Title
Performance in blood pressure determination

Author
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Publication Date
1979

Peer reviewed|Thesis/dissertation

PERFORMANCE IN BLOOD PRESSURE DETERMINATION: A STUDY OF NURSING KNOWLEDGE

by

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B.S., College of Mount St. Joseph, 1967

THESIS

Submitted in partial satisfaction of the requirements for the degree of

MASTER OF SCIENCE

in

Nursing

in the

GRADUATE DIVISION

of the

UNIVERSITY OF CALIFORNIA

San Francisco

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ABSTRACT

The general aim of the study was to determine if there was potential for improvement in nursing performance of blood pressure determination. Using a framework of performance analysis in which the critical requirement for blood pressure determination was identified as reliability, the study focused on nursing knowledge in blood pressure determination and two specific aims were derived:

Aim 1: to determine if variability exists among nurses in their knowledge of the procedure of blood pressure determination; and

Aim 2: to determine if nurse variability exists in the interpretation of the Korotkoff sounds for the purpose of blood pressure measurement.

Forty-one volunteer master's students in nursing were studied with two research tools developed and pretested by the investigator. Blood pressure readings made by these nurses were investigated by means of a Blood Pressure Sounds Tape which presented blood pressure sound sequences representative of patients with standard and nonstandard Korotkoff sounds. The Tape, constructed with seven patient-examples repeated once each, was played on the Blood Pressure Teacher, a machine that can present prerecorded blood pressure sounds, via earphones, synchronized with a pressure monitor dial. The nurses completed a twenty item Blood Pressure Procedure Knowledge Questionnaire and answered questions regarding their demographic characteristics and

questions relative to characteristics in blood pressure determination.

Within the limitations of the research design, the following characteristics of nurse performance in blood pressure determination were derived.

The large majority of nurses received their only education in blood pressure determination in their basic nursing program and, except for a very small minority of nurses, the standards of the American Heart Association for blood pressure determination were not identified as known or utilized. There was a lack of clarity and uniformity among and within nurses in their indicator of diastolic blood pressure. There was a wide variability among nurses in their knowledge of the procedure and, most importantly, there was potential for improvement in all aspects relative to knowledge of the procedure.

When an accuracy criterion of ± 5 mm Hg was applied, the following approximation of nurses were found to be inaccurate: one tenth of the nurses for the systolic readings, one half of the nurses for the diastolic Phase 4 readings, and one quarter of the nurses for the diastolic Phase 5 readings. In general, the systolic blood pressure readings were more reliable (according to both accuracy and stability) than were the diastolic blood pressure readings.

When the accuracy of the nurse blood pressure readings was examined according to the type of blood pressure sounds -- patient-examples with standard sounds as compared to patient-examples with nonstandard sounds -- the systolic standard sound readings were more accurate than the nonstandard sounds readings. The diastolic Phase 4 and the diastolic Phase 5 blood pressure readings were inaccurate, regardless of the patient-example blood pressure sound type.

When nurse knowledge of the procedure of blood pressure determination was compared to nurse accuracy in blood pressure reading, except for one patient-example no significant relationships were found. However, a trend in which nurses with greater knowledge of the procedure were more accurate than nurses with less knowledge was apparent.

There was no significant intranurse variability for the paired time 1 and time 2 blood pressure readings except for six blood pressure readings. In these cases generally only a small number of nurses contributed to the finding of nonsignificant correlation. Intranurse discrepancy in blood pressure reading was not related to the type of blood pressure sounds, i.e., patient-examples with standard sounds as compared to patient-examples with non-standard sounds.

When comparing intra to internurse variability in blood pressure reading, nurses were found to agree more within themselves than with each other for the large majority of the blood pressure readings. In addition, presence of intranurse consistency in blood pressure readings did not necessarily ensure accuracy among nurses in blood pressure reading.

From the qualitative data regarding the nurse perceptions of the study, general impressions were obtained. The study sensitized the nurses to issues in blood pressure determination and this sensitization led the nurses to question their knowledge base for the procedure. As a group, the nurses were not satisfied with their basic education in blood pressure determination and observed that the procedure was performed with undesirable variability among nurses.

It was concluded that nursing knowledge in blood pressure determination needed to be improved. It was proposed that this potential for improvement could best be actualized in teaching and practice by considering blood pressure determination as an active task in which patient and environmental factors may offer variable and unpredictable resistance towards achieving reliability in blood pressure determination. The implications of the findings were discussed along with possible strategies to attain exemplary nursing performance in blood pressure determination.

ACKNOWLEDGEMENTS

This study was made possible through the efforts of many, many people who are too numerous to mention individually. In particular, I am indebted to the late Abe Ravin, M. D., who provided the initial inspiration and encouragement for this work. In his wisdom he taught me that when people are "ignorant of their ignorance" there exists a major obstacle to improving human competence which must be overcome.

I am deeply grateful to my thesis Chairperson, Marlene Kramer, Phd., and my thesis committee members, Ruth Barstow, D. N. S., and Judy Pronovost, M. N., for their continuing guidance and support throughout this endeavor. I am thankful to authorities in the field who took the time and had the interest to respond to my queries: Dr. Jane Wilcox, Dr. Ronald Prineas, and Professor Geoffrey Rose. A special thanks goes to Del Ruhberg, Dr. James Beaumont, and to Rodney Smith for their patience and technical expertise in the development of the Blood Pressure Sounds Tape. Recognition is also extended to Narco Bio-Systems, Incorporated of Houston, Texas, for its cooperation and assistance.

A special thanks is extended to my fellow nurses without whose interest, enthusiasm, and participation, this study would not have been possible.

I would also like to express my appreciation to my manuscript consultant-typist Mary Gary for a difficult job well done; and to the staff and faculty of the University of

California, San Francisco, who assisted with the numerous arrangements necessary for the implementation of the study.

Finally, I express my gratitude to my husband, John, whose judgment and insight was equaled by his perseverance and dedication.

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CHAPTER I

OVERVIEW OF THE PROBLEM AND PERTINENT INVESTIGATIONS

Introduction

This chapter presents the background necessary to this study of nursing performance in blood pressure determination. General concepts regarding clinical observation are introduced. The technique of the auscultatory determination of blood pressure is described. The current recommendations for nursing practice of the procedure are presented. Finally, previous studies in observer variability in blood pressure determination and the issues and techniques surrounding standardization of observer performance for the procedure are discussed. The chapter concludes with a discussion of the importance of the problem and the implications of reliable nursing performance in blood pressure determination.

Clinical Observation

Variability of the Observer

The clinician is a unique and powerful scientific instrument because diagnoses, prognoses, and treatment evaluations are all partially based on clinical observations. However, clinical observations are subject to some degree of variability. While observer variability can be diminished, it probably can never be absolutely eliminated (Kilpatrick, 1963). As such, observer variability is a source of concern when precise and reproducible data are necessary in patient care.

Complacent attitudes regarding the frailities of clinical observations are detrimental to patient care and progress in clinical science. Observer variability can be diminished if the clinician is willing to acknowledge himself as an instrument most likely in need of improvement. This improvement in clinical observation is accomplished by attending to the factors that affect objectivity, precision, consistency, uniformity, and reliability on the part of those obtaining the data (Feinstein, 1964).

Criteria for Satisfactory Clinical Observation

The criteria for judging the acceptability of a procedure for use in patient diagnosis include simplicity, reproducibility, sensitivity of discrimination, and validity (Kilpatrick, 1963). The auscultatory determination of blood pressure has withstood the test of time in terms of its simplicity, sensitivity, and validity (Geddes, 1970). It is, however, most susceptible to problems in reproducibility because it may not be performed in a consistent fashion among nurses and by each nurse from observation to observation. As such, this procedure is subject to discrepancies in performance and may not meet the criteria for a satisfactory clinical observation. Because an understanding of blood pressure determination is essential to further conceptualization of the sources of variability in the performance of the procedure, the technique is now discussed.

The Procedure for Blood Pressure Determination

The Technique

The auscultatory technique of indirect blood pressure determination is universally adopted in clinical medicine (Geddes, p. 109, 1970; DHEW Pub. No. (NIH) 76-929). In this procedure, an air bladder enclosed in a cuff, applied to the upper arm, is inflated to a pressure greater than the systolic pressure. As the pressure in the air bladder is slowly released, a stethoscope placed over the distal artery detects a definite sequence of sounds known as the Korotkoff sounds (after N.S Korotkoff who first proposed the auscultatory technique) which are characteristic in nature. Five phases in this blood pressure sounds sequence have been defined:

Phase 1: The period marked by the first appearance of faint, clear tapping sounds which gradually increase in intensity.

Phase 2: The period during which a murmur or swishing quality is heard.

Phase 3: The period during which sounds are crisper and increase in intensity.

Phase 4: The period marked by the distinct, abrupt muffling of sound so that a soft, blowing quality is heard.

Phase 5: The point at which sounds disappear.

(Kirkendall, Burton, Epstein, and Freis, p. 13, 1967)

(In this study, blood pressure sound sequences which correspond to this description are referred to as the standard Korotkoff sounds or standard sounds. The blood pressure sound sequences which do not correspond to this description are referred to as nonstandard Korotkoff sounds or nonstandard sounds. The difference may be in any phase or in all phases but the general term nonstandard sounds is used.)

While there is no exact agreement as to the origin of the Korotkoff sounds, a description of their likely generation is useful to further understand the procedure. When the pressure in the occluding cuff is greater than systolic pressure, there is no flow in the artery below the cuff and no sound. As the pressure in the cuff is decreased, there is a period when the blood can spurt through the artery beneath the cuff. As the wall of the collapsed vessel is suddenly distended, clear tapping sounds are heard (Phase 1). Phase 1 corresponds with systolic blood pressure.

As the pressure in the cuff is further reduced, the tapping sound is followed by a murmur (Phase 2). The murmur is probably produced by turbulent blood flow from the narrowed artery beneath the cuff into the wider artery distal to the cuff and is created by eddies which cause the blood and vessel wall to vibrate.

As the pressure in the cuff is decreased further, the artery closes only for brief periods during diastole. Then high pitched sounds are created as the artery opens during the pulse wave (Phase 3). When the cuff pressure falls below intraluminal diastolic pressure, the tap becomes low pitched and muffled (Phase 4). Phase 4 is clinically important because it represents the theoretical diastolic pressure. When the blood vessel is no longer compressed and laminar flow is reestablished, no sound is heard (Phase 5).

In the auscultatory measurement of blood pressure a sound-pressure relationship is determined (Ravin, 1972, 1976). The sounds are perceived by auscultation and the corresponding pressure level on the manometer is recorded. By this technique a qualitative judgement (presence of tapping - Phase 1, muffling - Phase 4, and absence of sound - Phase 5) is made and transformed into a quantitative interpretation of the patient's blood pressure. The systolic pressure is recorded at the point at which the initial tapping sound is heard for at least two consecutive beats (Phase 1). The American Heart Association (Kirkendall et al., 1967) recommends the use of the onset of muffling, Phase 4, as the indicator of diastolic blood pressure and to record Phase 5 to complete the record. The Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure recommends the use of Phase 5 as the indicator of diastolic blood pressure (DHEW Pub. No. (NIH) 77-1088.)

Accurate interpretation of the blood pressure sound phases is essential to the measurement of blood pressure in the auscultatory technique. Strict adherence to the procedure is necessary as errors may affect the quality of the sounds and, therefore, the interpretation of the blood pressure reading.

Nursing Practice in Blood Pressure Determination

In 1930, nursing expectations for nursing performance in blood pressure determination were stated in the American Journal of Nursing:

> in accepting this responsibility the nursing profession presupposes for its component members a working knowledge of hemodynamics . . . In this particular field a nurse's intelligent cooperation is no less applicable than in the study of the pulse or the respiration (Middleton,

Early in this century then, nurses realized the importance of knowing the procedure so as to be credible utilizers of the procedure. For the next four decades, in contrast to the frequency with which nurses in practice measured blood pressure and taught and supervised others in this procedure, there were few published articles on blood pressure determination in the nursing literature. One interesting exception was an excellent programmed instruction which emphasized that, since errors in technique might result in significant erroneous readings, it was the role of the nurse to eliminate faults in technique (Glor, 1967).

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In this decade, with the upsurge of interest in hypertension, articles have appeared describing the techniques and principles of accurate measurement (Jarvis, 1976; Lancour, 1976; Steinfield, Alexander & Cohen, 1974). Presently, in its Guidelines for Educating Nurses in High Blood Pressure Control (p. 1219, 1976) the Task Force on the Role of Nursing in High Blood Pressure Control recommends adherence to the standards of the American Heart Association for blood pressure determination. Thus nursing has taken a position of nursing responsibility for knowledge of and adherence to the standards of the procedure for blood pressure determination.

Review of the Literature

The literature concerning the variability of blood pressure is vast and for the purposes of this study the discussion will focus on those studies dealing with the variability contributed by the observer. These studies will be grouped according to their similarity in approach. Additionally, that literature, which is not strictly research but deals with the issues of the importance of and standardization of observer technique in blood pressure measurement will be reviewed.

Observer Variability in Blood Pressure Determination

The first group of studies are those in which observers recorded the blood pressures of very large populations for epidemiological surveys (Eilersten & Humerfelt, 1968; Lowe & McKeown, 1963). While the chief purpose of the surveys was to obtain information regarding the population distribution of blood pressure levels, the variability of observers in blood pressure determination was also studied. To determine observer variability, the patients in the surveyed populations were categorized according to age and sex and the results of observer readings were compared within the categories. The assumption was that if inter-observer reliability was high, the blood pressure readings within given age and sex categories would be similar.

In the Lowe and McKeown study (12 physician observers; 5,239 male subjects) consistent and substantial differences among readings (approximately 15 mm Hg) by different doctors were found. Eilersten and Humerfelt found substantial differences among some observers (19 specially trained nurses; 70,000 male and female subjects) whose readings varied widely from the mean values for age and sex groups, while the majority of nurses showed insignificant variation from the mean. The variability could not be related to the sex or age of the subjects, the fatigue level of the observers, or to the height of the blood pressure.

Both studies concluded that observer variation in blood pressure readings may be substantial and affect the mean values found in population surveys (Eilersten) and that any irregularity in a distribution of blood pressure readings needs to be interpreted with caution (Lowe). While the differences in the blood pressure readings may have been due to the variability of the observer, the factor of "true" differences contributed by the patients was an alternative explanation. However, the large number of patients examined and the categorization of patients reduced this latter possibility.

In the Eilersten study the nurses were carefully screened, trained, and periodically rechecked so knowledge and compliance did not seem to be a factor affecting variability. In the Lowe and McKeown study, the physicians were instructed as to the diastolic criterion to use but, as standardization of other procedure factors was not mentioned, it is difficult to say if all physicians were measuring blood pressure in the same manner. These studies then, left unaswered the problem of the source of performance discrepancies in blood pressure determination.

In a second group of studies, observers determined the blood pressure readings of the same patients though not simultaneously (Anderson & Cowan, 1961; Comstock, 1957; Glor, 1967, 1970; Richardson & Robinson, 1971). The methodologies differed widely and each study is briefly described. In the Richardson and Robinson study, the blood pressure of each of 372 middle-age men was taken by one of 10 nurses and then, after a variable waiting period, by one of 15 doctors. The nurses' blood pressure readings were less variable and systematically lower than those of the physicians. In both groups there was less variation in the measurement of systolic pressure as compared to diastolic pressure. The systematic differences between the nurse and doctor readings were attributed to factors affecting the patient's blood pressure (e.g. differing room temperatures). Variability in measurement technique, however, could not be eliminated as a factor.

In the Comstock study, four nurses each recorded blood pressures on the same patients. The mean difference of the nurses from the group mean ranged from -3.4 mm Hg to +1.8 mm Hg for systolic pressure and -2.3 mm Hg to +1.8 mm Hg for diastolic pressure (Phase not specified). Comstock did not mention standardization of nurses in their technique but did conclude they were accurate for survey purposes.

In the Anderson and Cowan study, two observers measured the blood pressure of 510 men and women. Observer variability was greater for the systolic readings as compared to the diastolic readings. Anderson and Cowan note standardization for the diastolic reading but do not mention other aspects of the procedure. They concluded that systolic pressure is read with greater variability than is diastolic pressure.

Glor's research (1967, 1970) differed in its strict control of all aspects of the procedure (mechanical control of cuff inflation and deflation, placing of cuff and stethoscope by one technician, use of health volunteers under rest conditions, vision and hearing testing of observers, adjusting of manometer to individual eye level, checking of manometer, use of quiet room) which the previous investigators either chose to let operate as variables, or did not clearly mention as controlled in their reports. Utilizing such control, Glor found no statistically significant differences among observers in either systolic or diastolic blood pressure readings. While the methods used by Glor to control variables limited generalizability to the clinical setting, the study did raise the question: "is observer error to a large degree only an excuse for nonstandardization of the procedure?" (Glor, p. 67, 1967). According to Glor, control of variables was the most significant factor in reducing observer variability in blood pressure determination.

In a third group of studies, observers obtained blood pressure readings on the same individual at the same time but from different arms (Kilgore, 1915; Shock and Ogden, 1939). Shock and Ogden analyzed 16,230 blood pressure measurements made on 130 healthy male subjects by three observers. They found that when the effects of temporal differences and differences between the two arms were eliminated, systematic differences between the observers were insignificant. Under the controlled conditions of their study they concluded that the probable error of measurement of a single blood pressure observation was 1.2 mm Hg to 1.8 mm Hg for systolic pressures and 1.8 mm Hg to 2.0 mm Hg for diastolic (Phase 4) readings.

In Kilgore's study two physician observers each recorded two blood pressures on each arm in 61 young men. The range of differences was from +15 mm Hg to -15 mm Hg for systolic readings and from +15 mm Hg to -10 mm Hg for diastolic readings. The differences were attributed to observer differences and to actual differences in the blood pressure in the two arms and/or differences in the size and position of the artery and/or the adjustment of the cuff and stethoscopes.

For both the studies, the limitations of the special circumstances of conditions, subjects, and observers prevent the generalizability of the results to the clinical setting.

In the fourth group of studies, the investigators studied observer variability when observers determined the blood pressure of the same patient simultaneously. These studies will be subdivided into those involving actual patients (Gunn, Sullivan, & Glor, 1966; Kilgore, 1915; Wilcox, 1961, Wright, 1938) and those utilizing prerecorded blood pressure sounds (Wilcox, 1961).

The use of prerecorded blood pressure sounds facilitated studying observer variability without inconveniencing patients. Wilcox (1961) studied 349 nurses observing 14 blood pressure sound sequences presented by sound motion picture. The diastolic criterion to be used was not specified and it was found that 33% of the nurses used Phase 4, while 57% used Phase 5. Ten percent used both phases or either phase as appropriate to each subject (the patient's prerecorded BP). Wilcox found that:

> (1) the variability among the readings differ considerably from subject to subject; (2) the variability among

> readings for any subject is less for systolic than for diastolic; (3) readers do not always sharply distinguish between Phase 4 and Phase 5 diastolic; (4) the distributions of the readings by subject are not entirely normal, the systolic distributions being generally more nearly normal than the diastolic; (5) of the total variability for any subject, the majority arises from a very few readings (Wilcox, p. 11, 1961).

The variability in the readings could not be attributed to the observer's age, work position and setting, recency of experience and frequency of blood pressure measurements, or visual or hearing defects. It was determined that the variability was subject (patient's prerecorded BP) related. The measurements of the subjects with standard blood pressure sounds gave an estimate of little variability among observers. In identifying the problem as nurse variability in the interpretation of the blood pressure sounds, Wilcox concluded that until nurses became more skillful, they would continue to interpret blood pressure sounds with mediocre results.

In the studies involving simultaneous readings on actual patients, the degree of variability found by different investigators was similar (Kilgore, 1915; Wilcox, 1961, Wright, Schneider & Ungerleider, 1938) except for one investigator, Gunn et al. (1966). For those investigators with similar findings it was noted that the majority of the differences among readers were 10 mm Hg or less; that there were a small number of very large differences; and that the systolic differences were generally smaller than the diastolic differences (Kilgore, 1915; Wilcox, 1961; Wright et al., 1938). The variability found was attributed to personal defferences between the observers in the identification of the systolic and diastolic sounds. Kolgore specified to the observers the diastolic criterion to be used while Wright and Wilcox dis not. Wilcox noted that homogeneity among observers with regard to the diastolic criterion was not accompanied by lower reader variance. Both Wilcox and Kilgore noted that interpretation of the Korotkoff phases in some patients was more difficult than in others and this was associated with increased variability in blood pressure measurement. This conclusion was supported by Gunn, who in a study of patients with standard blood pressure sounds, could find no observer differences in blood pressure readings (1966). Gunn further concluded that the observer agreement found resulted from the strict control and standardization of the procedure and questioned the acceptance of observer error as a necessary component of the blood pressure measurement.

In this fourth group of studies, the chief variables operating were perception of and interpretation of the blood pressure sounds. In the clinical setting, additional sources of variability might well be operating in a manner that can best be termed "variably variable". Therefore, findings of studies in which procedural and environmental variables were controlled to greater and lesser extents would be difficult to generalize to the clinical setting. None of the studies were predictive of all of the effects of all of the possible combinations of variables associated with blood pressure determination on the clinical setting. What would be the reliability of blood pressure readings in the clinical setting?

Mitchell and Van Meter studied the variables in the clinical setting in a project that investigated the extent to which the blood pressures recorded on patient's charts were reproducible (1971). The investigators used the standards recommended by the American Heart Association and found that there were mean differences of 7 mm Hg or less of Phases 1, 4, and 5. The systolic readings showed a difference of ±15 mm Hg for 24% of the patients, the diastolic Phase 4 readings showed a difference of ±15 mm Hg for 27% of the patients, and the diastolic Phase 5 readings showed a difference of ±15 mm Hg for 21% of the patients.

