when respiratory excursions are present. The results of the study should provide information to better prepare nurses to interpret PCWP values and improve patient care through selection of appropriate interventions based on PCWP values.

If you decide to volunteer for this study, your participation will involve the completion of a questionnaire. The questionnaire includes questions related to educational and employment experience and assessment of PCWP recordings. Total time of participation should not exceed 15 minutes. There is no risk involved with this study.

The questionnaires will be identified by a letter indicating participation category only, so that your name will not be used. All information will remain confidential. Results will be summarized and your name will not appear in any of the findings. Also, all information will be locked in a desk drawer at my home for a period of three years then destroyed.

Participation in this study is strictly voluntary. You have the right to withdraw from the study at any time without any penalties.

If you have questions about this study or your participation, please call or write me or my major professor at the address or telephone number provided below.

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Major Professor
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APPENDIX F

**PCWP VALUE REVIEW AND INTERPRETATION QUESTIONNAIRE-
INFORMATION SHEET**

PCWP Value Review & Interpretation Questionnaire

Dear Potential Participant:

I would like to inform you of a study I am conducting as part of my requirements for a Master's degree in Nursing at the University of Tennessee, Knoxville and request your assistance as a participant. The purpose of this study is to examine the ability of critical care nurses to interpret pulmonary capillary wedge pressure (PCWP) values when respiratory excursions are present and determine if review of an instructional information pamphlet improves performance. The results of the study should provide information to better prepare nurses to interpret PCWP values and improve patient care through selection of appropriate interventions based on PCWP values.

If you decide to volunteer for this study, your participation will involve the review of an educational pamphlet and the completion of a questionnaire. The questionnaire includes questions related to educational and employment experience and assessment of PCWP recordings. Total time of participation should not exceed 30 minutes. There is no risk involved with this study.

The questionnaires will be identified by a letter indicating participation category only, so that your name will not be used. All information will remain confidential. Results will be summarized and your name will not appear in any of the findings. Also, all information will be locked in a desk drawer at my home for a period of three years then destroyed.

Participation in this study is strictly voluntary. You have the right to withdraw from the study at any time without any penalties.

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VITA

James Lee Cathelyn was born in Elizabethton, Tennessee on November 13, 1955. He attended both primary and secondary schools in Elizabethton. In August 1977 he received a Bachelor of Science in Nursing from East Tennessee State University.

In August 1989 he entered The Graduate School of The University of Tennessee, Knoxville. A Master's degree in Nursing will be awarded in May, 1991. He is listed in the 1991 "Who's Who Among Students in American Colleges and Universities." He has worked in critical care nursing for the past 13 years and currently holds the position of Clinical Nurse Specialist for Adult Critical Care at Johnson City Medical Center Hospital.