The authors concluded that the lack of standardization among nursing personnel was the major contributor of variability in blood pressure measurement. While sources of variability were not systematically studied, the authors observed such factors as improper eye level of the manometer, improper arm positioning, less than optimum equipment, observer bias, failure to consider the patient adequately, errors in cuff deflation rates, and increased speed of the procedure with less attention to details as probable sources of discrepancies. This study raises the question: Were the observed discrepancies a function of skill deficiency (lack of knowledge) or were there factors present in the clinical setting which interfered with the proper execution of the skill?

Standardization of Observer Performance: Issues and Techniques

While researchers have been puzzling over the sources of variability in blood pressure determination, controlling first one variable, then another, one clinician in particular has been forthright about his perception of the problem:

> Physicians would be shocked if they could see how the sphygomanometer is abused in most hospitals. Every conceivable error is made in technique . . . very few nurses or aides have ever learned under the control of the double stethoscope to be certain that their measurements were correct. Most do not know whether they measure the diastolic pressure by muffling of the sound or disappearance . . . In short, in most institutions the recorded blood pressure may be and usually is grossly misleading! (Page, p. 73, 1968)

Echoing similar thoughts, King noted that the potential errors of blood pressure measurement are inadequately recognized while clinicians are overconfident in the sphygmomanometer as an objective "machine measurement" (King, 1969). The various sources of error have been extensively discussed (Glor, 1967, 1970; Jarvis, 1976; King, 1969; Mitchell & Van Meter, 1971; Ravin, 1972, 1976; Steinfield et al, 1974; Thulin et al, 1975; DHEW Pub. No. (NIH) 76-929) in the medical and nursing literature. The need for standardization has been studied (Mitchell & VanMeter, 1971; Wright, 1938) and continues to be emphasized as a means of reducing variability (Burch and dePasquale, 1962; Glor, 1967, 1970; King, 1969; Page, 1968; Ravin, 1972, 1976; Rose, 1964, 1965; Wilcox, 1961).

To standardize observers in blood pressure sound pattern recognition, Rose utilized tape-recording of Korotkoff sounds. By presenting each observer with the same Korotkoff sounds, he was able to identify those observers with systematic differences as well as the individual "patient" about whom observer disagreement frequently arose. In common with others, he identified Phase 4 diastolic measurement as a cause of difficulty (Burch & dePasquale, 1962; King, 1969; Thulin, 1975; Wilcox, 1961). This use of training tape is a "sina qua non" in observer education for some investigators (Eilersten & Humerfelt, 1968; Labarthe, 1976; Rose, 1965). Epidemiological researchers state that the shortcomings of the indirect method of blood pressure measurement can be controlled solely or in part by careful attention to the conditions of measurement, the apparatus itself, and the proper training of observers (Labarthe, 1976). Burch and dePasquale simply summarize the necessary strategy: "proper habits, proper equipment, and proper techniques" (p. 121, 1962).

This need for proper training of observers to increase measurement reliability led to a unique approach by one investigator. Koran (1978) used a blood pressure sounds film developed by Wilcox to teach medical students about the ubiquity of observer variation. Specifying the diastolic criterion to be used, he found greater variation for systolic than for diastolic readings. He noted that when the students were shown the data they had generated, they were reluctant to accept the unreliability of their blood pressure readings. He concluded that students need to be sensitized to issues of observer variation. This finding supports Feinstein's statement that the chief means to improve clinical observation is for the observer to recognize the necessity for self-improvement (1964).

Implications and Importance of the Problem

What can be made of the maze of literature on variability in blood pressure determination, especially in view of the multiple approaches various investigators have taken? It seemed most useful to approach the problem pragmatically. First of all, could the auscultatory measurement of blood pressure be a reliable procedure? Could it meet the criterion of reproducibility? The answer to these questions is a qualified yes. The most significant research done to answer the questions was that of a nurse researcher who concluded:

> indirect blood pressure measurements have the capability of being taken and reproduced by different observers to a degree of accuracy which is acceptable in the research setting when the procedure is sufficiently controlled and standardized (Glor, p. 65, 1967)

A critical point here is the use of the term "capability". Blood pressure readings in the research setting have the capability of being reproducible. Would they have this capability in the clinical setting? What would become of reproducibility when the control and standardization obtained in the research might no longer be operative? Could blood pressure determination in the clinical setting have the same reliability as that done in the research setting?

All of the evidence accumulated would seem to indicate that observer knowledge of and compliance with the standardized technique for blood pressure determination was a means of controlling variability in blood pressure measurement. What is the current state of the art regarding nursing and blood pressure determination? Are nurses knowledgeable regarding the factors that affect variability in blood pressure determination? Is, as before, observer variability a euphemism for less than optimum performance? If discrepancies in performance are still operating to decrease the reliability of this clinical observation, nursing should be concerned. Modifications in instruction and in the clinical setting might be needed to achieve optimal performance.

Reliable measurements are desirable but are they important to patient care? Gunn, reflecting upon the amount of effort required to control the variables to obtain reliability in the research setting, asked: "Is the additional effort of standardizing the method and procedure of blood pressure measurement to obtain repeatable measurements, justified in the clinical setting?" (p. 10, 1966). Burch and dePasquale noted that it was just as easy to determine blood pressure accurately and reliably as it would be to obtain it haphazardly and erroneously and stated emphatically: "No data is better than wrong data! (p. 121, 1962). Ravin noted that "diagnoses are made, life insurance given or refused, prognoses made, patients treated, and treatment evaluated" on the basis of blood pressure determination (p. 34, 1972). He stated that "one would think that if a procedure were that important, it would be done uniformly well by only those who know the proper technique and the limitations of the procedure" (p. 34, 1972). Page succinctly summarized the argument for efforts to improve reliability in blood pressure measurement: "Errors in blood pressure measurements are too important to the future of patients to be taken as casually as they now are . . . Far better no measurement at all than an inaccurate one" (p. 74, 1968).

The patient as a consumer has every right to the most accurate blood pressure reading possible and nursing has the responsibility to ensure the patient reliable blood pressure readings. In addition to accurate data, however, there are two more benefits to be gained from examining nursing performance in blood pressure determination. First of all, when the methods of clinical observation at the bedside are standardized, the art and science of clinical observation is advanced. Secondly, when nursing ensures that this procedure is taught and practiced uniformly well, it establishes nurses as credible observers. How this study explored nursing performance in blood pressure determination is addressed in the next chapter.

Summary

The concept of observer variability as a factor affecting the criteria for a satisfactory clinical observation was presented. The technique of the auscultatory determination of blood pressure was presented and the literature regarding the nursing practice recommendations for this procedure was discussed. Previous research in the variability of observers in blood pressure determination was reviewed as well as the techniques and issues surrounding standardization of observer performance for the procedure. The chapter concluded with a statement of the importance of the problem and the implications of reliable nursing performance in blood pressure determination.

CHAPTER 2

THE SUPPORTING FRAMEWORK AND AIMS OF THE RESEARCH

Introduction

This chapter presents the framework which has guided the development and execution of the study. Central in the framework is performance: its components and its analysis. A behavior engineering model is described and used to demonstrate how nursing performance in blood pressure determination was analyzed in this study. Reliability is identified as the critical requirement in blood pressure determination. Then, theory of reliability is discussed with emphases on the factors affecting reliability in clinical observation as applied to blood pressure determination. The chapter concludes with the aims of the study.

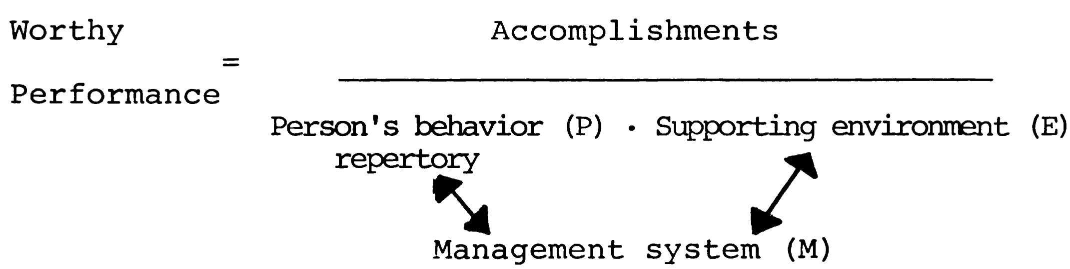
Performance: Components and Analysis

The Behavior Engineering Model

A behavior engineering model was used to order the observation of behavior towards the end of improving competence. Gilbert, the developer of the model used in this study, states:

> For any given accomplishment, a deficiency in performance always has as its immediate cause a deficiency in a behavior repertory (P) or in the environment that supports the repertory (E), or in both. But its ultimate cause will be found in a deficiency of the management system (M). (Gilbert, p. 76, 1978)

The relationships among the constructs of the model, the person's behavior repertory (P), the supporting environment (E), and the management system (M) are diagrammed as:



(Gilbert, p. 89, 1978)

Components of Performance

According to this model, worthy performance is a function of, (1) the accomplishment - the product, the effects on the world accomplished by the task, and (2) the components of the person's repertoire and the environment that go into accomplishing the task. Worthy performance is exemplary performance, the most sustained performance that can be reasonably expected in terms of a particular accomplishment; it is performance in which the value of the accomplishment exceeds the cost of the behavior.

Competent people are exemplars, those who create valuable accomplishment without using excessively costly behaviors. As human competence is "a function of the ratio of valuable accomplishment to costly behavior", the way to achieve competence is to increase the value of the accomplishment while reducing the cost of the effort (Gilbert, p. 18, 1978).

The components that go into accomplishing a task - the person's repertoire of behavior and the supporting environment - are of equal importance and together form a transaction known as behavior. These components each have three aspects:

Aspects of the person's repertoire of behavior:

1. Knowledge -- the training designed to match the requirements needed for exemplary performance

2. Capacity -- the ability to perform as well as the exemplar

3. Motives -- the willingness to perform for the available incentives

<u>Aspects of the supporting environment:</u>

1. Data -- guidelines to both how one should perform and feedback regarding performance

2. Instruments -- the tools needed for the task - designed to match the human factors

3. Incentives -- may be of various types, the presence of which are contingent upon worthy performance.

In the behavioral engineering model, whatever the cause of poor performance, its ultimate cause is traceable to a deficiency in the management system. The management system components instrumental in maintaining performance are setting standards and evaluating performance, organizing for optimal performance, and ensuring resources for improving performance.

As no person or environment is likely to be perfectly designed for the accomplishments expected. improvement in some of the behavior components is often possible. The question of what to improve is a problem in assessing leverage. The overall management strategy is to identify those deficiencies in behavior which are most accessible to improvement. However, because of the unitary nature of behavior, whenever one condition is changed, most often this will have a significant effect on the other components and this is known as the diffusion of the effects (Gilbert, 1978).

Components of Performance in Blood Pressure Determination

The components of the behavior engineering model were used as a framework to categorize the myriad factors associated with blood pressure measurement in the clinical setting (see Table 1 for details of categorization). In general, the categorization was developed as follows:

I. Observer Components (Nurse's repertoire of behavior)

A. Knowledge of the Standards for the Procedure

Eleven factors comprising the core knowledge necessary for reliable blood pressure measurements were listed.

B. Capacity of the Observer

The physiological, educational-experiential, and social-psychological factors that might affect nurse capacity in blood pressure determination were listed.

C. Motivation of the Observer

Role conception and task conception were identified as possibly affecting motivation; indicators of these affectors in blood pressure measurement have not been developed.

II. Environmental Components (The Supporting Environment)

A. Data

The factors of standards for performance and feedback regarding performance.

(categorization continued next page)

B. Instruments

The equipment of the procedure, including setting as an extension of the equipment.

C. Incentives

The rewards, contingent upon performance, which were professional, personal, and/or financial.

Analyzing Performance

To analyze performance according to the behavior engineering model a performance model is utilized which has the following steps: (1) Identify accomplishments; (2) Identify requirements; (3) Identify exemplary performance; (4) Measure exemplary performance; (5) Measure typical performance; (6) Determine the potential for performance improvement; and (7) Calculate the impact of improved performance. These steps of the performance audit were applied to analyze nursing performance in blood pressure determination.

Analyzing Nursing Performance in Blood Pressure Determination

The audit steps are identified in the order they were done for the study.

Table 1

Components of Performance in Blood Pressure Determination

I. Observer Components (Nurse Repertoire of Behavior)

A. Knowledge of the Standards for the Procedure

1. Means of preparation of the patient -- physical and psychological
2. Positioning of the extremity
3. Use of cuff: choice of size, method of application
4. Position of manometer
5. Position of observer, in relation to patient and instruments
6. Cuff inflation and deflation rates
7. Use of stethoscope: placement of bell/diaphragm, positioning of earpieces
8. Palpation of systolic prior to auscultation
9. Criteria for the interpretation of the Korotkoff sounds
10. Convention for recording findings
11. Procedures to decrease observer bias

B. Capacity of the Observer

1. Physiological

a. acuity of hearing
b. acuity of vision
c. reaction time
d. general health status
e. fatigue

2. Educational-Experiential

a. general professional education, particularly in blood pressure determination
b. kinds and amounts of nursing experience
c. recency and frequency in blood pressure determination

3. Social-psychological

a. age
b. sex

C. Motivation of the Observer

1. Task conception
2. Role conception

(Table 1 continued next page)

Table 1 (cont.)

II. Environmental Components (Supporting Environment)

A. Data

1. Expected performance described
2. Feedback regarding performance

B. Instruments

1. Physical condition, quality, availability of equipment
2. Calibration of manometer
3. Setting in which equipment used

C. Incentives

1. Accomplishments were identified. Accomplishment in blood pressure determination was defined as error free blood pressure readings. The review of the literature suggested that a performance discrepancy had existed among nurses for this procedure and so it was decided that this would be a fruitful area for further investigation.

2. Requirements were identified. Requirements for blood pressure determination were identified as simplicity, sensitivity, validity, and reliability (refer to Chapter 1 for discussion). Reliability was the chief requirement threatened by nursing discrepancies in performance. This concept of reliability in clinical observation is developed in detail in the next section of this chapter.

3. Exemplary performance was identified. This was defined as nurses meeting the behavioral objectives of the task force on the Role of Nursing in High Blood Pressure Control, (DHEW Pub. No. (NIH) 76-1052, 1976) so as to meet the requirement of reliable blood pressure measurement (see Table 2 for complete listing of these objectives).

Succeeding steps in the performance audit formed the basis for this study. First it was necessary to determine if a discrepancy existed between the nursing standards for the procedure (exemplary performance) and present nursing performance of the procedure (typical performance).

Table 2

Behavioral Objectives for Nurses in Blood Pressure Determination

Performance skills

I. Measures blood pressure accurately in a manner consistent with scientific principles

- A. Provides a quiet environment.
- B. Positions patient and equipment properly.
- C. Utilizes correct technique.
- D. Palpates pulse prior to auscultating.
- E. Takes blood pressure in more than one extremity and/or position when indicated.
- F. Communicates orally and in writing significant information to other health team members.
- G. Records diastolic findings according to recommendations of American Heart Association.

Cognitive skills

I. Identifies principles of sphygmomanometric measurement of arterial pressure and can describe technique for blood pressure determination as recommended by the American Heart Association.

- A. Distinguishes the proper cuff size recommended for average adults, obese adults, and children, and its influence on arterial pressure measurement.
- B. Determines necessity for taking blood pressure in more than one extremity and/or position.
- C. Explains effects of body position on level of blood pressure.
- D. Recognizes Korotkoff sounds and relates them to arterial pressure.
- E. Identifies auscultatory gap.
- F. Explains implications of auscultatory gap for accurate measurement.

Affective skills

I. Is committed to the importance of accurate blood pressure determination as a vital skill in physical assessment.

In this determination the analysis was limited to the components in the nursing repertoire of behavior while the environmental components were controlled. This approach was selected because there are many potential variables involved in the performance of blood pressure determination. It was reasoned that if the components (person's repertoire and environmental factors) varied simultaneously, it would be extremely difficult to identify which were the source of any discovered performance discrepancy.

As knowledge is the most important component in the person's behavior repertoire accessible to change, the study focused on assessing knowledge deficiencies. In so doing, three assumptions were made about the behavior repertoire for blood pressure determination among nurses:

1. that among most nurses, there is no difference in their capacity to make reliable blood pressure measurements;

2. that among most nurses, there is no difference in their motivation towards making reliable blood pressure measurements; and

3. that among most nurses, there is sufficient capacity and motivation (given a supporting environment) to make reliable blood pressure measurements.

The use of these assumptions meant that among the aspects of the nurse's repertoire of behavior, knowledge of the procedure was conceptualized as the most potent factor affecting reliability in blood pressure measurement, while capacity and motivation were less important. The conditions of a supporting environment, although they would not be directly studied, were recognized as the other most potent variables affecting performance in blood pressure determination. This was not to underestimate the potency of the variables of capacity and motivation; however, it was recognized that it is usually not efficacious to solve performance problems by focusing on them. Furthermore, because of the diffusion of effects phenomenon, capacity and motivation -- if inadequate -- might be improved by correcting the deficiencies in the nurse's knowledge repertoire and/or correcting deficiencies in the environment.

The next section discusses reliability in clinical observation, as it is the critical requirement for accomplishment in blood pressure determination.

Performance: Requirement of Reliability

To obtain reliability in clinical observation, the factors affecting it must be known and controlled by the professionals utilizing the observation. Feinstein states that the scientific function of the observer is gravely impaired when the "clinician's" observations are imprecise and unstandardized, and when his interpretations are made without appropriate criteria and without vigorous attempts to achieve uniformity and consistency" (p. 53, 1975). For laboratory equipment, standardization and calibration is simply done by checking the equipment repeatedly against itself or against another apparatus that performs the same duty. The methodologic problems of obtaining reliability in clinical performance are much more complex.

The Nature of Reliability

The definition of reliability can be approached in three ways (Kerlinger, 1973). The first approach defines reliability in terms of stability, dependability, and predictability. In this sense, reliability means obtaining similar results time after time under the same conditions. The second approach is through the accuracy definition. There are two basic sources of inaccuracy: deficiency in the instrument itself and inconsistency between individuals and within individuals who are making the observation(s). When these deficiencies and inconsistencies are minimized, the measure obtained by the measuring instrument or the individuals doing the measuring, are more likely to be the "true" measure of the property being measured (Kerlinger, 1973).

The third and formal approach to defining reliability is through the theory of reliability which states that "Reliability is the proportion of the 'true' variance to the total obtained variance of the data yielded by a measuring instrument." (Kerlinger, p. 446, 1973). Total obtained variance includes systematic and error variance. Systematic variance leans in one direction, the variability happening in a certain predictable way. Error variance is random variance. the fluctuation, the variability due to chance. Reliability is the relative absence of errors of measurement in a measuring instrument. Thus, reliability is defined through error: "the more error, the greater the unreliability; the less error, the greater the reliability" (Kerlinger, p. 446, 1973).

Reliability in the Clinical Setting

Reliability regarding clinical methods has been conceptualized by Koran as "agreement" (1975). Agreement of two or more observers is termed "inter-observer agreement". According to Koran then, observer agreement means that if an observer measures the same set of objects again and again with the same or comparable measuring instruments, the same result will be obtained. Koran further develops the understanding of observer agreement by stating that agreement regarding observations or judgements is to be distinguished from their accuracy. The findings of two observers may agree and not be accurate when compared to an independent standard of accuracy (1975).

A means of determining accuracy, by an independent standard, may not be easily accessible for many clinical observations. In these situations, observer agreement is relied upon to function as the independent standard. For example, to determine accuracy in blood pressure determination, a nurse could compare her indirect auscultatory reading to that of a direct arterial line reading (the independent standard). For most patients this is impractical and so, in the clinical situation, the nurse either repeats her observation and compares the results or asks another nurse to make the blood pressure determination on the same patient and they compare results. If the readings are in agreement they are said to be reliable and, since the nurses agreed, their readings are interpreted as probably being accurate. Therefore, in clinical observations, inter or intraobserver agreements carry the double weight of both stability and accuracy.

The accuracy dimension of reliability is really dependent upon the "calibration" of the individuals who made the blood pressure readings. It is imperative that in clinical observation such as blood pressure determination inconsistencies between individuals be minimized by training observers in a standardized technique. When observers' techniques are standardized, the measures obtained are more likely to be the "true" measure of the property being measured.

Reliability and Blood Pressure Determination

In clinical observation, many factors influence observer reliability. Koran (1975) has identified these factors and those which are relevant to blood pressure determination are discussed.

1. Agreement for dichotomous judgments -- present/ absent - will usually be higher than for judgments regarding continuous or qualitative variables (Koran, 1975). Agreement for systolic blood pressure readings will probably be higher than agreement for the diastolic Phase 4 blood pressure readings since systolic pressure is more of a present/absent judgment based on the first presence of sound. The diastolic Phase 4 pressure reading requires a more qualitative

interpretation of the Korotkoff phases which are continuous in nature and, therefore, a high degree of agreement might not be expected. As the diastolic Phase 5 reading is more of a dichotomous judgment as compared to the diastolic Phase 4 judgment, diastolic Phase 5 readings would be expected to have less variability than the diastolic Phase 4 readings. Systolic pressure readings and diastolic Phase 5 pressure readings would be expected to have less variability as they are both relatively dichotomous judgments.

2. Observers with training relevant to the test task will agree more often than . . . observers with less training (Koran, 1975). Training increases agreement. Variability in the Korotkoff sound patterns has been cited by investigators as a contributing source to variability in blood pressure determination. If nurses have had training in the interpretation of the various Korotkoff sound patterns, the types of blood pressure sounds should not affect reliability in blood pressure readings.

3. If observers discuss terminology, criteria, decision rules and disagreements, they usually will agree more often but if qualitative judgments are involved they may not (Koran, 1975). As nursing

knowledge of the criteria and decision rules for blood pressure determination was the subject of the study, criteria was not presented to the nurses beforehand. It was anticipated that for nurses who utilized the AHA standards there would be greater knowledge of the procedure and less variability in their blood pressure readings. For example, with regard to the diastolic criterion for blood pressure, it was anticipated that in the absence of the use of set standards, some nurses would choose Phase 4 while others would choose Phase 5. Lack of agreement as to the criteria would lead to greater observer variability for diastolic readings as compared to the systolic readings.

4. Intra-observer agreement for a particular task will be higher than interobserver agreement for that task (Koran, 1975). This factor predicted that greater variability in blood pressure readings would be found among observers for the same patient than between readings on the same patient by observers.

In developing this study, the concepts of reliability, relevant training and adherence to standards were seen as directly related: the better the training, the less the error; the greater the knowledge of the procedure. Observer knowledge is a necessary aspect of performance; and, reliability is a requirement towards the end of achieving worthy performance.

Research Aims

The general aim of the study was to determine if there was potential for improvement in nursing performance of blood pressure determination. Within the framework of performance, this study focused on the aspects of knowledge and two specific aims were derived:

Aim 1 to determine if variability exists among nurses in their knowledge of the procedure of blood pressure determination

Aim 2 to determine if nurse variability exists in the interpretation of the Korotkoff sounds for the purpose of blood pressure measurement.

Aim 2 was divided into the categories of internurse variability, intranurse variability, and intra as compared to internurse variability. Within these categories specific research questions were proposed.

Internurse Variability.

Is internurse variability for systolic and diastolic Phase 5 blood pressure readings less than that of the diastolic Phase 4 blood pressure readings?

Is internurse variability in blood pressure readings for patient-examples with standard Korotkoff sounds less than that of internurse variability in blood pressure readings for patient-examples with nonstandard Korotkoff sounds?

Do nurses with greater knowledge of the standards of the procedure for blood pressure determination have less variability in their blood pressure readings than those nurses with less knowledge of the standards of the procedure?

Intranurse Variability

Is intranurse variability in blood pressure readings the same for patient-examples with standard Korotkoff sounds as compared to the blood pressure readings of the patient-examples with nonstandard Korotkoff sounds?

Intra as compared to Internurse Variability

Is intranurse variability in blood pressure readings less than internurse variability in blood pressure readings?

The means by which this study sought to answer these aims and questions are presented in the next chapter.

Summary

This chapter presented the framework of the study-performance, its components and how it is analyzed. The concept of and factors affecting reliability, the central requirement for performance in blood pressure determination, were discussed. The chapter concluded with the aims of the research.

Chapter 3

The Methodology

Introduction

The purpose of this chapter is to present the methodology of the study.

The research tools developed by the investigator, the Blood Pressure Sounds Tape and the Blood Pressure Procedure Knowledge Questionnaire are presented. Following this, the study approach, the sample and the setting are discussed. A description of the implementation of the study is given. The chapter concludes with a discussion of the data analysis procedures used to answer the aims of the research.

Tools of the Research

The Blood Pressure Sounds Tape

A blood pressure sounds tape was designed to study nursing reliability in the interpretation of the Korotkoff sounds for the purpose of blood pressure measurement.

Tape development. When choosing the Korotkoff sound patterns to be included on the tape it was believed advisable to include not only a range of blood pressure levels but also a variety of blood pressure sounds. The criteria used in the choice of the sound patterns for the tape were: (1) the sound patterns be encountered in the nursing of adults; (2) the American Heart Association had specified the standards for the blood pressure sound interpretation; and (3) expert designed, clear examples of the sound patterns be available for use in the study. Many resources were utilized to choose the actual sound patterns: (1) information form previous research and tool development by Wilcox (1961); (2) the writings of Ravin (1972, 1976) and Rodbard (1963, 1972) on the clinical implications of the Korotkoff sounds; (3) discussions with nurses in practice and nurse educators regarding their perceptions of the difficulties encountered in Korotkoff sound interpretation; and (4) personal experience both in practice and teaching of blood pressure determination. Based on the above, and because previous research had clearly demonstrated minimal observer variability in blood pressure readings on patients with standard sound patterns, it was decided to weight the tape examples towards nonstandard Korotkoff sound patterns.

The tape was constructed with the technical assistance of Narco Bio-Systems, Incorporated, utilizing blood pressure sound patterns developed by Abe Ravin, M.D., F.A.C.C. to teach health professionals about the Korotkoff sounds and blood pressure measurement (1972, 1976). The tape was designed to be played on the Blood Pressure Teacher, an instructional device conceived by Dr. Ravin and developed by Narco Bio-Systems. A feature of the Teacher pertinent to this study is that it can present taped blood pressure sounds synchronized with a pressure monitor dial via individual earphones. By this technique, the blood pressure determinations made by nurses presented with a common set of stimuli could be studied while controlling for the "variably variable" factors affecting blood pressure determination in the clinical setting.

The quality of the blood pressure sounds for the various examples presented was very clear so as to answer the question: given clear examples, how did nurses interpret varying blood pressure sounds patterns to obtain the blood pressure reading? The use of such a strategy isolated one aspect of the procedure and, as such, did not simulate reality -- the quality of the blood pressure sounds was not dependent upon the nurse's technique, there was no extraneous noise, and all the interaction with the patient and the equipment was removed. The stimuli presented to the nurses was somewhat modified -- the manometer was enlarged as compared to those used in practice and the blood pressure sounds were not heard through the nurse's own stethoscope. Nevertheless, for persons accustomed to taking blood pressure, it was believed that there was a feeling of familiarity in measuring blood pressure by this technique. For nurses who were accustomed to listening critically to blood pressure sounds, the tape was probably realistic, while for those who were not, the sounds were probably clearer than usual. However, in either event it was believed that this technique would focus attention on the blood pressure sounds per se.

A series of seven blood pressure sound examples were used, repeated once on the tape, and labeled as patient "A through "N". All seven "patient-examples" were first presented and then repeated in a different order (see Table 3). The tape began with two practice scenes; the testing section began and ended with standard sound patterns. The order of presentation was determined by the investigator with physician and nursing consultation so as to avoid possible bias in construction. The nurse was given no clue that the 14 examples were in truth only seven. The two presentations of each patient-example were identical. The blood pressure readings for the first and second presentation of the patient-examples were recorded on two separate sheets of paper, so as to have the first reading out of sight when recording the second blood pressure reading (see Response Form, Appendix B).

Tape content. The blood pressure sound patient-examples represented patients with standard and nonstandard sound patterns. The term nonstandard sound pattern referred to a Korotkoff sound pattern which differed from the standard American Heart Association (AHA) description (see Chapter 1 for AHA description of the five Korotkoff phases). The difference may have been in any phase or in all phases, but the general term, nonstandard sound pattern or nonstandard sounds, was used. In this study, the patient-examples with nonstandard sound patterns

Table 3

Order of Labeled Presentation

and Actual Order of Patient-Examples

on the Blood Pressure Sounds Tapes

Order of labeled presentation	Actual Order*
A	A1
B	B1
C	C1
D	D1
E	E1
F	F1
G	G1
H	B2
I	A2
J	D2
K	F2
L	E2
M	G2
N	C2

*In presenting and discussing the results, the patient-examples are referred to according to this nomenclature. The number indicates the time of presentation: time 1 or time 2.

were: B, D, E, and G. The sound patterns used are described along with a short description of hypothesized sources of difficulty in determining the blood pressure.

Patient-example B. The patient-example in which Phase 5=0. This sound pattern represented an absent fifth phase, which can occur in a number of conditions: aortic regurgitation, severe anemia, thyrotoxicoses, in normal persons after vigorous exercise, in pregnancy, and patients with hyper-kinetic cardiovascular systems. In taking blood pressure in such patients, sound is heard down to zero on the manometer and the diastolic pressure is read at the beginning of Phase 4. The pressure is recorded as, for example, 180/62/0 to indicate this phenomenon. Failure to attend to the reading of Phase 4 could lead to errors of either over or under-estimation of the diastolic blood pressure (Hurst, Logue, Schlant & Wenger, 1975; Kirkendall et al., 1967; Ravin, 1972; DHEW Pub. No. (NIH) 76-929).

Patient-example D. The patient-example with respiratory variation in blood pressure sounds. In this cardio-pulmonary condition, as the pressure in the cuff is slowly lowered, a beat or two is heard followed by silence for a few beats. As the cuff pressure is lowered further, more beats are heard with shorter periods of silence until all the beats come through. Because of the respiratory variation in sound, interpretation of the Korotkoff phases is more difficult. This type of nonstandard sound pattern may occur in patients with emphysema, chronic pulmonary fibrosis, congestive heart failure, constrictive pericarditis, restrictive cardiomyopathy, pulmonary embolism, hypovolemia, and in acute asthma; it is often referred to as a paradoxical pulse (Cohen, Kupersmith, Aroesty, & Rowe, 1973; Hurst et al., 1974; Ravin, 1972, 1976; Rebuck & Pengelly, 1973; Rodbard, 1963, 1972; Vaisrub, 1975; Wagner, 1973).

Patient-example E. The patient-example with an auscultatory gap. The gap is the temporary disappearance of sound occurring during the latter part of Phase 1 and Phase 2. The gap may cover a range of 40 mm Hg and result in observer error of either underestimating the systolic pressure or overestimating the diastolic pressure. The gap is estimated to occur in 5% of hypertensive patients (Askey, 1975) and may occur in patients with aortic stensis (Rodbard, 1972; Hurst et al., 1974).

Patient-example G. The patient-example with atrial fibrillation. Beat to beat variations in the strength of ventricular contraction and in the arterial sounds occur when the heart is beating irregularly which introduces problems into the estimation and interpretation of the arterial pressure. Interpretation of the phases is very difficult. The readings should be recorded as only approximate and the diagnosis (if not stated elsewhere) noted with the blood pressure recording (Rodbard, 1972; Ravin, 1972; Kirkendall et al., 1967).

Patient-examples A, C, and F. The patient-examples with standard blood pressure sounds. The blood pressure levels for these patient-examples were in the high, normal, and low-normal ranges and the blood pressure sounds corresponded to the classic Korotkoff phases.

The characteristics of the Korotkoff sounds tape are summarized in Table 4. For each patient-example, each Korotkoff phase is specifically identified as standard or nonstandard, according to whether or not the sound phase corresponded to the standard AHA description of the arterial sounds (Kirdendall et al., 1967). The blood pressure reading is given. The length of duration of the sounds for each patient-example is given. The relative difficulty of obtaining the blood pressure is noted along with a short description of the hypothesized sources of difficulty.

Table 4

Summary of Blood Pressure Sounds Tape Characteristics
According to Specified Variables

Tape Characteristic	Patient-example			
	A	B	C	D
	Hypertensive	Absent Phase 5	Normotensive	Paradoxical Pulse
Phase 1	Standard	Standard	Standard	Standard
Phase 2	Standard	Standard	Standard	Nonstandard
Phase 3	Standard	Standard	Standard	Nonstandard
Phase 4	Standard	Standard	Standard	Standard
Phase 5	Standard	Nonstandard	Standard	Standard
Blood Pressure Reading ($\pm$2 mm Hg)	184/118/110	138/48/0	100/70/64	122/84/72
Duration ($\pm$2 sec)	43 sec	53 sec	18 sec	49 sec
Degree of Difficulty	1/4/5 Average	1 Average 4/5 More difficult	1/4/5 Average	1 Average 4/5 More difficult
Source of Difficulty	- -	Must recognize Phase 4/Phase 5=0	- -	Waxing/waning of beats Phases 2-4

Table 4 (cont.)

Tape Characteristic	Patient-example		
	E	F	G
	Auscultatory Gap	Normotensive	Atrial Fibrillation
Phase 1	Standard	Standard	Standard
Phase 2	Nonstandard	Standard	Nonstandard
Phase 3	Standard	Standard	Nonstandard
Phase 4	Standard	Standard	Nonstandard
Phase 5	Standard	Standard	Standard
Blood Pressure Reading (± 2 mm Hg)	178/118/108	118/78/72	134/(78)/68
Duration (± 2 sec)	38 sec	32 sec	39 sec
Degree of Difficulty	1/4/5 Average	1/4/5 Average	1 Average 4/5 More difficult
Source of Difficulty	Must recognize gap	- -	Waxing/waning of beats Phases 2-4

In order to present each patient-example in a similar manner, the rate of descent of the pressure indicator dial was standardized at approximately 2-3 mm Hg/second (the rate of cuff deflation recommended by the AHA); the duration ranged from 18 to 53 seconds, depending on the pulse pressure of the patient-example. In addition, for each patient-example, with each beat, there was an upward movement of the manometer needle which started approximately 20 mm Hg above systolic pressure, simulating the "pulsing" of the manometer indicator in the clinical situation.

The standard readings. In order to investigate any error in blood pressure measurements made by the nurses it was necessary to establish a standard reading for each patient-example and analyze the nurses' readings against this standard. For five of the seven patient-examples, the standard reading was available from the work of Dr. Ravin (originally, all of the standards were to have been obtained from Dr. Ravin but his serious illness prevented this). For four of those standard readings, an adjustment of ∓ 2 mm Hg was made to correct for changes encountered when constructing the study cassette tape from the Narco Bio-Systems master reel-to-reel tape; this was done to ensure that the standard set was specific to the tape and Teacher used for this sutdy. For the remaining two patient-examples, the investigator developed the standard with physician consultation. The physician was chosen on the basis of his interest in the reliability of blood pressure determination, his previous work with the American Heart Association, and the fact that he frequently made blood pressure determinations in a variety of settings (outpatient, emergency room, and critical care units).

Prior to determining the standard reading for the two patient-examples, the physician and the investigator completed the instructional module developed by Dr. Ravin (1976) and the reliability of their readings was checked on three occasions against standard readings developed by Dr. Ravin. The reliability of their responses was ±2 mm Hg. The standard readings were established by the investigator and the physician recording the blood pressure readings of the two patient-examples on three occassions. Three determinations in two chair positions (right and left) were made -- a total of six readings per example for each occasion. The physician and investigator agreement was within ±2 mm Hg for the readings; the averages of readings were computed and this then was considered the standard reading.

Tape-teacher reliability. Reliability for the tape, as played on the Blood Pressure Teacher was established with the cooperation of Narco Bio-Systems. The Teacher was inspected and calibrated and the study tape played repeatedly on the machine over a period of days by a Narco engineer. In addition, the investigator checked the tape on the identical machine, playing it twice a week over a month's period and recording all of the Phases possible for each patient-example (a total of 66 readings per trial). Only slight differences ($\pm$2 mm Hg) were noted inter-trial and intra-trial for the same patient-examples and, as this occurred infrequently, in a random fashion, the differences were attributed to investigator variability. During the study, the tape and Teacher were checked by the investigator prior to each use.

The Pre-test Phase

The blood pressure sounds tape, its instructions and response form, the machine, and extraneous environmental variables of concern were pre-tested on four MS and DNS students.

The tape instructions and response form. Written instructions as to the procedure were provided; the instructions were repeated on the tape. The instructions and the response form were modified until agreement was reached that the manner of presentation of the items (choice of words, clarity, timing, amount of space for recording content of each page) did not introduce variance.

The tape and the machine. The sound level of the tape, the adjustment of the earphones, and the lighting of the dial on the machine was established. It was determined that although the tape was long and required concentration, the response time allowed was very adequate. To minimize possible effects of fatigue, the tape was presented as the first part of the study.

Other environmental factors. The approximate location of the chairs was decided and tested to ensure that the location would not systematically affect the blood pressure readings. The amount of lighting needed and the general amount of background noise tolerable were determined.

The Blood Pressure Procedure Knowledge Questionnaire

Questionnaire Construction. A questionnaire was developed by the investigator to measure the degree of variability among nurses in their knowledge of the procedure for blood pressure determination. The rationale for the choice of the items was obtained from the Task Force behavioral objectives for nurses in blood pressure determination (DHEW Pub. No. (NIH) 76-1052). The content of the items was drawn from the AHA standards for blood pressure determination (Kirkendall et al., 1967) and nursing and medical literature regarding the procedure (see list of content validation references, Table 5).

In Table 6, the following factors of construction are identified for each questionnaire item:

1. The Performance Variable in the blood pressure determination procedure involved, according to the categorization of Components of Performance in Blood Pressure Determination previously presented (Table 1, Chapter 2);

2. The Task Force Objective being tested, according to the Behavioral Objectives for Nurses in Blood Pressure Determination previously presented (Table 2, Chapter 2). Performance skills were measured from the

viewpoint of knowledge of the procedure. The affective objectives were not tested;

3. The taxonomy level of the item, according to Taxonomy of Education Objectives, Cognitive Domain (Bloom, 1974); and

4. References, according to Content Validation References (Table 5).

The format of the questionnaire was objective with multiple-choice items. The number of choices for a response to an item ranged from 4-6; this was established by analyzing nurses' responses to the items during pre-testing. In completing the questionnaire, the nurses were instructed not to guess and to indicate "don't know" if the proper response to the item was unknown.

<u>Reliability of the blood pressure procedure knowledge questionnaire</u>. The questionnaire was pre-tested and then tested for reliability on a heterogenous sample of nurses (N=23) by the test-retest method. Elapsed time between administration of the questionnaire varied from 1-3 weeks depending on the availability and convenience of the nurses. The data were analyzed in two ways:

1. A score was computed for each nurse for each questionnaire administration (time 1 and time 2) by allotting 1 point for each correct response and 0 points for each

Table 5

Blood Pressure Procedure Knowledge Questionnaire
Content Validation References

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Table 6

Blood Pressure Procedure Knowledge Questionnaire Items According to Performance Variable, Task Force Objectives, Taxonomy Level, and Content References

Item #	Item Content	Performance Variable	Task Force Objective	Taxonomy Level (Cognitive Domain)	Content References
1	Cardiac cycle	Warm-up question		1.3. Knowledge of principles and generalizations	8.9
2	Labeling cuff width/length	I.A.3	I.A (C)*	1.21 Knowledge of conventions	1,2,6,7
3	Criterion for cuff width	I.A.3	I.A. (C)	1.25 Knowledge of methodology	1,2,3,4
4	Choosing cuff length	I.A.3	I.A.(C)	1.25	1,2,3,4
5	Effect cuff width	I.A.3	I.A.(C) I.C (P)**	2.30 Extrapolation	1,2,4,7
6	Effect loose cuff	I.A.3	I.A.(C) I.C.(P)	2.30	1,2,4,9
7	Arm Position standard	I.A.2	I.C (C) I.B (P)	1.25	1,2,7
8	Effect arm position	I.A.2	I.C (C) I.B.(P)	2.30	1,3,4,7
9	BP Phase criteria	I.A.9	I.D (C)	1.21	1,2,4,6,9
10	Palp vs ausc BP	I.A.8	I.D.(P)	1.24 Knowledge of criteria	1

* Task Force Cognitive objective
** Task Force Performance objective

Table 6 (Cont.)

Item #	Item Content	Performance Variable	Task Force Objective	Taxonomy Level (Cognitive Domain)	Content References
11	Ordering BP phases	I.A.9	I.D.(C)	1.24	1,2,4,6
12	Systole/BP Phase	I.A.9,10	I.D.(C)* I.C.(P)**	1.24	1
13	Diastole/BP Phase	I.A.9,10	I.D.(C) I.G.(P)	1.24	1
14	Identifying asc gap	I.A.9	I.F (C)	1.31	1,2,3,4,5,7,9
15	Asc gap/BP Phase	I.A.9	I.F.(C)	2.20 Interpretation	1,2,3,4,5,7,9
16	Technique avoid asc gap	I.A.8	I.F.(C)	1.25	1,2,3,4
17	Rate cuff deflation	I.A.6	I.C.(P)	1.25	1,2,3,4
18	Effect of reinflation	I.A.1	I.C.(P)	2.30	1,4
19	Effect manometer level	I.A.4,5	I.B.(P)	1.25	1,2
20	Techniques to sounds	I.A.1	I.B,C (P)	1.31	2,4

* Task Force Cognitive objective
** Task Force Performance objective

incorrect and "don't know" responses. The Pearson correlation coefficient for the two scores was 0.65 ($p=0.001$, 2 tail test).

2. Each item at each time administration was examined for the number of correct, incorrect, and "don't know" responses. Chi square analysis indicated responses of the nurses (time 1 and time 2) as significant ($p < 0.05$) for all but one item. This item was reworded to increase clarity. One other item was discarded as a few nurses indicated they found the question confusing.

During the pretest phase it was found that the administration of the questionnaire produced a reactive effect. A majority of the nurses either asked for the correct response to the items, sought the information themselves, or requested instruction. This finding led to two decisions:

1. to administer the questionnaire after the blood pressure sounds tape so that the questionnaire would not change the way the nurses responded to the tape; and

2. to retain the response "don't know" as an option in answering the items.

It was thought that a strategy would decrease forced guessing, which would elicit a more accurate picture of nursing knowledge and also decrease anxiety about performance.

The Questionnaire as presented to the nurses can be found in Appendix C.

Blood Pressure Study Comment Section

During the pretest phase it was discovered that a rich source of information was the spontaneous comments of the nurses. For this reason an optional section for comments was entered immediately after the blood pressure sounds tape and again at the conclusion of the study.

The Research Approach

The general approach taken for this study is best described as descriptive and explanatory. The approach was descriptive because the aim was to discover facts about the range of nursing performance in blood pressure determination. The approach was explanatory because the aim was to determine the relationships among variables by testing whether stated hypothesis were true or false (Abdellah, 1965). The independent variables were all of the aspects of the components affecting performance in blood pressure determination. The dependent variable was nurse performance in blood pressure determination. The comparative base was inter and intra nurse performance in blood pressure determination.

The Design

The design used can best be described as nonexperimental because the chief aspect of the component affecting performance in blood pressure determination in the nurse repertoire, that of knowledge of the standards of the procedure, was measured and not manipulated. However, because the relationships among the aspects of the components affecting performance in blood pressure determination are so complex, it was necessary to plan the study to control for the impact of some of the aspects affecting performance in order to measure the aspects of concern. This rationale was explained in Chapter 2 in the section on analyzing nursing performance in blood pressure determination. The investigator's conceptualization of which aspects of the components affecting performance in blood pressure determination were controlled during the implementation of the study is discussed in this Chapter in the next section.

The Sample

This study utilized a form of nonprobability sampling labeled purposive sampling, which is characterized by the use of judgment and deliberate effort to obtain a representative sample by including presumably typical groups in the sample (Kerlinger, 1973). Master's students (N=41) in nursing were chosen believing that this population would yield a sample diverse in background (regional, educational, and in terms of nursing experience). Efforts were made to include as wide a variety of students as possible. It was believed that such a sample would probably be better educated than the "average nurse", but that this education would probably not be in blood pressure determination.

Information regarding the demographic characteristics of the nurses in the study was collected through self-report. The questions for eliciting these data were pretested for on nurses in practice and nursing faculty. The characteristics of the sample are discussed in Chapter 4. The limitations of the sample are discussed in Chapter 5.

The Setting

The setting for the study was the University of California School of Nursing, San Francisco. Two small, similar rooms were selected on the basis of quietness, lighting, privacy, and freedom from distractions. One room was used for all but two of the groups in which instance it was chosen because of unanticipated noise adjacent to the primary room. No difference in the nurses response was noticed because of this change.

Procedure for the Study

The nurse-subjects who had volunteered to be in the study were contacted and mutual times for pairs of students to participate were established. Because of conflicting schedules, etc., data collection extended over a period of 6 weeks. The investigator did all the recruitment of the nurses and administered all tools of the study. Although pre-testing had been done to establish the procedure, one change had to be made after the initial pair of nurses went through the study. This change had to do with adding an explanation of how the Blood Pressure Teacher mechanically operated.

The subjects reported to the room and introductions were made. The purpose and the components of the study were explained first orally by the investigator and then read by the subjects. The consent form was signed (Appendix A). The first page of instructions was read and, if there were no questions, the tape was started. After the practice scenes, if there were no questions, the rest of the tape was played and the nurses recorded their blood pressure readings for each patient-example. When the tape was finished, the subjects recorded the diastolic criterion they were accustomed to using and any comments they had about the tape (See Appendix B for forms used). At this point, an opportunity for a break was offered.

The variables (refer to Table 1 for complete listing) associated with performance in blood pressure determination operating during this part of the study were conceptualized as those involving the nurses' repertoire of behavior: the I. Observer Components and within this category, A.9 Criteria for the interpretation of the Korotkoff sounds and A.10 Convention for recording findings, were believed to be the most potent in determining the nurses' reliability in blood pressure determination. Knowledge variables A,1-8 were not operating, as they were controlled by the design of the research. The other Observer Variables -- Capacity and Motivation -- were operating but not directly measured.

In the next part of the study, the nurses answered the Blood Pressure Procedure Knowledge Questionnaire (Appendix C) and completed the demographic data forms (Appendix D). If desired, the optional comment section regarding the study was filled out (Appendix D).

At this point, if no spontaneous comments were made, a standard stimulus question was asked: "What was it like for you to go through this study?" This was done to elicit and diminish any uncomfortable feelings the study may have stimulated in the nurses and to obtain feedback as to the nurses' perceptions of the tools the investigator used. The subjects were asked to refrain from discussing the exact content of the study with fellow students.

The variables operating during the administration of the Blood Pressure Procedure Knowledge Questionnaire were those associated with the nurses' repertoire of behavior: the Observer Components, categories A, B, and C. The variables regarding Knowledge of the Standards for the Procedure were the chief focus and believed to be the most potent in determining the degree of variability in nursing response to the Questionnaire items.

The demographic items (Appendix D) were designed to gather data about variables possibly affecting Capacity in blood pressure determination. Information was also sought regarding the environmental component of setting standards for performance through the questions about the use of the AHA standards.

Throughout the study, the Environmental Components, B. Instruments, and C. Incentives, affecting blood pressure determinations made by these nurses in the clinical setting were not measured due to the research approach selected; i.e., a laboratory setting with special equipment with volunteer nurses was used. To what extent the specialized equipment and the probable Hawthorne effect operated to influence the results of the study is not known and limits the generalizability of the study.

Participation in the study required approximately one hour of time during which the investigator was present to answer any questions and to monitor the tape and Teacher for possible mechanical failure. The entire packet, in the order presented to the nurses in the study can be found in Appendices A, B, C, and D.

Procedures for Data Analysis

The data obtained from this study were grouped into four categories; the sample characteristics, the nurse responses to the Blood Pressure Procedure Knowledge Questionnaire, the blood pressure readings obtained from the Blood Pressure Sounds Tape, and the qualitative data reflecting the reactions of the nurse-subjects to the study. The data analysis procedures for each of the categories are presented; the procedures for handling the Questionnaire responses and blood pressure readings are discussed according to the aims of the study. The level of significance for the study was set at p=0.05. Statistical consultation was obtained and the facilities at the University of California, San Francisco, Scientific Computer Center, were utilized for data analysis. The general plan of the analysis for each category is described next.

The Sample Characteristics

Descriptive statistics and frequency distributions were used to determine the basic distributional patterns of the demographic characteristics and the characteristics related to blood pressure determination of the participating nurse-subjects.

Aim 1

The purpose of Aim 1 was to determine if variability exists among nurses in their knowledge of the procedure of blood pressure determination.

Data to answer this aim was obtained from the nurses' responses to the Blood Pressure Procedure Knowledge Questionnaire. Responses to the items were categorized as "correct", "incorrect", and "don't know" and frequency distributions were done for each item. A score was computed for each nurse, based on one point for each correct response. Descriptive statistics were used to examine these scores.

The items were also grouped according to their similarity of focus into five categories:

Category 1. Blood pressure cuff items: #2,3,4,5,6

2. Positioning effect items: #7,19,8

3. Korotkoff sound items: #9,11,12,13

4. Technique effect items: #10,17,18,20

5. Auscultatory gap items: #14,15,16

The number of nurses having the same percentage of incorrect items for each category was determined so as to calculate the percentage of improvement possible within each category.

Aim 2

The purpose of Aim 2 was to determine if nurse variability exists in the interpretation of the Korotkoff sounds for the purpose of blood pressure measurement.

To answer this aim the blood pressure readings recorded by each nurse-subject for each patient-example, for each time of reading (time 1 and time 2), by each Korotkoff phase used (systolic, diastolic Phase 4 and/or diastolic Phase 5) had to be transfered for computer analysis. In this transfering, for the majority of nurses N=25 (61%), the investigator encountered at least one difficulty either in understanding the nurse's statement, in understanding what was meant by a recorded blood pressure reading, or in both. In these situations, with nursing and physician consultation, the investigator determined the data entry procedures according to that judgment which best reflected the intent of the nurse-subject. The difficulties encountered were grouped into three categories: 1. those regarding entry of the data for the diastolic reading(s); 2. those regarding entry of the data for patient-example in which Phase 5=0; and 3. those regarding entry of the data for the patient-example with an auscultatory gap. The data entry decisions for these categories are detailed in Appendix E.

Following coding and data entry, frequency distributions and descriptive statistics were used to determine the variability among nurses according to the stability approach to reliability; i.e., were all nurses reading blood pressures the same. In reporting these data, the range and standard deviation for each patient-example, for each time of reading, were used to illustrate the variability.

To answer the question, were the nurses reading blood pressures accurately -- the accuracy approach to reliability -- an accuracy discrepancy score was computed for each nurse by subtracting the nurse's reading from that of the standard reading:

Accuracy discrepancy score = Standard reading -- Nurse reading.

This was done for each patient-example, for each BP phase used, for each time of reading. This accuracy discrepancy score will be referred to as the nurse accuracy score in the rest of this report.

Following the tabulation of the nurse accuracy scores, the percentage of nurses NOT falling within stipulated ranges for each patient-example was determined.

These stipulated ranges, developed by the investigator with nursing consultation, were:

Stipulated Range		Characterization of Performance
±2.0 mm Hg	=	Exemplary performance
±5.0 mm Hg	=	Acceptable performance
>8.0 mm Hg	=	Unacceptable performance

The rationale for the exemplary range was that in previous research in which observer technique was carefully standardized, the probable error of a single blood pressure reading was determined to be ±2 mm Hg (Shock and Ogden, 1939). The unacceptable range was based on the AHA statement that a mean error of up to ±8 mm Hg may be expected in individual blood pressure readings in the clinical setting; an error greater than ±8 mm Hg was outside this expected range (Bordley III, Connor, Hamilton, Kerr, & Wiggers, 1957). Acceptable performance for this study was calculated as the average between exemplary and unacceptable performance ranges. It was believed that performance when using blood pressure tapes of patient-examples should exceed that of the clinical setting because of the control exerted in the study setting but be less than exemplary performance as standardization of observer technique was not done.

The data obtained were analyzed for statistical significance according to categories of internurse variability, intranurse variability, and intra as compared to internurse variability.

Internurse Variability

Question 1. Is internurse variability for systolic and diastolic Phase 5 blood pressure readings less than that of the diastolic Phase 4, blood pressure readings.

To answer this question, the variance of each patient-example for each time of reading (time 1 and time 2) was compared by means of a t-test for correlated variances.

1. The systolic variance was compared to the diastolic Phase 4 variance;
2. The systolic variance was compared to the diastolic Phase 5 variance;
3. The diastolic Phase 5 variance was planned to be compared to the diastolic Phase 4 variance but this was not feasible because of small sample size (N=2-3).

Question 2. Is internurse variability in blood pressure readings for patient-examples with standard Korotkoff sounds less than that of internurse variability in blood pressure readings for patient-examples with nonstandard Korotkoff sounds?

To answer this question, the nurse accuracy scores were subjected to a one factor repeated measures analysis of variance to determine if the variability of the nurses' blood pressure readings was related to the patient-examples and, in particular, to grouping the patient-examples according to standard sounds (A,C,F) as compared to nonstandard sounds (B,D,E,G). This was done for each blood pressure phase (systolic, diastolic Phase 4, and diastolic Phase 5) and for each time of reading (time 1 and time 2).

Question 3. Do nurses with greater knowledge of the standards of the procedure for blood pressure determination have less variability in their blood pressure readings than those nurses with less knowledge?

1. The exemplar approach. For the study, an exemplar nurse was defined who had the following characteristics: (1) stated she used the standards of the AHA for blood pressure determination, (2) recorded her blood pressure readings according to the convention recommended by the AHA, (3) expressed her diastolic criterion clearly and according to the convention recommended by the AHA, and (4) answered all the items in Group 3 (Korotkoff sound items) on the Blood Pressure Procedure Knowledge Questionnaire correctly. The strategy was to identify these nurses and compare their BP readings with those of the other nurses. Unfortunately, no nurses could be characterized as exemplars

by the above definition.

2. <u>The Questionnaire score approach</u>. In lieu of the above, an alternative approach was sought to determine if there was a relationship between knowledge of the AHA standards and accuracy in blood pressure reading. As the Blood Pressure Procedure Knowledge Questionnaire was designed to measure general knowledge of the BP procedure, the nurses were divided into three groups according to their scores on the Questionnaire: those having high (11 - 16 items correct), average (8 - 10 items correct), and low (3 - 7 items correct) scores (see Appendix H for frequency distribution of nurses' scores). The mean accuracy scores of the nurses were subjected to a three factor analysis of variance to determine if there was any relationship between accuracy in blood pressure reading and level of Questionnaire score. This was done for each patient-example, for each blood pressure phase (systolic, diastolic Phase 4, and diastolic Phase 5).

Intranurse Variability

To determine the general magnitude of intranurse variability in blood pressure determinations, the readings of the patient-examples for time 1 and time 2 were correlated by means of the Pearson product moment correlation coefficient. This was done for each blood pressure Phase (total of 21 correlations).

Question 4. Is intranurse variability in blood pressure readings the same for patient-examples with standard Korotkoff sounds as compared to the blood pressure readings of the patient-examples with nonstandard Korotkoff sounds?

To answer this question, intranurse discrepancy scores were calculated; the intranurse discrepancy score is the difference between the time 1 and time 2 reading for the same patient-example, for the same blood pressure Phase:

Nurse discrepancy score = Time 1 BP reading - Time 2 BP reading.

The intranurse discrepancy scores were then subjected to a one factor repeated measures analysis of variance to determine if intranurse variability in blood pressure readings was related to the patient-examples. The patient-examples were grouped according to standard sounds (A,C,F) and nonstandard sounds (B,D,E,G) and contrasts were used to determine if there was variability related to this grouping. This was done for each blood pressure Phase (systolic, diastolic Phase 4, and diastolic Phase 5).

Intra as Compared to Internurse Variability

Is intranurse variability in blood pressure reading less than internurse variability in blood pressure reading?

The unit of analysis for this question was intra and internurse variance (see definitions of terms below). The mean of the intranurse variances was compared to the total variance of the mean for all nurses for each patient-example, for each blood pressure Phase (systolic, diastolic Phase 4, and diastolic Phase 5). Although no statistical test could be applied to determine the strength of the relationships between the variances, a general trend could be determined by a general inspection of the data.

Definition of Terms

Intranurse variance: calculated using the nurse discrepancy scores according to the formula $V = \frac{D^2}{2}$. This was done for each patient-example, for each blood pressure Phase.

Mean of the intranurse variances: descriptive statistics were used to calculate the mean of the intranurse variances for each patient-example, for each blood pressure Phase.

Variance of the mean for all nurses: determined by obtaining for each nurse a mean reading for each patient-example, for each blood pressure Phase. Descriptive statistics were used to calculate the variance of the nurses' mean readings.

Nurse Reactions to the Study

Nurse reactions to the Blood Pressure Sounds Tape and the study as a whole were categorized for similarity of content, with the assistance of an impartial observer. The general categories were then discussed using direct quotations to illustrate points of interest in the interpretation of the results of the study and in planning strategies for future studies.

Summary

This chapter has presented the methodology of the study. The research tools developed by the investigator, The Blood Pressure Sounds Tape and The Blood Pressure Knowledge Questionnaire were presented and discussed. The study approach, the sample, and the setting were discussed. A description of the procedure of the study was presented. The chapter concluded with a discussion of the data analysis procedures used to answer the aims of the research.

CHAPTER 4

THE RESULTS

Introduction

The general aim of the study was to determine if there was potential for improvement of nursing knowledge in blood pressure determination. This chapter presents the data to answer that aim: the sample characteristics are presented followed by the nurses' responses to the Blood Pressure Procedure Knowledge Questionnaire and the blood pressure readings obtained from the Blood Pressure Sounds Tape. These data are discussed according to the specific aims and questions of the study. The chapter concludes with the presentation of the data reflecting the reactions of the nurse-subjects to the study.

The Sample

General Characteristics

From the frequency distributions of the demographic characteristics of the nurse-subjects (N=41), the following profile of the average nurse in this study was determined; the nurse was female, young (modal age = 28 years), had graduated from nursing school three years ago, had been actively practicing nursing for three years, and was currently employed as a staff nurse in a hospital on a critical-care or medical unit. The nurse had no visual or hearing defect which would have compromised her ability to participate in the study. All of the nurses were currently enrolled in the master's program at the University of California, School of Nursing. (See Appendix F for a more detailed presentation of this data.)

The nurse-subjects were volunteer and no particular difficulty was encountered in their recruitment. Instead, the willingness to participate and the continued interest shown by many of the nurses has led the investigator to believe that the nurses were interested in the study and generous in their participation.

Characteristics Related to Blood Pressure Determination

Slightly over half of the nurses (N=23, 56%) determined blood pressure very frequently (at least daily) in their nursing practice. Approximately two-thirds of the nurses did not supervise (N=25, 61%) or teach (N=28, 68%) others in blood pressure determination. A large majority of the nurses (N=34, 83%) identified their basic nursing educational program as the only source of their instruction in blood pressure determination. In response to the items regarding the American Heart Association standards for blood pressure determination, a large percentage stated they did not know what the standards of the American Heart Association were (N=34, 83%) and were unable to say if these standards were used as the protocol in their place of nursing practice (N=30, 73%) or if the AHA standards were used by most nurses (N=29, 71%). Only a small minority (N=5, 12%) identified the AHA standards as the guidelines they followed when determining blood pressure. (Refer to Appendix G for complete listing of data.)

The nurse's choice of the criterion she used to measure the diastolic blood pressure was determined by self-report after the completion of the blood pressure readings from the tape. It was believed that such timing would not sensitize the nurse to this variable prior to listening to the tape and would be reflective of the criterion she used while listening to the tape.

The criteria for diastolic measurement, as reported by the nurses were:

Diastolic criterion	# Nurses	Description
Phase 4 only	7	These nurses checked the response "muffling or dulling of the sound".
Phase 5 only	18	These nurses checked the response "cessation of the sound".
Phase 4 and 5	6	These nurses checked both the responses "muffling" and "cessation", described under Other that they used both, or did both of these things. Example wording was: "I use both and record BP as three #'s".
Phase 4 or 5	2	These nurses used either "muffling" or "cessation", depending upon the circumstances.
Phase 5, modify to Phases 4 & 5	5	These nurses modified their criterion of Phase 5 to Phases 4 and 5 in the case of patients with Phase 5 readings of 0. Example wording was: "sometimes both -- when the sound goes to 0 then I mark the change in sound as well as the fact it went to 0".
Phase 5, modify to Phase 4	3	These nurses modified their criterion of Phase 5 to Phase 4, in the case of the patients with Phase 5 readings of 0. Example wording was: "I only use dulling of sound or change to soft when a beat can be heard back to zero".

The data indicated a lack of uniformity among nurses in their choice of the indicator of diastolic blood pressure. A majority of the nurses (N=26, 63%) used Phase 5 (the convention recommended by the Joint National Committee, 1977) and of these nurses, one-third modified this criterion in cases in which Phase 5=0. A small number of nurses (N=6, 15%) stated they used Phase 4 and 5 (the convention recommended by the AHA, 1967) and an even smaller number of

(N=2, 5%) actually recorded their blood pressure readings according to the AHA standards.

Aim 1

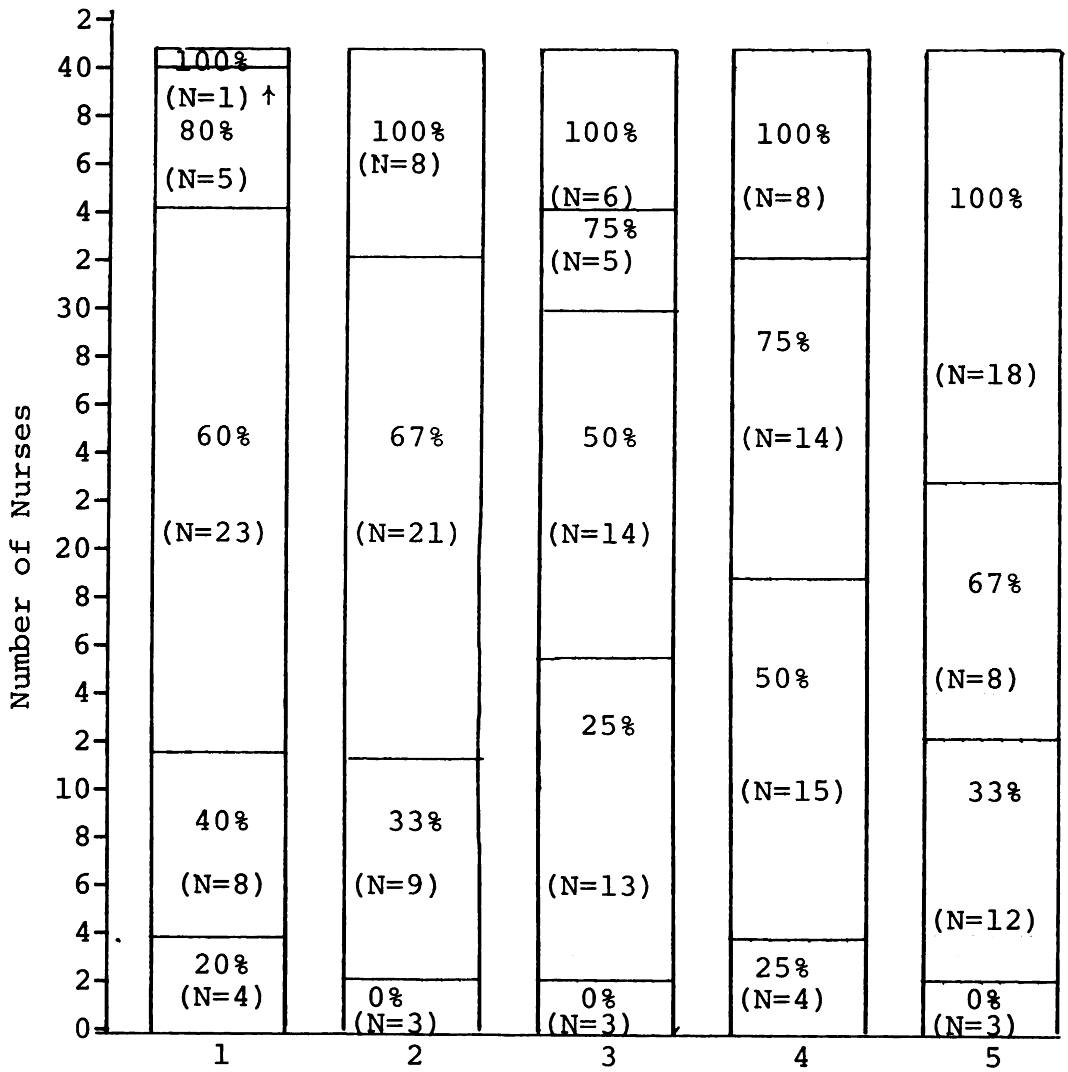
This aim referred to determining the variability among nurses in their knowledge of the procedure of blood pressure determination. The unit of analysis was nurse scores on the Blood Pressure Procedure Knowledge Questionnaire.

Descriptive analysis of the scores obtained indicated a normal distribution with a mean number of correct responses of 8.8 and a standard deviation of 2.5 (see Appendix H for data details). There was a wide range in the number of correct responses, from a high of 16 (of a possible 20) items correct to a low of 3 items correct. There was a mean of 6.4 incorrect responses as compared to 4.7 "don't know" responses.

The number of nurses having the same percentage of incorrect items for each category was illustrated by a bar graph (see Figure 1). Results indicated that, except for Category 5, the auscultatory gap items, the categories were similar in terms of the number of nurses having the same percentage of incorrect answers. For example, for category 1, cuff items, 23 nurses had 60% of the items incorrect and in category 2, positioning effect items, 21 of the nurses had 67% of the items incorrect.

Figure 1

Number of Nurses and Percentage of Incorrect Responses within each Category



Categories of Knowledge

1 Cuff items (N=5)
2 Positioning effect items (N=3)
3 Korotkoff sound items (N=4)
4 Technique effect items (N=4)
5 Auscultatory gap items (N=3)

Aim 2

This aim was concerned with determining nurse variability in blood pressure readings, as measured by the nurses' response to the Blood Pressure Sounds Tape. The aim is meant by presenting a general descriptive picture of the data; then each research question, rephrased as a hypothesis, is answered in the respective categories of internurse variability, intranurse variability, and inter as compared to intranurse variability.

General Description of the Data

What is the nurse variability in blood pressure determination? The data answering this question are presented in Table 7. In this table, the data are separated according to the systolic, diastolic Phase 4, and diastolic Phase 5 readings. Within these divisions, the data are presented for each patient-example, for each time of reading (time 1 and time 2), and according to the type of blood pressure sounds -- standard sounds (A,C,F) and nonstandard sounds (B,D,E,G).

The range and standard deviations as calculated from the nurse readings are presented -- the stability approach -- along with the percentage of nurses NOT falling within the stipulated accuracy ranges -- the accuracy approach. The data from this Table are averaged and presented in Table 8. (The correlations are included here for ease of presentation: they are appropriate to and discussed in the intranurse variability section of this chapter.)

As can be seen in Table 8, the systolic and diastolic Phase 5 ranges were smaller than the diastolic Phase 4 ranges. The range for the patient-examples with standard sounds was smaller than that of the patient-examples with nonstandard sounds. The standard deviations were smaller for systolic and diastolic Phase 5 readings as compared to Phase 4 readings; the standard deviations were all less for the standard sound readings as compared to the nonstandard sound readings. The standard deviations calculated by the accuracy approach were generally smaller than those calculated by the stability approach.

With regard to the stipulated ranges, in general, except for Phase 4 diastolic readings, the majority of nurses were within the ±2 mm Hg accuracy range. Any interpretation of nurse accuracy however, is related to the range used, the ±2 mm Hg and ±5 mm Hg ranges excluded more nurses than the ±8 mm Hg range. Nurses using Phase 4 did less well for any of these stipulated ranges; and for standard sounds, fewer percentage of nurses were out of the stipulated ranges than for non-standard sound patient-examples. Using the ± 5 mm Hg indicator of mean accuracy, 11% of the systolic readings, 49% of the diastolic Phase 4 readings, and 24% of the diastolic Phase 5 readings were out of range.

Table 7

Summary Data of Blood Pressure Readings on Specified Variables by Patient-Example

Systolic Readings

Patient Example	#Nurses	Range	Std. Dev. (Stability)	Std. Dev. (Accuracy)	Correlation Time 1 & 2	%Nurses not within stipulated range		
Standard Sounds						±2 mm Hg	±5 mm Hg	±8 mm Hg
A1	41	21	3.8	3.4	.61*	7	5	2
A2	41	30	5.3	4.9		10	7	5
C1	41	28	3.7	3.3	.10	7	7	5
C2	41	28	3.8	3.3		10	7	5
F1	41	18	2.9	2.5	.64*	7	5	2
F2	41	12	2.4	1.8		15	5	0
Non Standard Sounds								
B1	41	26	4.0	3.5	.61*	15	12	5
B2	41	22	3.5	3.1		17	7	2
D1	41	23	5.0	4.7	.90*	19	15	15
D2	41	21	4.1	3.9		12	12	10
E1	40	42	10.3	10.3	.58*	35	12	12
E2	40	50	6.7	6.5		35	10	2
G1	41	26	5.4	5.2	.68*	46	27	15
G2	41	26	5.2	5.1		46	17	15

$p < 0.05$, two-tail test

Table 7 (cont.)

Diastolic Phase 4 Readings

Patient Example	#Nurses	Range	Std. Dev. (Stability)	Std. Dev. (Accuracy)	Correlation Time 1 & 2	%Nurses not within stipulated range		
Standard Sounds						± 2 mm Hg	± 5 mm Hg	± 8 mm Hg
A1	13	34	12.5	9.3	.68*	50	50	25
A2	14	32	8.8	8.2		31	31	15
C1	13	26	7.0	5.1	.23	75	67	17
C2	13	18	5.3	3.5		50	42	8
F1	13	16	6.3	6.4	.69*	42	42	42
F2	14	22	7.7	6.9		54	46	46
Non Standard Sounds								
B1	24	40	15.8	14.0	.41	70	65	60
B2	24	38	14.2	13.5		78	78	78
D1	14	44	11.3	8.2	.63*	69	54	23
D2	15	44	10.9	8.2		64	50	21
E1	16	46	12.4	8.9	.80*	60	53	40
E2	12	30	11.3	9.4		50	50	31
G1	13	24	6.4	5.1	.46	33	25	17
G2	13	40	10.0	9.2		33	33	25

$p < 0.05$, two-tail test

Table 7 (cont.)

Diastolic Phase 5 Readings

Patient Example	#Nurses	Range	Std. Dev. (Stability)	Std. Dev. (Accuracy)	Correlation Time 1 & 2	%Nurses not within stipulated range		
Standard Sounds						± 2 mm Hg	± 5 mm Hg	± 8 mm Hg
A1	34	42	6.9	5.7	.57*	42	30	9
A2	34	16	4.1	3.3		27	24	6
C1	34	30	5.1	4.6	.49*	21	9	3
C2	34	12	2.2	1.8		15	6	0
F1	34	20	4.5	3.6	.61*	67	54	6
F2	34	12	3.3	2.8		33	18	3
Non Standard Sounds								
B1	31	60	16.6	16.8	.74*	17	17	17
B2	32	80	25.1	25.4		19	19	19
D1	34	38	6.1	5.3	.12	43	27	3
D2	34	12	2.9	2.6		21	18	3
E1	34	18	4.5	3.6	.09	24	18	12
E2	34	120	19.3	3.1		39	21	9
		20	18.2					
G1	34	14	4.5	4.0	.47*	36	33	21
G2	34	46	8.2	7.6		48	36	21

$p < 0.05$, two-tail test

Table 8

Means of Data from Summary Table 7
According to Specified Variables by Blood Pressure Phase

Variable	Systolic	Diastolic Phase 4	Diastolic Phase 5
Range			
Total	27	33	30
Standard	23	25	22
Nonstandard	30	38	36
Std. Dev. (Stability)			
Total	4.7	9.9	8.0
Standard	3.7	7.9	4.3
Nonstandard	5.5	11.5	10.9
Std. Dev. (Accuracy)			
Total	4.4	7.6	6.4
Standard	3.3	6.6	3.6
Nonstandard	5.3	8.3	8.6
Stipulated Ranges (Percentage of nurses NOT within stipulated range)			
	%	%	%
±2 mm Hg			
Total	20	54	28
Standard	9	50	24
Nonstandard	28	57	31
±5 mm Hg			
Total	11	49	24
Standard	6	46	24
Nonstandard	14	51	24
±8 mm Hg			
Total	7	32	9
Standard	3	26	5
Nonstandard	10	37	13

Internurse Variability

Hypotheses 1a and 1b. From the first research question guiding this study, the following hypotheses were derived:

1a. Internurse variability for systolic readings will be less than that for diastolic Phase 5 readings.
1b. Internurse variability for systolic readings will be less than that for diastolic Phase 4 readings.

The unit of analysis used to answer these hypotheses were the variances of the blood pressure readings. T-tests for correlated variances were done and then the instances in which systolic blood pressure was read with less variability than diastolic blood pressure were tabulated. The data are presented in Table 9. (For details of the individual t-tests, see Appendix I.)

As can be seen in Table 9, systolic blood pressure was read with less variability than diastolic Phase 4 blood pressure for patient-examples A1, B1, B2, C1, D1, D2, E2, F1, and F2. Hypothesis 1a was accepted for the blood pressure readings of those patient-examples but rejected for the readings of patient-examples A2, C2, F1, G1, and G2.

Systolic blood pressure was read with less variability than diastolic Phase 5 blood pressures for patient-examples A1, B1, B2, D1, F1, F2, and G2.

Hypothesis 1b was accepted for the readings of those patient-examples but rejected for the readings of patient-examples A2, C1, C2, D2, F1, F2, and G1.

Table 9

Instances in which Systolic Blood Pressure was Read with Less Variability than Diastolic Blood Pressure according to Patient-Example.

	Blood Pressure Phases Compared			
	Systolic to diastolic Phase 4		Systolic to diastolic Phase 5	
	yes[1]	no[2]	yes[1]	no[2]
Patient-example				
A1	*		*	
A2		*		*
B1	*		*	
B2	*		*	
C1	*			*
C2		*		*
D1	*		*	
D2	*			*
E1		*		*
E2	*			*
F1	*		*	
F2	*		*	
G1		*		*
G2		*	*	

yes[1] = systolic pressure was read with less variability than the diastolic pressure

no[2] = systolic pressure was not read with less variability than diastolic pressure

In order to further examine the findings, hypothesis 1 was subjected to a secondary analysis using the nurse blood pressure reading accuracy scores (Accuracy scores = Standard reading - Nurse reading). A two factor repeated measures analysis of variance was used to compare the systolic readings to the diastolic Phase 4 readings and the systolic readings to the diastolic Phase 5 readings. This data can be seen in Table 10. As can be seen in Table 10, systolic blood pressures were read more accurately than either the diastolic Phase 4 or the diastolic Phase 5 blood pressure readings. There was a significant difference in the accuracy scores among the patient-examples. In addition, there was a significant interaction between patient-example and blood pressure Phase.

Table 10

Systolic as Compared to Diastolic Blood Pressure Reading Accuracy Scores: Two Factor Repeated Measures Analysis of Variance

Significance of Differences on Nurse Systolic as Compared to Diastolic Phase 4 Blood Pressure Reading Accuracy Scores by Patient-Example

	df	SS	MSS	F
Between Nurses	10	762.31		
Within Nurses	143	7090.55		
Blood Pressure Phase	1	886.56	886.56	12.42**
Error (BP Phase)	10	713.74	71.37	
All Patient-Examples	6	888.55	148.09	4.52**
Groups: Std/Nonstd	1	123.38	123.38	3.77 NS
Residual	5	765.17	153.03	4.67*
Error (patient-example)	60	1966.47	32.77	
BP Phase x Patient-Example	6	1064.80	177.47	6.78***
Error (BP Phase x patient-example	60	1570.49	26.17	

Significance of Differences on Nurse Systolic as Compared to Diastolic Phase 5 Blood Pressure Reading Accuracy Scores by Patient-Example

	df	SS	MSS	F
Between Nurses	29	3740.54		
Within Nurses	390	17909.06		
Blood Pressure Phase	1	474.67	474.67	4.33*
Error (BP Phase)	29	3181.15	109.69	
All Patient-Examples	6	700.24	116.71	3.35*
Groups: Std/Nonstd	1	335.32	335.32	9.62*
Residual	5	364.93	72.99	2.09 NS
Error (patient-example)	174	6063.29	34.85	
BP Phase x Patient-Example	6	900.29	150.05	3.96**
Error (BP Phase x patient-example	174	6589.95	37.87	

*$p < 0.05$
**$p < 0.01$
***$p < 0.001$

Hypothesis 2. From the second research question guiding this study, the following hypothesis was derived: internurse variability in blood pressure readings for patient-examples with standard Korotkoff sounds will be less than that of internurse variability in blood pressure readings for patient-examples with nonstandard Korotkoff sounds. The data used to investigate this hypothesis were the nurse accuracy scores (Accuracy score = Standard reading - Nurse reading). A single factor repeated measures analysis of variance using contrasts (standard sounds as compared to non-standard sounds) was used to analyze the accuracy scores. The analyses for the systolic readings are presented in Table 11; for the diastolic Phase 4 readings in Table 12; and for the diastolic Phase 5 readings in Table 13.

Systolic readings. As can be seen in Table 11, there was a significant difference in the accuracy of the blood pressure readings of the nurses according to patient-example. In addition, the readings of the patient-examples with standard sounds were significantly more accurate than were the blood pressure readings of the patient-examples with nonstandard sounds for both times of reading. Hypothesis 2 was accepted for the systolic readings.

Diastolic Phase 4 readings. In Table 12, it can be seen that there was a significant difference in nurse accuracy in blood pressure readings across all patient-examples, for both times of reading. When grouped according to patient-examples with standard and non-standard Korotkoff sounds, there were no significant differences in the accuracy of the blood pressure readings. Hypothesis 2 was rejected for diastolic Phase 4 readings.

Diastolic Phase 5 readings. In Table 13 it can be seen that there was no significant difference in nurse accuracy in blood pressure readings across all patient-examples, for either time of reading. When grouped according to patient-examples with standard and non-standard Korotkoff sounds, there were no significant differences in the accuracy of the blood pressure readings. Hypothesis 2 was rejected for the diastolic Phase 5 readings.

Table 11

Systolic Blood Pressure Reading Accuracy Scores:
Single Factor Repeated Measures Analysis of Variance

Significance of Differences on Nurse Systolic Blood Pressure Reading Accuracy Scores by Patient-Example at Time 1

	df	SS	MSS	F
Between Nurses	39	2170.98		
Within Nurses	240	4903.12		
All Patient-Examples	6	634.50	105.75	5.80**
Groups: Std/Nonstd	1	328.12	328.12	17.99**
Within Groups	5	306.38	61.26	3.36**
Error	234	4268.90	18.24	

Significance of Differences on Nurse Systolic Blood Pressure Reading Accuracy Scores by Patient-Example at Time 2

	df	SS	MSS	F
Between Nurses	39	1193.82		
Within Nurses	240	2879.11		
All Patient-Examples	6	253.09	42.18	3.76**
Groups: Std/Nonstd	1	112.20	112.20	13.32**
Within Groups	5	140.89	28.18	2.51*
Error	234	2626.03	11.22	

* $p < 0.05$
** $p < 0.01$

Table 12

Diastolic Phase 4 Blood Pressure Reading Accuracy Scores:
Single Factor Repeated Measures Analysis of Variance

Significance of Differences on Nurse Diastolic Phase 4 Blood Pressure Reading Accuracy Scores by Patient-Example at Time 1

	df	SS	MSS	F
Between Nurses	9	1385.20		
Within Nurses	60	4380.53		
All Patient-Examples	6	1223.77	203.96	3.49**
Groups: Std/Nonstd	1	82.97	82.97	3.36 NS
Within Groups	5	1140.80	228.16	3.90**
Error	54	3156.79	58.46	

Significance of Differences on Nurse Diastolic Phase 4 Blood Pressure Reading Accuracy Scores by Patient-Example at Time 2

	df	SS	MSS	F
Between Nurses	10	1354.08		
Within Subjects	66	5695.94		
All Patient-Examples	6	2156.25	359.39	6.09**
Groups: Std/Nonstd	1	181.93	181.93	2.89 NS
Within Groups	5	1974.32	394.86	6.69**
Error	60	3539.73	59.00	

** $p < 0.01$

Table 13

Diastolic Phase 5 Blood Pressure Reading Accuracy Scores:
Single Factor Repeated Measures Analysis of variance

Significance of Differences on Nurse Diastolic Phase 5 Blood Pressure Reading Accuracy Scores by Patient-Example at Time 1

	df	SS	MSS	F
Between Nurses	28	2379.60		
Within Nurses	174	7844.00		
All Patient-Examples	6	477.96	79.66	1.82 NS
Groups: Std/Nonstd	1	18.80	18.80	0.49 NS
Within Groups	5	459.16	91.83	2.09 NS
Error	168	7366.27	43.84	

Significance of Differences on Nurse Diastolic Phase 5 Blood Pressure Reading Accuracy Scores by Patient-Example at Time 2

	df	SS	MSS	F
Between Nurses	26	902.55		
Within Nurses	162	4010.99		
All Patient-Examples	6	139.25	23.21	0.94 NS
Groups: Std/Nonstd	1	74.48	74.48	3.39 NS
Within Groups	5	64.78	12.96	0.52 NS
Error	156	3871.88	24.82	

Hypothesis 3. From the third research question guiding this study, the following hypothesis was derived: Nurses with greater knowledge of the procedure for blood pressure determination will have less variability in their blood pressure readings than those with less knowledge.

The unit of analyses for this hypothesis was the nurses' mean blood pressure accuracy scores by patient-example according to the level of the nurses' scores on the Blood Pressure Procedure Knowledge Questionnaire. Analysis of variance indicated only one significant relationship between blood pressure accuracy scores and Questionnaire scores, that of patient-example A, the diastolic Phase 4 reading (see Table 14). Hypothesis 3 was accepted for patient-example A, diastolic Phase 4 reading, but rejected for all the other patient-examples.

Table 14

Nurse Mean Blood Pressure Accuracy Scores by Level of Questionnaire Scores, Patient-Example A, Diastolic Phase 4 Reading: ANOVA

	df	SS	MSS	F	F Prob
Between Questionnaire score groups	2	408.90	204.45	4.32	0.04
Within Questionnaire score groups	10	473.87	47.39		
Total	12	882.77			

The mean nurse blood pressure accuracy scores were inspected according to patient-example and blood pressure phase for each of the Questionnaire score levels. This data is listed in Table 15. Inspection of this data indicated that, while it was not statistically significant, the trend was in the right direction for patient-examples A, B, C, D, E, and F diastolic Phase 4 readings and B, C, D, E, F, and G for diastolic Phase 5 readings. This meant that the highest accuracy scores (highest accuracy score possible = 0.0, indicating no difference between the standard reading and the nurse reading) were associated with the highest Questionnaire scores and the lowest accuracy scores were associated with the lowest Questionnaire scores.

This same trend was not distinguishable for the systolic readings. However for all patient-examples (systolic readings A - G) the accuracy scores of the nurses with the highest Questionnaire scores were still greater than the mean of the accuracy scores for the nurses with average and low Questionnaire scores. This was also true for patient-example G, diastolic Phase 4 reading and A, diastolic Phase 5 reading. Thus, for all patient-examples, for those nurses with greater than 10 items correct on the Questionnaire, the blood pressure readings were more accurate when compared to the nurses who had less than 10 items correct.

Intranurse Variability

What is the intranurse variability in blood pressure reading? The answer to this question was obtained by comparing the blood pressure readings for each patient-example according to time of reading, time 1 and time 2, for each blood pressure Phase (systolic, diastolic Phase 4, and diastolic Phase 5). This analysis indicated 15 of the 21 patient-examples to be significantly correlated (see Table 7 for listing of correlations and level of significance). The six patient-examples which were not correlated were:

1. Cl and C2, systolic reading; four nurses contributed to this variability. The correlation was done without them and found to be significant ($p < 0.000$).
2. Cl and C2, diastolic Phase 4 reading; two nurses contributed to this variability. The correlation was done without them and found to be significant ($p = 0.01$).
3. Cl and C2, diastolic Phase 4 reading; one nurse contributed to this variability. The correlation was done without her and found to be significant ($p < 0.000$).

4. B1 and B2, diastolic Phase 4 readings. At least 9 of the 22 nurses using this phase were variable, so the correlation was not redone.

5. D1 and D2, diastolic Phase 5 reading; two nurses contributed to this variability. The correlation was done without them and found to be significant ($p < 0.000$).

6. E1 and E2, diastolic Phase 5 reading. One nurse contributed to this variability. The correlation was done without her and found to be significant ($p=0.002$).

In general, only a small number of nurses (N=7) contributed to the intranurse variability (except for patient-example B). On two occasions, one nurse contributed to the variability and on one occasion, she was the sole source of the variability.

Table 15

Means of Nurse Accuracy Scores According to Level of Blood Pressure Procedure Knowledge Questionnaire Scores by Patient-Example and Blood Pressure Phase

Level of Questionnaire Score*	Patient-Example							Blood Pressure Phase
	A	B	C	D	E	F	G	
Low	0.9	1.4	1.2	1.4	2.0	1.0	5.1	
Average	3.0	2.7	2.1	4.4	5.3	2.1	4.8	Systolic
High	0.8	1.1	0.9	2.0	4.4	1.0	2.1	
Low	17.3	27.6	6.7	9.8	11.6	12.3	6.0	
Average	5.6	18.9	5.5	6.2	8.6	7.4	7.0	Diastolic Phase 4
High	3.0	15.4	4.2	5.8	6.5	3.0	2.8	
Low	2.9	18.7	2.3	4.0	4.2	4.6	6.2	
Average	3.6	8.4	2.0	2.4	2.8	4.1	4.5	Diastolic Phase 5
High	2.6	0.0	0.7	1.9	1.7	3.2	2.3	

* Level of Questionnaire Score
Low = 3-7 items correct
Average = 8-10 items correct
High = 11-16 items correct

Hypothesis 4. From the fourth question guiding this study, the following hypothesis was derived: There will be no difference in intranurse variability in blood pressure readings for patient-examples with standard Korotkoff sounds as compared to the blood pressure readings of patient-examples with nonstandard Korotkoff sounds.

The unit of analysis for this hypothesis were the discrepancy scores of the nurses (Discrepancy score = Time 1 BP reading - Time 2 BP reading). The scores were subjected to a single factor repeated measures analysis of variance using contrasts (standard sounds as compared to nonstandard sounds). The results can be seen in Table 16. There were no significant differences in the nurse discrepancy scores by patient-example for the systolic, diastolic Phase 4 or diastolic Phase 5 readings. The blood pressure readings of the nurses for patient-examples with standard Korotkoff sounds had the same variability as the blood pressure readings of the patient-examples with nonstandard sounds. Hypothesis 4, therefore, was accepted.

Table 16

Blood Pressure Reading Discrepancy Scores:
Single Factor Repeated Measures Analysis of Variance

Significance of Differences on Nurse Systolic Blood Pressure Reading Discrepancy Scores by Patient-Example

	df	SS	MSS	F
Between Nurses	39	1019.37		
Within Nurses	240	4051.60		
All Patient-Examples	6	159.88	26.65	1.60 NS
Groups: Std/Nonstd	1	17.72	17.72	0.89 NS
Within Groups	5	142.16	28.43	1.71 NS
Error	234	3891.80	16.63	

Significance of Differences on Nurse Diastolic Phase 4 Blood Pressure Reading Discrepancy Scores by Patient-Example

	df	SS	MSS	F
Between Nurses	10	190.70		
Within Nurses	66	1618.28		
All Patient-Examples	6	145.35	24.23	0.99 NS
Groups: Std/Nonstd	1	37.44	37.44	1.54 NS
Within Groups	5	107.91	21.58	0.88 NS
Error	6	1472.93	24.55	

Significance of Differences on Nurse Diastolic Phase 5 Blood Pressure Readings Discrepancy Scores by Patient-Example

	df	SS	MSS	F
Between Nurses	29	2999.63		
Within Nurses	180	16018.55		
All Patient-Examples	6	612.16	102.03	1.15 NS
Groups: Std/Nonstd	1	159.00	159.00	2.23 NS
Within Groups	5	453.16	90.63	1.02 NS
Error	174	15406.64	88.54	

Intra as compared to Internurse Variability

Was intranurse variability in blood pressure reading less than that of internurse variability?

The unit of analysis for this question was the mean of the intranurse variance for the blood pressure reading of the patient-example as compared to the variance of the mean for all nurses. This data is summarized in Table 17, according to the systolic, diastolic Phase 4, and diastolic Phase 5 readings. As can be seen in this table, in most instance (18 out of 21 patient-examples or 86%) intranurse variance was less than internurse variance. The three patient-examples in which intranurse variance was greater than internurse variance were patient-examples: C, systolic reading, and D and E, diastolic Phase 5 readings.

Table 17

Mean Intranurse and Internurse Variance According to Patient-Example and Blood Pressure Phase

	Patient-Example							
	A	B	C	D	E	F	G	
Mean Nurse Variance								Blood Pressure Phase
Intranurse	8.70	5.48	12.21*	2.49	36.21	2.54	8.74	Systolic
Internurse	16.50	11.24	7.60	19.40	58.11	5.64	23.39	Readings
Intranurse	14.83	84.54	10.83	14.52	11.52	5.27	13.51	Diastolic 4
Internurse	99.81	162.82	23.60	107.60	134.86	41.30	49.42	Readings
Intranurse	12.88	83.29	8.78	16.87*	156.15*	8.87	21.40	Diastolic 5
Internurse	23.79	478.52	10.47	12.35	101.77	12.25	30.94	Readings

* Indicates those patient-examples in which mean intranurse variance was greater than mean internurse variance (N=3, 14%)

Nurse Reactions to the Study

The data regarding the nurses' reactions to the study were obtained from their statements made at the end of recording the blood pressure readings and at the end of the study. A general review of this data indicated all but three of the participating nurses had made some type of comment, that there were a wide variety of comments, and that many of the nurses had raised multiple issues in their comments. Because this data was qualitative rather than quantitative and as there was such a wide range of response, the decision was made to present the data in a descriptive manner.

The comments are discussed according to the categorization of behavior components in performance of blood pressure determination: the observer components and the environmental components (refer to Table 1 for listing), as developed in Chapter 2. Following this presentation, the comments regarding the methodology of the study are presented.

Observer Components

In this study, knowledge, capacity, and motivation were identified as the three aspects necessary for performance found in the person's repertoire. A review of the nurse comments indicated that none of them could be clearly characterized as dealing with capacity or motivation. With regard to knowledge, over half of the nurses indicated that the study had pointed out to them deficiencies in their knowledge: "I thought I knew a . . . lot more . . . I'm a little surprised"; "I take the principle for taking BP's rather lightly and have not previously considered myself with such finite aspects of the procedure". For the nurses, this finding was a source of concern: "I was not sure of my answers and felt that I should know the correct answers". The knowledge-base most frequently cited as lacking was that of knowledge about the Korotkoff sounds -- their general interpretation and, in particular, the phenomenon of the auscultatory gap. Most of these nurses wanted to obtain the AHA standards and some of them wanted to go over the study.

Environmental Components

The setting of standards and giving feedback regarding performance, the availability of equipment, and the use of incentives were identified as the three aspects necessary for performance found in the environment. Over one-half of the nurses stated they thought that basic nursing education in blood pressure determination was inadequate either in content, in the method of teaching and supervising, or in both. Four nurses commented on the problem of variability among observers "everybody has a different method" and two inservice instructors commented that they had assumed competence in this skill when hiring/orienting new personnel. Only one nurse commented on the lack of and poor condition of BP equipment. None of the comments could be clearly categorized as relating to inadequate incentives. One nurse best summarized the data, stating ". . . with many skills (nursing) there has been a wide variety of teaching and techniques of performing . . . They are subjects that are not discussed among nurses . . . These basic skills have not been updated in any inservice programs where I have worked".

Methodology Comments

These comments are discussed according to the Blood Pressure Sounds Tape, the Blood Pressure Procedure Knowledge Questionnaire, the Blood Pressure Teacher (the machine), and general comments.

The blood pressure sounds tape. Almost one-half of the nurses commented that they thought the tape was too slow or too long. Some of the nurses agreed that only the time between examples was too long while others thought that the time allotted for each example was too long, creating problems in concentration. A few nurses commented they would have preferred to write the systolic reading as it happened rather than waiting till the end, and a few nurses commented they would have preferred an opportunity to repeat some of the readings, particularly with the more difficult patient-examples. Some of the nurses reported that blood pressure sounds were very clear and a few nurses expressed concern that this was not realistic. A few nurses reported that they were unfamiliar with the types of patient-examples given on the tape while others thought that there was good variation of the blood pressure sounds. Three of the nurses noted that the BP's were repeated and questioned why.

The blood pressure Teacher. Two of the nurses commented that they thought the Teacher would be an effective instructional device. One nurse thought that the systolic reading was too easily anticipated and this should be changed.

The Blood Pressure Procedure Knowledge Questionnaire

Two of the nurses reported they found the Questionnaire the most difficult part of the study. One nurse thought the items regarding the Korotkoff sounds were confusing and one nurse stated she could not answer those items as she did not know if her idea of the Phases agreed with that in the Questionnaire. A few of the nurses indicated that hearing the blood pressure sounds tape focused their attention and helped them answer some of the Questionnaire items. A few nurses stated they found it difficult not to guess.

General Comments

In general the nurses agreed that while they felt uncomfortable if they did not know how to respond to an item, they found the content challenging. One nurse commented she thought a post-test would be interesting, wondering if the study would encourage people to update their knowledge.

Summary

This chapter has presented the results by which to answer the general aim of this study, that of determining if there is potential for improvement in nursing knowledge of blood pressure determination. The sample was described. The data obtained from the Questionnaire and the blood pressure sounds tape was presented according to the aims and questions of the study, within the categories of internurse variability, intranurse variability, and intra as compared to internurse variability. The chapter concluded with a general description of the data reflecting the reactions of the nurse-subjects to the study.

CHAPTER 5

CONCLUSIONS AND IMPLICATIONS

Introduction

The framework, the methodology, and the results of this study have all been presented. The purpose of this final chapter is to discuss the results, to draw conclusions and to present the implications of the study for nursing education and practice. The limitations of the study and the discussion of the results and conclusions are presented according to the aims of the study. The chapter ends with a discussion of the implications of the study.

Study Limitations

The interpretation and generalization of the results of this study must be viewed within the limitations of the study. Towards this end, the limitations of the sample, the study approach, and the tools of the research are presented and discussed.

The Sample

Because this study utilized nonrandom sampling, generalization of the conclusions from the sample population to the target population of all nurses is not statistically justifiable. Departure from random sampling may have affected the representativeness of the sample in a number of ways.

According to 1974 statistics, only 3.3% of employed nurses have a master's degree (DHEW Pub. No. (HRA) 75-43, p. 69). Since all of the nurses in the study were enrolled in a master's program in nursing, it could be argued that the sample was not representative of the nursing population. This realized limitation is mitigated by the fact that this sampling strategy enabled the investigator to sample nurses with experience and employment in a wide range of settings as evidenced by the demographic data (Appendix F). Inspection of this data indicated that while certainly not all kinds of nurses were represented (for example, nurse anesthetists, occupational health nurses), a reasonable cross-section of nurses in terms of position, practice, type of setting, age, number of years active in nursing, and currency of employment, participated in the study.

Did participation in the master's program itself affect the nurse's knowledge of blood pressure determination? For this sample, the answer is no. None of the nurses reported receiving instruction in this skill concurrently with their master's study. Only 15% (N=6) of the nurses reported any further instruction in blood pressure determination since the time of their basic training. This finding is congruent with the investigator's experience that blood pressure determination is considered a skill taught at a basic level, and thereafter, competency is assumed by both the nurse herself and her employer. The concern that the volunteer nature of the sampling process would yield a sample of only those nurses who felt very confident in their skill in blood pressure determination was found to be without basis. Although the purpose and methods of the study were explained by the investigator at the time of recruitment, it was found that at the time of participation while many of the nurses knew the study was about blood pressure, they were unclear as to its focus.

In the planning of the study, consideration had been given to testing the hearing and vision of the participants. This was discarded for two reasons: first, the testing procedure itself would have increased an already operant Hawthorne effect by sensitizing the nurses to the issues of vision and hearing; and second, in the clinical setting, the nurse usually makes the decision as to her degree of impairment based on such input as her present health, results of previous physical examination, and the degree of any perceived difficulties. It was believed the same would hold true for the research setting. Thus, if any nurse contributed to variability in the blood pressure readings by reason of a visual or hearing defect, the same would hold true of her performance in the clinical setting.

One final concern was whether or not to include nurses who did not routinely take blood pressures in their practice. With respect to the aims of the study, it did not seem logical to determine potential for improvement of a skill that was not practiced. The decision was made, however, to include such nurses on the basis that blood pressure determination is considered a basic nursing skill and previous research had demonstrated no relationship between frequency and competency in blood pressure determination. In this study sample, only 5% of the nurses did not routinely take blood pressure.

The Study Approach

The rationale for the study approach taken was given in Chapter 2. The chief limitation of this approach was that the use of a laboratory setting limited the focus of the study to one aspect of performance in blood pressure determination -- knowledge -- and even this aspect was not studied under the usual clinical conditions. While this approach markedly limited the external validity of the study, it was believed to be the most feasible to answer the study aims because control of extraneous variables in blood pressure determination was necessary in order to measure nursing knowledge of the procedure.

The Tools of the Research

The tools for this study were developed by the investigator and the limitations inherent in their design are discussed.

The blood pressure sounds tape. Many issues surround the use of a tape of blood pressure sounds to determine nursing knowledge in the interpretation of Korotkoff sounds.

The Hawthorne effect. The use of the tape may have focused the nurses' interest and may have increased the consistency of the blood pressure readings of some of the nurses who may not be consistent in the practice setting.

The quality of the sounds. The blood pressure sounds were probably clearer than those generally heard by some nurses in practice. This could have operated either to increase (easier to interpret) or decrease (clarity was unfamiliar) the nurse's reliability as compared to that in her clinical practice. The blood pressure sounds might have been clearer either because of the nature of the tape or because some nurses were not accustomed to critically listening to the sounds.

Anticipation of the systolic reading. The systolic reading could be anticipated because the needle started to pulsate about 20 mm Hg above the systolic reading. This was not considered a serious limitation because in practice nurses can generally anticipate the systolic reading based on a number of sources: palpation before auscultation, knowledge from previous BP readings, and, in some cases, the manometer similarly pulsates when taking blood pressure on actual patients.

Rate of needle descent. The rate of descent of the indicator needle was slower than what had been desired; this may have led to problems in concentration and retention for some nurses. Using the 2 mm/second cuff deflation rate, the average extra time per patient-example was 6.8 seconds, with a high of 24 seconds for patient-example D1-D2 and no extra time for patient-examples B1-B2 and C1-C2.

Time between patient-examples. The time allotted between patient-examples was found to be excessive and may have contributed to lapses in attention. Even though requested not to most of the nurses recorded their readings immediately upon the cessation of the sound but before the indicator needle had reached zero on the manometer. This behavior (which would not be possible in practice) led to increased waiting time between patient-examples above and beyond that which had been prepared for.

Time and patient-example. A concern that the time 1 and time 2 readings could be systematically different because of fatigue or a learning effect was examined. The blood pressure reading accuracy scores of the nurses were subjected to a two factor repeated measures analysis of variance which indicated no significant differences for time as the main effect or for time by patient-example interaction (data in Appendix J). Thus, for this sample, time had no apparent effect on accuracy in blood pressure reading.

No blood pressure repeat advantage. In using the blood pressure sounds tape, there was no opportunity to immediately repeat a reading. This is, of course, possible in clinical practice so this aspect was a recognized disadvantage. This disadvantage was believed to be balanced by the fact that the difficulties associated with the interaction of the patient and the equipment were removed and that the quality of the sounds was not dependent upon the nurses' technique. Since only three nurses commented on the repetition of the patient-examples, it was difficult to ascertain if the repetition was recognized and, if recognized, it was perceived as an opportunity for a repeat blood pressure reading.

Representativeness of the tape. The sound patterns presented on the blood pressure sounds tape may or may not have been similar to those the nurse was accustomed to hearing. For a nurse practicing among healthy adults the sound patterns would be less representative than those usually heard by nurses working in an acute care facility. While certainly not all blood pressure sounds were represented it was believed that there was a reasonable variety of commonly occuring standard and nonstandard Korotkoff sounds on the tape which were representative of a wide range of patient conditions. Representation of patient conditions was more appropriate than representation of nurse practice settings so as to answer the study question regarding nurse ability to interpret various blood pressure sound patterns. It was reasoned that if increased variability was found for nonstandard sound patterns, then the aspect of nurse setting could be studied.

The Blood Pressure Procedure Knowledge Questionnaire

Paper and pencil testing of a skill always has its inherent limitations because, as has been described, performance has aspects other than knowledge. A nurse may score high on the Questionnaire but not obtain reliable blood pressure readings in the clinical setting because of problems in her capacity (e.g., difficulties with manual dexterity or she may encounter disadvantages in the environment (e.g., unavailability of proper equipment). (The counter argument that a nurse may be reliable, but do poorly on the Questionnaire is discussed under Hypothesis 3 in this chapter.)

In retrospect, some of the items on the Questionnaire need to be rewritten. The items on cuff size, for example, might be easier to conceptualize if drawings rather than numbers were used. The items on the auscultatory gap are interdependent and the answers can be problem-solved.

The item as to which Korotkoff phase represented diastolic blood pressure was a particularly vexing problem to the investigator. The decision was made to accept as a correct answer Phase 4, Phase 5, or Phase 4 and 5 because of the controversy in this area. However, lack of uniformity among nurses as to the answer for this item certainly runs counter to increasing nursing reliability in blood pressure measurement.

In summary, the limitations of the study which may affect the generalizability of the study to the clinical setting are the sampling technique employed and the research approach chosen. Within these limitations, the next section discusses the results and conclusions of the study.

Results and Conclusions

In this section, the data obtained from the Blood Pressure Procedure Knowledge Questionnaire and the Blood Pressure Sounds Tape are discussed according to the aims of the study. The investigator's interpretation of the nurse comments regarding the study are presented. The section ends with a summary of the results and conclusions.

Aim 1

Was there variability among nurses in their knowledge of the procedure of blood pressure determination? Within the limits of the Questionnaire, for this sample of nurses, the answer was yes.

The data indicated a range of 13 points on the 20 item knowledge Questionnaire, with no nurse correctly answering all the items. More items were answered incorrectly (mean = 6.4) than "don't know" (mean = 4.7), indicating that nurses who thought they knew the correct answer, in truth, did not. When grouped according to the categories of blood pressure procedure knowledge, except for the auscultatory gap items, no clear pattern of deficiency emerged; the average deficiency for all categories equaled 62%. The auscultatory gap items may have had a greater deficiency than the others for two reasons. First, the interdependency of the items may have yielded a false high; this probability is lessened by the fact that nurses have indicated they could "figure the answers out". The second, and most likely probability congruent with the investigator's experience, was that nurses were unfamiliar with the phenomenon and so a clear pattern of deficiency emerged.

The nurse subjects performed very poorly on two items on the Questionnaire which are of practical importance to nurses. These items were identifying the criterion for cuff width and choosing techniques to augment audibly difficult Korotkoff sounds. In conclusion, therefore, it can be said that not only was there variability among nurses in their knowledge about the procedure for blood pressure determination, there was also much potential for improvement in nursing knowledge of the procedures for blood pressure determination.

Aim 2

Was there nurse variability in the interpretation of the Korotkoff sounds for the purpose of blood pressure measurement? Within the limits of the study approach the answer is yes. This answer is discussed according to the categories previously developed: internurse, intranurse, and inter as compared to intranurse variability. A general discussion of the variability among nurses in their choice of the indicator for diastolic blood pressure is presented first as this variability is so important to a discussion of the implications of the study.

Nurse Choice of the Indicator of Diastolic Blood Pressure

There was a lack of clarity and uniformity both among and within nurses in their choice of the indicator of diastolic blood pressure. This was indicated by their varied responses to the question relative to their choice of diastolic criterion and by the difficulties encountered by the investigator in transfering individual nurse blood pressure readings for analyses. This variety of responses was probably a reflection of the current controversies regarding this issue. The Joint National Committee on Detection, Evaluation, and Treatment of High Blood Pressure recommends using Phase 5 (1978) while the American Heart Association recommends using Phase 4 and also recording Phase 5 (1967). Dr. Herbert Langford, the American Heart Association's representative to the

Joint National Committee, recommends using Phase 5, as there is more variance with Phase 4 and it is more difficult to train observers (Langford, personal communication, 1977). The Task Force on Nursing in High Blood Pressure Control recommends adherence to the AHA standards (1977). It would seem most logical for nurses to adhere to the recommendations of the Nursing Task Force and use the AHA standards. However, how clear are these standards?

In reply to the investigator's query about the measurement of the diastolic blood pressure, the American Heart Association said:

> . . . it was recommended that blood pressure be recorded at the fifth phase in community mass screening programs and this was stated in our publication, "High Blood Pressure Control: A Guide for Community Programming".
> Recording at the fourth and fifth phases was recommended in one of our publications for physicians entitled "Human Blood Pressure Determination by Sphygmomanometers" (1967). This publication was for the guidance of practicing physicians and those functioning in hospital settings, research projects, teaching, etc . . .

Until there is a change in AHA standards, it is suggested that you consider adherence to those recommended in the publication "Human Blood Pressure Determination by Sphygmomanometers" (1967). (Paul, A., personal communcation, 1978)

The inverstigator's interpretation of the above response was that there are two sets of standards, one for mass screening programs (Phase 5) and one for "other occasions" (Phase 4 and 5). The AHA was expected to release more current guidelines in May, 1978, but these have not been forthcoming as of yet.

Within the controversy, what is clear is that nursing performance in blood pressure determination is dependent on nursing knowledge. Nursing knowledge, however, is interdependent with the environmental component of the setting of standards and evaluation regarding the use of standards. Thus, nursing performance in blood pressure measurement is dependent on the resolution of the diastolic measurement issue.

Internurse Variability

Hypothesis 1A. This hypothesis predicted that systolic blood pressure would be read with less variability than diastolic Phase 4 blood pressure. In 64% of the patient-examples systolic blood pressure was read with less variability than the diastolic Phase 4 blood pressure; in 36% of the patient-examples it was not read with less variability (data in Table 9). In an effort to explain why the systolic pressure was not read with less variability than the diastolic Phase 4 blood pressure in 36% of the patient-examples, the pairs of patient-examples in which the findings were consistent were examined.

In only one pair were the findings consistent; patient-example G1-G2. Patient-example G1-G2 represented a patient with atrial fibrillation. In this patient-example, after the initial systolic sounds were heard, the blood pressure sounds waxed and waned. Perhaps for some nurses the reading of the systolic pressure was more of a continuous rather than a dichotomous judgment and so it was read with the same variability as the diastolic Phase 4 pressure. The reason for the inconsistent findings for the other patient-examples was not clear but was probably related more to observer error than to the blood pressure phase itself.

Hypothesis 1B. This hypothesis predicted that systolic blood pressure readings would be read with less variability than diastolic Phase 5 readings. As the data indicated that systolic blood pressure was read with less variability than diastolic Phase 5 blood pressure only one-half of the time, the blood pressure readings of the pairs of patient-examples in which there were no differences were examined. Patient-examples C1-C2 and E1-E2 had the same amount of variability in their systolic and diastolic Phase 5 readings.

Patient-example C1-C2 represented a patient with standard Korotkoff sounds. The systolic pressure judgment was probably as easily made as the diastolic Phase 5 judgment and so there was no difference in nurse variability according to phase. The same was not true of patient-example F1 and F2, another example with standard sounds. This was probably because diastolic Phase 5 in this patient-example was low-pitched and more difficult to ascertain and so it was read with greater variability. The findings of F1 and F2 illustrate the objection some authorities have to the use of Phase 5, i.e, that is dependent upon the hearing acuity of the observer.

Patient-example E1-E2 represented a patient with an auscultatory gap. In this patient-example, systolic pressure was read with greater variability than diastolic Phase 5 pressure because of the gap. Some of the nurses recorded the systolic pressure at the end of Phase 1 while others recorded it at the beginning of Phase 3. This finding, together with the mediocre performance in the Questionnaire on the items relating to the auscultatory gap, illustrated the need for improvement in nursing knowledge about the auscultatory gap.

The findings of the analyses of Hypothesis 1 according to the stability approach of reliability left unanswered many questions because an across patient-examples and across nurse comparison was not statistically possible. For this reason, the hypothesis was subjected to a secondary analysis using the nurse blood pressure accuracy scores, the accuracy approach to reliability.

When the systolic readings were compared to the diastolic Phase 4 and to the diastolic Phase 5 readings by means of repeated measures analysis of variance using the accuracy scores, the findings were easier to interpret. As predicted, systolic readings were less variable than either diastolic Phase 4 or diastolic Phase 5 blood pressure readings (data in Table 10). Hypothesis 1, therefore, was accepted. As the unit of analyses was the nurse accuracy scores, the data indicated that systolic blood pressure were read more accurately than diastolic blood pressures. This analysis confirmed the trend found in the earlier general inspection of the data and demonstrated that the reading of diastolic blood pressure by nurses is variable, less accurate than systolic, and definitely in need of improvement.

Hypothesis 2. This hypothesis, predicting that internurse variability in blood pressure readings for patient-examples with standard Korotkoff sounds would be less than that for patient-examples with nonstandard sounds, was accepted for the systolic readings and rejected for the diastolic Phase 4 and diastolic Phase 5 readings. The unit of analysis used to test this hypothesis was the nurse accuracy scores. The data indicated that the nurse systolic blood pressure readings for patient-examples with standard sounds were more accurate than those for patient-examples with non-standard sounds. This means that there is greater deficiency in nursing knowledge regarding the reading of systolic blood pressure for patients with nonstandard sounds and that nursing knowledge in this area needs to be improved.

The finding that there were no significant differences in accuracy scores for the diastolic Phase 4 and the diastolic Phase 5 readings is spurious. While the nonstandard sounds were read with the same accuracy as the standard sounds, the diastolic blood pressures were read with less accuracy than the systolic blood pressures (as discussed under Hypothesis 1). Thus the inaccuracy in blood pressure readings for the diastolic

Phase 4 and 5 readings was not limited to the nonstandard sounds. Diastolic Phase 4 and diastolic Phase 5 readings, as a whole, needed to be improved.

Hypothesis 3. This hypothesis, predicting that nurses with greater knowledge of the procedure of blood pressure determination would have less variability in their blood pressure measurements than those nurses with less knowledge, was rejected. At issue here is whether there was no relationship between knowledge of the standards for blood pressure determination and accuracy in blood pressure determination or whether the hypothesis was inadequately tested. In light of the trends demonstrated in the data, the investigator believes the latter to be the more reasonable conclusion.

In retrospect, the division of the nurses into three groups according to the scores on the Questionnaire probably did not clearly distinguish the nurses with very high scores from those with very low scores. A high score was defined as one in which the number of correct items exceeded ten. Thus, nine nurses were included in this category who at best only had 65% of the 20 items correct. The investigator believes that with a larger sample, more nurses with truly high scores could be located; the division could then be done more appropriately for analysis.

Another explanation of the failure to find a strong relationship between knowledge and accuracy of blood pressure determination could be that the tools, while both testing nurse knowledge of the procedure of blood pressure determination, actually measure different aspects. The Questionaire measures general knowledge about procedural standards while the Tape measures knowledge about interpretation of the Korotkoff sounds both in standard and nonstandard conditions. To increase the congruence between the similarity of the knowledge base tested by both tools, the Questionnaire could be adapted to include items about the interpretation of the Korotkoff sounds in nonstandard conditions, as exemplified on the Blood Pressure Sounds Tape.

Intranurse Variability

Hypothesis 4. This hypothesis, predicting that there would be no difference in blood pressure readings for patient-examples with standard Korotkoff sounds as compared to the blood pressure readings of patient-examples with nonstandard Korotkoff sounds was accepted. The data indicated that the nurses' blood pressure readings were consistent regardless of the type of blood pressure sounds. The readings for the paired patient-examples were significantly correlated in 71% of the cases; of the reamining 29% of the cases, only seven nurses (with the exception of patient-example B1-B2) contributed to intra-nurse variability.

Did consistent readings imply accurate readings? The data indicated no clear relationship between consistent readings and accurate readings when the correlations and the percentage of nurses not within the stipulated ±5 mm Hg accuracy range were compared. For patient-example E1-E2, diastolic Phase 4 reading, there was a significant correlation between the time 1 and time 2 reading but an average of 52% of the nurses were outside of the ±5 mm Hg accuracy range. On the other hand, for patient-example C1-C2 systolic readings, there was no correlation between the time 1 and time 2 reading, but only 7% of the nurses fell outside of the ±5 mm Hg accuracy range. Therefore, while both consistent and accurate blood pressure readings are desirable, these data indicate that the presence of one dimension does not necessarily ensure the presence of the other.

Intra as Compared to Internurse Variability

The data indicated that for 86% of the patient-examples, the nurses agreed more with themselves as to the blood pressure readings than they agreed with each other. The framework for this study predicted that, in the absence of the use of a standardized technique, there would be more interobserver variability. Only 12% (N=5) nurses in this study stated they used the AHA standards for blood pressure determination. Therefore, a large majority of the nurses were probably reading the blood pressure without reference to a standard criterion; hence the greater internurse variability.

The small amount of intranurse variance demonstrated the self-standardization of the nurse, that is, the nurses were internally consistent. However, in the absence of decision rules discussions, the nurses were not other-standardized; hence there was internurse variability in the blood pressure readings.

Intranurse variance was generally smaller than internurse variance. In three cases where there was a large degree of intranurse variance, internurse variance was smaller than intranurse variance (see correlations for patient-examples C systolic reading, and D and E diastolic Phase 5 reading, in Table 7). This intranurse variance was due to a small number of nurses. Therefore, when a small number of nurses are responsible for a large amount of intranurse variability, intranurse variability will be greater than internurse variability. When a large number of nurses have both a great degree of intra and inter observer variability, intranurse variance is still smaller than internurse variance (for example, see patient-example B).

Nurse Comments Regarding the Study

From the qualitative data regarding the nurse comments about the study, the investigator obtained three general impressions. First of all, the study did sensitize the nurses to issues in blood pressure determination and this sensitization led the nurses to question their knowledge-base about the procedure and to many questions regarding the strategies and results of the study. Secondly, the nurses as a group were not satisfied with their basic education in blood pressure determination; most of the nurses responded that there were aspects about the procedure of which they were uncertain and that, as a whole, they perceived that the procedure was performed with variability among nurses. Thirdly, although there was no general agreement, some of the limitation of the study tools identified by the investigator, were also labeled as such by the nurse participants.

Summary of Results and Conclusions

Within the limitations of the approach, the sample, and the tools selected for the study, the following characteristics of nursing knowledge in blood pressure determination were derived.

The large majority of nurses received their only education in blood pressure determination in their basic nursing program; and, except for a very small minority of nurses, the American Heart Association Standards for blood pressure determination were not known or utilized. There was wide variability among nurses in their knowledge of the procedure and, most importantly, there was potential for improvement in all aspects of knowledge of the procedure.

When the accuracy indicator of ± 5 mm Hg was applied, the following approximation of nurses were found to be out of range: one tenth of the nurses for the systolic readings, one half of the nurses for the diastolic Phase 4 readings, and one quarter of the nurses for the diastolic Phase 5 readings.

When the nurse blood pressure readings were compared according to the blood pressure phase (by the accuracy approach), the systolic readings were less variable than the diastolic readings.

When the nurse blood pressure readings were compared according to the type of blood pressure sounds, the systolic standard sounds readings were more accurate than the nonstandard sound readings. The diastolic

Phase 4 and the diastolic Phase 5 readings were inaccurate, regardless of whether the patient-examples had standard or nonstandard sounds.

When comparing nurse knowledge and accuracy in blood pressure reading, except for one patient-example, no significant relationships were found. However, a trend in which nurses with greater knowledge were more accurate than nurses with less knowledge was apparent.

The blood pressure readings of the patient-examples were not significantly different according to time of reading except for six cases, in which only a small number of nurses contributed to the nonsignificant correlations (except for patient B). Intranurse variability in blood pressure reading was not related to the type of blood pressure sounds, i.e., standard and nonstandard.

When comparing intra to internurse variability in blood pressure reading, nurses were found to agree more within themselves than with each other for the large majority of the blood pressure readings.

On the basis of the above data it was concluded that nursing knowledge and practice in blood pressure determination needed to be improved, particularly in the knowledge of the standards of the procedure in general and in determining the blood pressures of patients with nonstandard sounds. Intranurse consistency in blood pressure readings did not necessarily imply accuracy among nurses. Knowledge of and utilization of standards threatened nursing reliability in blood pressure readings, particularly diastolic blood pressures.

Implications

It was a paradox, in this time of emphasis in nursing on physical assessment skills, to find nurse knowledge of the procedure of blood pressure determination to be less than exemplary. It was ascertained that when given standard conditions relating to blood pressure measurement, nurses were able to respond reliably; however, when given conditions that differed from the ordinary, nurses did not respond reliably. This variability raises the question: "How closely do nurses examine, with what specificity can they describe, how fully do they understand, the phenomena with which they deal every day?" (Lewis, p. 221, 1975). Variability in nurse knowledge about the aspects of blood pressure determination is an impediment to nursing practice based on scientific principles and is incongruous with the end of achieving exemplary performance for this common clinical observation.

To achieve exemplary performance in blood pressure determination, the accomplishment -- reliability -- has to exceed the cost of the nurse's repertoire and the supporting environment. Because it was ascertained that the accomplishment -- reliability -- was less in nonstandard as compared to standard conditions, a perplexing performance discrepancy for a single task emerged which must be addressed. How can the variability in accomplishment for blood pressure determination be explained? Is there a unifying concept which would assist in comprehending how various levels of performance were found for a single task?

To answer this question, it is useful to consider performance in blood pressure determination within the concept of inert and active tasks. All tasks offer some resistance to the achievement of a desired error-free outcome. What is critical, and distinguishes inert from active tasks, is the variability and predictability in the amount of resistance of a task. Active tasks, as compared to inert tasks, are those in which the amount of resistance is unpredictable and highly variable; active tasks require decision making and judgment. Active tasks, because they present with many variables, require workers who have the complete knowledge necessary to permit them to make the judgment about the resistance likely to occur. Inert tasks are those that are standardized and routine (Kramer, 1974, 1977).

As a task, blood pressure determination could be conceptualized as either inert or active. If it is conceptualized as an inert task, it must be considered as routine, as a procedure for which minimal decision-making is required. As an inert task, it would be a procedure for which the components that affect exemplary performance are few and nonvarying because patient and environmental factors offer predictable and constant degrees of resistance. To the extent that these suppositions can be applied to performance in blood pressure determination, the procedure is inert. However, to the extent that decision making and judgment is necessary to determine the predictability and variability of the patient and the environmental resistances towards affecting exemplary performance, blood pressure determination is an active, not an inert task.

The problem with conceptualizing blood pressure determination as inert is that the associated suppositions of an inert task are incongruous with the multiple and variable components affecting exemplary performance in blood pressure determination. The danger in conceptualizing blood pressure determination as inert is that by focusing on task performance per se, rather than on the resistance offered by patients and environments to task performance, patients and nurses are also perceived as inert. Patients and environments do offer variable and unpredictable resistance to accomplishing reliability in blood pressure determination and that is what makes exemplary performance in blood pressure determination the active nursing task that it is.

It is the responsibility of the nurse to differentiate the variability and predictability in the amount of resistance present to overcome the resistance and effect exemplary performance. For example, for patients with normal cardiopulmonary states, under the standard conditions of blood pressure measurement, the margin of error in blood pressure determination is likely to be small and the accomplishment -- reliability -- is likely to be achieved by an observer with minimal training. However, under other conditions the factors affecting reliability are numerous, the knowledge base necessary to perform the procedure is greater and patient and environmental factors offer many and variable resistances. Under such conditions, unless the observer utilizes discretion and judgment, the margin of error is likely to be larger and the accomplishment -- reliability -- not achieved. Such would be the case in obese patients, in patients in whom proper positioning is difficult, and patients in whom, because of their cardiopulmonary status, the Korotkoff sounds diverge from the standard pattern. Whatever the case, the point is that decision making and judgment is necessary to assess on an individual basis the appropriate plan for blood pressure determination for the patient. This assessment of the amount, predictability, and variability of resistance associated with blood pressure determination is based on nursing knowledge and experience and is essential to effecting exemplary performance.

How is exemplary performance in blood pressure determination by nurses attained? The answer to this question is found within the behavior engineering model when it states that behavior is unitary in nature and through the interplay of the nurse's repertoire and the supporting environment emerges the diffusion of effects. Nursing performance in blood pressure determination exists only as a function of the ratio of the accomplishment -- reliability -- to the interaction of the nurse's repertoire and the environment. Therefore, strategies to effect exemplary performance in blood pressure determination must then consider both the nurse and her repertoire and the aspects of the environment.

Further Nursing Research

Because the conclusions of this study were similar to the areas of concern raised by previous investigators, further studies of nursing deficiencies in blood pressure determination per se would not be very fruitful. Rather, it is believed to be more advisable to undertake studies to determine how to operationalize the potential for improvement into actual exemplary nursing performance in blood pressure determination. Towards this end the following issues are raised.

Have nursing educational programs adopted the behavioral objectives of the Task Force on the Role of Nursing in High Blood Pressure Control as the basis for their instruction in blood pressure determination? Are nurses who are taught according to these objectives more reliable in their blood pressure determinations as compared to those who are not? What are the situations in which patient and environmental factors offer unpredictable and variable resistance towards reliable blood pressure readings? How can nurses be taught to effectively distinguish the variable resistance factors so as to overcome them and effect exemplary performance in blood pressure determination?

While this study did not measure the effects of the environment on nursing knowledge in blood pressure determination, this component of performance is integral to nursing accomplishment. In reviewing the literature, and the results of this study, many issues came to mind which are raised here as ways to investigate nursing performance from the viewpoint of the type of environment in which the nurse practices.

If nurses adhered to standards and provided feedback as to performance in blood pressure determination, would there be increased reliability for the procedure in the clinical setting? What measures are most effectively undertaken by nurses to ensure uniformity among nurses in the measurement of diastolic blood pressure? If proper equipment was available in the clinical setting, would blood pressures be read with greater reliability? Are there new mechanical means of blood pressure determination which need nursing investigation and, perhaps adoption to facilitate exemplary performance in blood pressure determination?

In many instances, blood pressure determination is no longer done by nurses but is delegated to other personnel. While for some blood pressure determination this may result in exemplary performance, for others it may not. In which situations is delegation of blood pressure determination appropriate? If nurses did or did not delegate blood pressure determination on the basis of assessed patient and environmental resistance factors, would this result in exemplary performance in blood pressure determination?

In conclusion, the quality of nursing performance for this common clinical observation has the following implication: "For it may safely be said, not that the habit of ready and correct observation will by itself make us useful nurses, but that without it we shall be useless with all our devotion" (Nightingale, 1859, as cited on p. 199 of 1946 facsimile). Towards the end of achieving the habit of ready and correct observation, nursing knowledge for the procedure of blood pressure determination needs improvement, particularly in those situations in which patient and environmental factors offer unpredictable and variable resistance to exemplary performance.

It is the responsibility of nurses to have the knowledge base necessary to distinguish the situations in which blood pressure determination is predictable and nonvariable and in which situations it is unpredictable and variable. Strategies need to be identified to increase nursing knowledge of the procedure so that nurses are able to distinguish the proper ratio of accomplishment to costs to effect exemplary performance in blood pressure determination. Strategies are probably also needed to ensure that the environment is conducive to optimal nursing practice in blood pressure.

It is hoped that this study was helpful in determining the nursing knowledge repertoire necessary to effect exemplary performance and the habits needed to attain ready and correct observation in blood pressure determination so as to be useful nurses.

Summary

This chapter presented the results and conclusions with respect to their implications for nursing education and nursing practice in blood pressure determination. The implications of the study were discussed and questions were raised as possible avenues for further nursing research. The chapter concluded with the investigator's perceptions of the direction for change necessary for exemplary nursing performance in blood pressure determination.

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APPENDICES A, B, C, and D

The Study Packet as Presented to the Nurse-Subjects:

APPENDIX A	Consent Form
APPENDIX B	Introduction and Blood Pressure Sounds Tape Response Form
APPENDIX C	Blood Pressure Procedure Knowledge Questionnaire with Response Form
APPENDIX D	Demographic Data and Comment Forms

Note: The content, and order of content, of the written component of the study presented here is identical to that of the actual study. The exact spacing of individual items may not be because of the limitations of thesis style.

APPENDIX A

CONSENT FORM

University of California, San Francisco
Consent to Act as a Research Subject
Protocol No. 930226-01

I understand that the purpose of this study is to obtain knowledge about the factors involved in the measurement of blood pressure by nurses. I understand that I will be asked to listen to prerecorded blood pressure sounds and respond in writing as if I were recording a blood pressure. I understand that I will be asked to complete a survey which will ask questions regarding my current nursing practice, my experience in taking blood pressure, and my knowledge about the procedure for blood pressure determination. I understand that while there is no anticipated physical, social, or psychological risk, I may feel uncomfortable if I am not sure how to respond to an item. I understand that the investigator will be present while I am participating so I may obtain any needed support and guidance.

I understand that my name will not be recorded and that my answers will be used only by the investigator in the analysis of the data. I understand that I may withdraw at any time without penalty and definitely without jeopardy to my professional status or progression through the graduate program.

I understand that there will be no benefits to me personally, but it is possible that the information sought will help to develop means for improvement of nursing practice. I am not being compensated for my participation.

Mrs. Patricia Dervin, a graduate nursing student, has explained this study to me. She can be reached at (707) 823-2839 if I have any questions.

__________________ Date

__________________________ Signature

APPENDIX B

Blood Pressure Study

Introduction

To the Participant:

This study about nurses and blood pressure determination is divided into four parts:

Part 1 A Blood pressure Sounds Tape with a Response Form

Part 2 A Blood Pressure Procedure Survey with a response form

Part 3 A Participant Profile

Part 4 Participant Comments - Optional

Each part will be individually explained to you before its presentation.

Thank you for your participation and I think you will find this experience fun and interesting.

Part 1

Blood Pressure Sounds Tape and Response Form

In this part you will listen to the recorded blood pressure sound sequences of a number of subjects (identified as Subject "A" through "N" on the tape) and record your response. There will be two practice examples (Example 1 and 2) on the tape to familiarize you with the procedure.

Procedure Instructions:

1. Listen first to the entire blood pressure sound sequence for a subject while watching the manometer on the machine in front of you. The tape will notify you when the blood pressure sounds sequence is completed for that subject.

2. After the completion of the sound sequence for the subject, record your response to the question:

   "What is the subject's blood pressure reading?"

   Record the systolic and diastolic reading in the space provided.

These instructions will be repeated on the tape.

Turn to the next page, the Response Form.

Part 1 (continued)

Blood Pressure Tape Response Form

Reminder: Listen first to the ENTIRE blood pressure sound sequence for the subject. Then record the systolic and diastolic reading for that subject.

Blood Pressure Readings

Item	Reading
Example 1	
Example 2	
Subject A	
Subject B	
Subject C	
Subject D	
Subject E	
Subject F	
Subject G	

Go on to the next page

Part 1 (continued)

Blood Pressure Tape Response Form

Blood Pressure Readings (continued)

Item	Reading
Subject H	
Subject I	
Subject J	
Subject K	
Subject L	
Subject M	
Subject N	

End of Tape

Go to the next page

Part 1 (continued)

What do you use as an indication of the diastolic level of blood pressure?

Muffling or dulling of the sound __________

Cessation of the sound __________

Other (describe) ________________

____

____

End of Part 1

Please write any comments or questions you may have about Part 1 in the space below.

Go on to next page, Part 2

APPENDIX C

Part 2

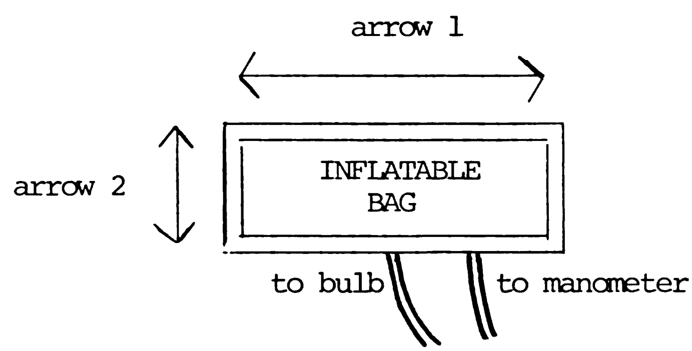
Blood Pressure Procedure Survey

Instructions: For each item, circle one answer only on answer sheet. Remember, to answer "don't know" circle the "x".

1. The cardiac cycle consists of period of contraction called ___1___ followed by a period of relaxation called ___2___.

   a) 1=systole 2=diastole   b) 1=diastole 2=systole   c) neither a or b

2. In this drawing of a blood pressure cuff, which arrow refers to cuff width and which arrow to cuff length?



   a) arrow 1=cuff length arrow 2=cuff width   b) arrow 1=cuff width arrow 2=cuff length

   c) neither a or b

3. The blood pressure cuff/inflatable bag should be how much WIDER than the diameter of the limb it is to encircle?

   a) 10%   b) 20%   c) 40%   d) none of these figures

4. Mrs. Smith's arm is 50 cm. in circumference. Is a standard size cuff/inflatable bag (12 x 23 cm.) LONG enough for the nurse to use to obtain Mrs. Smith's blood pressure?

   a) yes   b) it depends on how the blood pressure cuff is applied

   c) no   d) both a and b

5. If the blood pressure cuff/inflatable bag is not WIDE enough, the blood pressure reading obtained will be:

   a) erroneously high   b) erroneously low

   c) not enough data to say

6. The blood pressure cuff should be applied evenly and snugly. If the cuff is too loosely applied, the blood pressure reading obtained may be:

   a) erroneously high   b) erroneously low

   c) not enough data to say

7. In the sitting or standing position, choose the phrase which best describes the standard position of the arm for obtaining blood pressure:

   a) the arm hangs freely, parallel to the patient's trunk
   b) the forearm is supported at the level of the heart
   c) the whole arm is supported at the level of the shoulder

8. The nurse has not positioned the patient's arm properly. The patient's arm is positioned too low and the blood pressure reading obtained will be:

   a) erroneously high   b) erroneously low

   c) not enough data to say

9. The blood pressure sounds (the Korotkoff sounds) are divided into 5 Phases according to:

   a) the length of duration of the sounds
   b) the quantity of the sounds
   c) the quality of the sounds

10. If the palpated systolic pressure is higher than that of the auscultated pressure, which should be recorded as the systolic pressure?

   a) the auscultated pressure
   b) the palpated pressure
   c) this phenomena does not occur and such an observation is most likely a nursing error

11. Each Korotkoff phase (blood pressure sound phase) is described. Place the descriptions in the order in which you would normally hear them when listening to your patient's blood pressure sounds.

    A. The period during which a murmur or swishing sound is heard.

    B. The period marked by the distinct, abrupt muffling of sounds so that a soft, blowing quality is heard.

    C. The period marked by the first appearance of a faint, clear tapping sound which gradually increases in intensity.

    D. The point at which the sounds disappear.

    E. The period during which the sounds are crisper and increase in intensity.

    a) A,C,E,B,D b) C,A,E,B,D c) C,D,E,A,B

    d) C,E,A,B,D e) C,E,B,A,D f) A,E,C,B,D

12. Systolic blood pressure corresponds to which Korotkoff phase(s) - (blood pressure sound phase(s))?

    a) Phase 2 b) Phases 1+2 c) Phase 1

    d) Phases 2+3 e) Phase 3 f) Phases 1+3

13. Diastolic blood pressure corresponds to which Korotkoff phase(s) - (blood pressure sound phase(s)) ?

    a) Phase 4 b) Phases 4+5 c) Phase 3

    d) Phases 3+4 3) Phases 3+5 f) Phase 5

14. An auscultatory gap may occur when taking the blood pressure. Choose the answer which best describes this phenomena. An auscultatory gap is:

    a) the disappearance of the blood pressure sounds with inspiration

    b) the presence of blood pressure sounds down to zero on the manometer

c) an auscultated pressure difference of 10 mm Hg or greater between the right and left arms

d) none of the above answers

15. Mr. Reed has an auscultatory gap. In taking his blood pressure, the nurse has unknowingly stopped cuff inflation PRIOR to his auscultatory gap. The nurse then deflates the cuff and records the blood pressure reading. Which Korotkoff phase (blood pressure sound phase) will the nurse mistakenly read as the systolic pressure?

a) Phase 1 b) Phase 2 c) Phase 3

16. Which of the following measures can be taken by the nurse to avoid error in blood pressure measurement when the patient has an auscultatory gap?

a) recording the systolic pressure on expiration only

b) palpating for the disappearance of the radial pulse as the cuff pressure is raised

c) obtaining the blood pressure reading in both arms

d) recording the muffling of sound as diastole when the blood pressure sounds persist to zero on the manometer

17. What is the most appropriate rate for deflating the blood pressure cuff?

a) a rate of deflation that is about 2-3 mm Hg/ heartbeat

b) as quickly as possible

c) a rate of deflation that is about 2-3 Hg/second

d) as slowly as possible

18. The pressure in the blood pressure cuff is dropped below systolic level and the nurse desires a recheck on the systolic pressure. The nurse pumps the cuff up to above systolic level without first deflating

the cuff. What effect would a recheck on the systolic level without first deflating the cuff have?

a) this is an acceptable technique and it would not have any effect on the blood pressure reading

b) it may distort the systolic pressure reading

c) it may distort both the systolic and diastolic pressure reading

19. The blood pressure reading obtained may be inaccurate if:

a) the mercury manometer is above the patient's heart level but at the observer's eye level

b) the mercury manometer is tilted, that is, not level

c) both a and b could affect the accuracy of the blood pressure reading

d) neither a or b could affect the accuracy of the blood pressure reading

20. Mrs. Brown's blood pressure sounds are difficult for the nurse to hear. By which following way(s) could the nurse increase the intensity of Mrs. Brown's blood pressure sounds so as to be able to hear them better?

1. raise the patient's arm before cuff inflation, to permit venous blood to drain from the forearm

2. inflate the cuff slowly to prevent venous trapping and congestion

3. inflate the cuff to above systolic level, then ask the patient to open and close her hand rapidly eight to ten times

4. deflate the cuff very slowly, at a rate slower than 2 mm Hg/second

a) 1+4	b) 1+3	c) 2+3
d) 2	e) 1+2	f) 4

Code ____

Response Sheet
Blood Pressure Procedure Response Sheet

Instructions: The questions on this survey are designed to determine the range of nurse knowledge of the procedure for blood pressure determination. Please respond to all items. As this is not a test, please do NOT guess. If you do not know the answer, respond by circling the letter "x" which means "don't know".

Item Number	Your Response		(circle one, only)
1	a b c	x	
2	a b c	x	
3	a b c d	x	
4	a b c d	x	
5	a b c	x	
6	a b c	x	
7	a b c	x	
8	a b c	x	
9	a b c	x	
10	a b c	x	
11	a b c d e f	x	
12	a b c d e f	x	
13	a b c d e f	x	
14	a b c d	x	
15	a b c	x	
16	a b c d	x	
17	a b c d	x	
18	a b c	x	
19	a b c d	x	
20	a b c d e f	x	

APPENDIX D

DEMOGRAPHIC DATA AND COMMENT FORMS

Part 3

Participant Profile

Note: For Sections A, B, and C, answer as per your last position held, PRIOR to starting graduate study.

Section A

Instructions: For each of the three categories, Position, Setting, and Practice:

1. Place an "X" by the item in Column 1 that best describes your current nursing practice.
2. Place an "X" by the item in Column 2 that best describes the bulk of your nursing experience.

POSITION

1	2	
___	___	Head Nurse or Ass't
___	___	Supervisor or Ass't
___	___	Administrator
___	___	Staff nurse
___	___	Clinical Specialist
___	___	Nurse Practitioner
___	___	Research
___	___	Educator/Instructor
___	___	Staff development
___	___	Undergraduate study
___	___	Not in practice
___	___	Other (specify)

PRACTICE

1	2	
___	___	Community Health
___	___	Psych/Mental Health
___	___	Geriatrics
___	___	Emergency Room
___	___	Pediatrics
___	___	Operating Room
___	___	Recovery Room
___	___	Critical Care
___	___	OB/Gyn
___	___	Medical
___	___	Surgical
___	___	Rehab
___	___	School Health
___	___	Other (specify)

SETTING

1	2	
___	___	Hospital
___	___	School of Nursing
___	___	Psych/Mental Health
___	___	Long Term Care
___	___	Private Duty

____ years. Total number of years active in nursing practice.

Go to the next page.

Part 3 (cont.)

SETTING (cont.)

1	2	
___	___	Voluntary Health Agency
___	___	Office
___	___	Industry
___	___	Community Agency
___	___	Ambulatory Care Clinics
___	___	Other (specify)

____ (date) Last date employed in nursing practice.

Section B

Instructions: Answer the next three questions according to the following scale:

1=very frequently, at least daily
2=frequently, at least weekly
3=infrequently, at least monthly
4=not at all
5=other, please explain

1. How often do you perform blood pressure determination as part of your nursing practice? 1 2 3 4 5

2. How often do you supervise others in blood pressure determination? 1 2 3 4 5

3. How often do you teach others blood pressure determination? 1 2 3 4 5

Section C

Instructions: Reply to the following questions by circling the appropriate answer or answers.

1. In your place of nursing practice, are the standards of the American Heart Association (AHA) the protocol for blood pressure determination?

   a) yes
   b) no
   c) unable to say
   d) other, please explain

2. Do you utilize the standards of the American Heart Association for BP determination?

   a) yes
   b) no
   c) I don't know what the AHA standards are
   d) other, please explain

Go to the next page.

Part 3 (cont.)

3. Do you think most nurses utilize the AHA standards for BP determination?

   a) yes
   b) no
   c) unable to say
   d) other, please explain

Section D

Instructions: Reply to the following questions by completing the appropriate answer.

1. Your age ________.

2. Year you graduated from your basic nursing program __________.

3. Setting and date (approximate) of your last instruction in blood pressure determination ____________________________

   ____

   ____________________________.

4. Do you have any known:

   Visual defect? yes ___ no ___ Corrected? yes ___ no ___

   Hearing defect? yes ___ no ___ Corrected? yes ___ no ___

End of Part 3

Part 4 is Optional.

Thank you for your participation!

Code ____

Part 4

Optional

Participant Comments

As this Blood Pressure Study is a pilot project, the investigator would appreciate any comments you may have regarding the study, your experiences in blood pressure determination, or your experiences in supervising or teaching this nursing skill. Please note that this section is OPTIONAL.

Comments:

Thank you very much for your participation in the study.

This concludes Appendices A, B, C, and D, the packet presented to the nurses.

APPENDIX E

DATA ENTRY DECISIONS FOR NURSE BLOOD PRESSURE READINGS

Category 1

Decisions regarding entry of the data for the diastolic reading(s):

a. Phase 4 decisions. Some nurses (N=4) described their own diastolic criterion, which was interpreted as being Phase 4: "according to the cessation of sharp sound". One nurse stated she changed her diastolic reading indicator during the tape; she was coded as using Phase 4 as she indicated this reflected the majority of her decisions.

b. Phase 4 and 5 decisions. Two nurses stated they used both Phase 4 and 5 for their diastolic criterion but inconsistently recorded and infrequently recorded two diastolic figures. If only 1 figure was given, it was coded as Phase 5. One other nurse consistently recorded two diastolic figures except for four examples; for these examples the diastolic figure given was entered into both slots.

c. Phase 4 or 5 decisions. Two nurses stated they used Phase 4 or 5: "If I hear a definite muffling in sound -- marked difference -- I use that, otherwise cessation of the sound". As it was difficult to distinguish if the recorded figure referred to Phase 4 or 5, so the figure was entered into both slots.

Category 2

Decisions regarding entering the data for the patient-example having blood pressure sounds in which Phase 5=0 (Patient-Example B1-B2):

a. Phase 4 decisions. Three nurses stated they modified their diastolic criterion from Phase 5 to Phase 4, given a patient in which Phase 5=0. Although these nurses did not specifically identify this as happening with patient-example B1-B2, their data were entered to parallel their statement.

b. Phase 5 decisions. Three nurses stated they used Phase 5 as their diastolic criterion, but gave what may have been Phase 4 readings for patient-example B1-B2. As this inference could not be strongly supported, the readings were entered according to their stated diastolic criterion.

c. Phase 4 and 5 decisions. When nurses (N=8) stated they used a single diastolic criterion (Phase 4, Phase 5, Phase 4 or 5), but for patient-example B1-B2 recorded two diastolic figures, both figures were entered. When two nurses stated they used Phase 4 and 5 for a patient-example like B1-B2 but gave only one diastolic figure, it was entered according to their usual diastolic criterion. Two other nurses were unclear in their recordings for patient-example B1-B2 and the investigator entered their data as Phase 4 and 5, because this best represented their meaning.

Category 3

Decisions regarding entering the data for the patient-example with an auscultatory gap (Patient-Example E1-E2):
Some Nurses (N=6) were either inconsistent or unclear when recording the blood pressure for this example. The decision was made, that when more than two figures were given, to record the first as the systolic reading, and the last two as the diastolic readings. The response to this item ranged from one nurse correctly identifying the example as having an auscultatory gap to that of another nurse who recorded six figures for the example, with a margin note stating "? 2 different".

Finally, for any of the patient-examples, when a nurse indicated she used only one phase for the diastolic blood pressure, and she recorded two figures, both of the figures were entered so as to prevent loss of data.

APPENDIX F

Description of Participating Nurses
According to Specified Variables

N=41

Demographic Characteristic	Median	Max	Min	Range	Mode
Age	29	45	23	22	28
Years since graduation	7.9	23	21	21	3
Years active in nursing	7.3	19	2	17	3
Years since BP instruction	7.5	19	1	18	4

	Now	<6 mos	<12 mos	>12 mos	
Time since last employed	23	2	14	2	

	Defect		Corrected		
	Yes	No	Yes	No	Other*
Visual defect	24	17	20	1	3
Hearing defect	5	36	0	2	3

* In these instances, the nurses responded by stating the defect did not interfere with their ability to participate in the study.

APPENDIX G

Number of Participating Nurses According to Specified Variables N=41

Characteristics Related to Blood Pressure Determination

	Daily	Weekly	Monthly	Not at all	Other
Frequency of:					
Taking BP	23	6	6	2*	4**
Supervising BP	4	2	7	25	3***
Teaching BP	1	1	5	28	6****
AHA Standards were utilized:	yes	no	other	"Don't know what the AHA standards are"	
By nurse herself	5	1	1*****	34	
	yes	no	other	"Unable to say"	
By other nurses	1	11	-	29	
In place of employment	4	6	1*****	30	

* 1 neonatal nurse
1 nurse supervisor

** 1 lmo/year very intensely with student
1 when nursing students need assistance
1 only with arterial lines
1 q 2-4 month

*** 1 lmo/year very intensely with students
1 when checking students
1 infrequently with EMT's

**** 1 teaching lmo/year very intensely
1 q 2-3 mos
1 when checking students
1 teaches adv. tech.
1 on 2 occasions
1 q 1-2 years

***** Not in the neonatal setting

Description of Participating Nurses According to Specified Variables

N=41

Type of Position	Now*	Most**	Type of Practice	Now	Most	Type of Setting	Now	Most
Head Nurse	4	4	Community	5	3	Hospital	31	36
Supervisor	2	-	Psych/Mental Health	4.5	5	School of Nursing	1	2
Administrator	2	-	Geriatrics	1	0	Long Term Care	1	0
Staff Nurse	26	34	E. R.	1	2	Community/ Voluntary Health Agency	4	2
Clin Specialist	1	1	Critical Care	11	13			
Educator	5	2	Medical	9.5	10			
Research assistant	1	-	Surgical	5	6	Ambulatory Care Clinics	3	1
	41	41	Neonatal	2	2			
			Research	1	-	Office (Research asst.)	1	-
			Missing Data	1	-		41	41
				41	41			

* Now: refered to the nurse's current practice.

** Most: refered to the majority of the nurse's experience.

APPENDIX H

Number of Nurses' Responses to each Item on
Blood Pressure Procedure Knowledge Questionnaire
According to Categories of Responses for each Item

Item	Correct	Incorrect	Don't know
	Categories of Responses		
1. The cardiac cycle	40	1	
2. Labeling cuff width/length	34		7
3. Criterion for cuff width	5	12	24
4. Choosing cuff length	21	4	16
5. Effect of cuff width	20	16	5
6. Effect loose cuff	11	24	6
7. Arm Position standard	27	13	1
8. Effect arm position	10	14	17
9. BP phase criteria	24	4	13
10. Palp vs ausc BP	14	20	7
11. Ordering BP phases	10	25	6
12. Systole/BP phase	21	9	11
13. Diastole/BP phase	29	1	11
14. Identifying auscultatory gap	15	16	10
15. Ausc gap/BP phase	11	13	17
16. Technique avoid ausc gap	15	10	16
17. Cuff deflation rate	17	17	7
18. Effect of reinflation	22	17	2
19. Effect manometer level	11	28	2
20. Techniques to $\uparrow$ sounds	3	20	18

Nurses' Scores on the Blood Pressure Procedure
Knowledge Questionnaire: Descriptive Statistics

Nurse Scores	Absolute Frequency	Relative Frequency (percent)	Cumulative Adj. Freq. (percent)
3	1	2.4	2.4
4	1	2.4	4.9
5	1	2.4	7.3
6	3	7.3	14.6
7	7	17.1	31.7
8	9	22.0	53.7
9	2	4.9	58.5
10	6	14.6	73.2
11	6	14.5	87.8
12	3	7.3	95.1
13	1	2.4	97.6
16	1	2.4	100.0
Total	41	100.0	

Mean	8.780	Std Err	0.399	Median	8.333
Mode	8.000	Std Dev	2.555	Variance	6.526
Kurtosis	0.589	Skewness	0.258	Range	13.000
Minimum	3.000	Maximum	16.000		

N=41

APPENDIX I

Significance of Difference in Blood Pressure Readings according to Blood Pressure Phase by Patient-example: t-Test for Equality of Correlated Variances

Example	BP Phases Compared	Std. Dev. of BP Readings	Correlation of BP Phases	df	t	P Two-tail Test
A1	1 to 4	1.67 3.48	.31	10	2.657	<0.05
B1	1 to 4	0.96 3.28	-.10	21	7.207	<0.01
C1	1 4	0.83 2.065	-.21	10	3.35	<0.01
D1	1 4	1.71 3.22	.42	11	2.47	<0.05
E1	1 4	2.48 3.31	.20	13	1.09	>0.10
F1	1 4	0.75 1.83	-.36	10	3.45	<0.01
G1	1 4	2.29 1.91	-.24	10	0.59	>0.10
A2	1 4	1.69 2.53	.03	11	1.39	>0.05
B2	1 4	0.89 3.00	-.19	21	7.15	<0.01
C2	1 4	1.82 1.60	-.10	10	0.40	>0.05
D2	1 4	1.53 3.01	.27	12	2.61	<0.05
E2	1 4	0.36 2.91	.41	14	16.36	<0.01
F2	1 4	0.73 2.19	-.10	11	4.44	<0.01
G2	1 4	1.94 3.00	-.27	10	1.48	>0.05

Significance of Difference in Blood Pressure Readings according to Blood Pressure Phase by Patient-example: t-Test for Equality of Correlated Variances

(cont.)

Example	BP Phases Compared	Std. Dev. of BP Readings	Correlation of BP Phases	df	t	p Two-tail Test
A1	1 5	0.26 1.21	.16	31	12.50	<0.01
B1	1 5	0.42 3.07	-.09	28	19.15	<0.01
C1	1 5	0.65 0.90	.10	31	1.90	>0.05
D1	1 5	0.69 1.07	.03	31	2.55	<0.02
E1	1 5	1.33 0.79	.18	31	3.12	<0.01
F1	1 5	0.50 0.77	-.03	31	2.57	<0.02
G1	1 5	0.67 0.78	-.31	31	0.86	>0.05
A2	1 5	0.80 0.72	.16	31	0.61	>0.05
B2	1 5	0.42 4.56	.02	29	28.82	<0.01
C2	1 5	0.36 0.39	.12	31	0.54	>0.05
D2	1 5	0.49 0.51	-.04	31	0.22	>0.05
E2	1 5	1.29 0.79	-.03	31	2.85	<0.01
F2	1 5	0.37 0.57	.23	31	2.54	<0.02
G2	1 5	0.74 1.43	-.17	31	3.97	<0.01

$H_o = (\text{std. dev.}_1)^2 = (\text{Std. dev.}_2)^2$

$H_a = (\text{std. dev.}_1)^2 \; (\text{std. dev.}_2)^2$

n-2 df

(Glass & Stanley, p. 306, 1970)

$$t = \frac{s_1^2 - s_2^2}{\frac{4s_1^2 s_2^2}{n-2}(1-r^2)}$$

APPENDIX J

Nurse Blood Pressure Reading Accuracy Scores, Time by Patient-Example: Two Factor Repeated Measures Analysis of Variance

Significance of Differences on Nurse Systolic Blood Pressure Reading Accuracy Scores, Time by Patient-Example

	df	SS	MSS	F
Between Nurses	39	2861.02		
Within Nurses	520	8301.14		
Time	1	15.78	15.78	1.22 NS
Error (time)	39	503.79	12.92	
All Patient-Examples	6	816.87	136.14	6.80**
Groups: Std/Nonstd	1	412.04	412.04	20.58**
Within groups	5	404.83	80.97	4.04**
Error (patient-examples)	234	4685.25	20.02	
Time x Patient-Examples	6	70.72	11.79	1.25 NS
Error (time x patient-examples)	234	2209.69	9.44	

Significance of Differences on Nurse Diastolic Phase 4 Blood Pressure Reading Accuracy Scores, Time by Patient-Example

	df	SS	MSS	F
Between Nurses	9	2293.83		
Within Nurses	130	9109.53		
Time	1	22.40	22.40	0.94 NS
Error (time)	9	214.17	23.80	
All Patient-Examples	6	2898.34	483.06	4.89**
Groups: Std/Nonstd	1	124.86	124.86	3.12**
Within Groups	5	2773.48	554.70	5.61**
Error (patient-examples)	54	5339.36	98.88	
Time x Patient-Examples	6	109.99	18.33	1.88 NS
Error (time x patient-examples)	54	525.43	9.73	

** $p < 0.01$

Continued next page

Significance of Differences on Nurse Diastolic Phase 5 Blood Pressure Reading Accuracy Scores, Time by Patient-Example

	df	SS	MSS	F
Between Nurses	26	1375.18		
Within Nurses	351	7900.43		
Time	1	11.52	11.52	0.64 NS
(Error time)	26	468.33	18.01	
All Patient-Examples	6	207.55	34.59	1.40 NS
Groups: Std/Nonstd	1	23.57	23.57	0.94 NS
Within Groups	5	183.97	36.79	0.94 NS
Error (patient-examples)	156	3858.47	24.73	
Time x Patient-Examples	6	132.66	22.11	1.07 NS
Error (time x patient-examples)	156	3222.47	20.66	