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The Incidence of Auscultatory Gaps in Hospitalized Adults

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THE INCIDENCE OF AUSCULTATORY GAPS IN HOSPITALIZED ADULTS

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DEDICATION

This thesis is dedicated to my husband, Frank, for his support and for his wonderful perspective, and to my children, Tayloe and Anne Bladen, for their patience.

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ABSTRACT

THE INCIDENCE OF AUSCULTATORY GAPS IN HOSPITALIZED ADULTS

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The study was undertaken to determine the incidence of auscultatory gaps in hospitalized adults and to determine whether a relationship existed between the presence of a gap and the patient's age, sex, race, or medical diagnosis. Blood pressures were taken bilaterally on 120 randomly selected hospitalized adults using the technique recommended by the American Heart Association. None of the subjects in the sample had an auscultatory gap present.

CHAPTER ONE

Introduction

One of the most frequent measurements performed by nurses is the measurement of patient blood pressure. Although blood pressure may be measured directly or indirectly, the indirect method using a sphygmomanometer and a stethoscope is by far the most widely used technique since it is the more convenient and practical method. Even though the indirect method is recognized as being only an approximation of what the blood pressure really is (Kirkendall, et al., 1981:510A), it is relied on heavily in the assessment of the individual's cardiovascular status. The nurse's assessment of blood pressure may greatly influence therapy, or lack of therapy, especially in cases of hypertensive patients. It is, therefore, essential that nurses determine and record the blood pressure accurately.

As early as 1939, the American Heart Association advocated standardizing the method for the indirect measurement of blood pressure (Barker, et al., 1939:294) in order to promote consistency in determinations. This method recommends first estimating the systolic pressure by palpation. To do this, the sphygmomanometer cuff is placed on the upper arm. The brachial or radial artery below the cuff is palpated as the cuff is inflated and the point at which the pulsations are no longer felt is the estimation of systolic or maximal blood pressure. The purpose of first assessing the pressure by palpation is to prevent underestimating the level of the systolic pressure, a dangerous error since hypertension may cause heart disease and stroke, two of the leading causes of death in the United States (Kozier and Erb, 1983:53). The systolic pressure may be underestimated dramatically if an auscultatory gap is present in the individual. An auscultatory gap is the "temporary disappearance of sound" which occurs "in some subjects, particularly hypertension patients" (Kirkendall, et al., 1981:514A), between the systolic and the diastolic pressures. The systolic blood pressure may be underestimated by as much as 60 mmHg if this phenomena is present (Gibson, 1927:1013).

Although the auscultatory gap has been recognized and described for at least 80 years, little is known about this phenomena--only that it does exist occasionally--in some individuals and that it seems to exist more frequently in hypertensive individuals (Cook and Taussig, 1917:1088; Gibson, 1927:1014; Hurst, 1982:184; Kirkendall, et al., 1981:514A; Mudd and White, 1928:253). Information about the frequency of its occurrence, what causes it, or whether it exists in certain individuals all of the time or only occasionally does not appear in the literature.

It is interesting to note that even though the American Heart Association has consistently recommended estimating the systolic pressure first by palpation as a standard when determining blood pressure (Barker, et al., 1939:295; Bordley, et al., 1951:504; Kirkendall, et al., 1967:981; Kirkendall, et al., 1981:514A), this technique was not described in nursing textbooks until 40 years after the initial recommendation (Brunner and Suddarth, 1982:20; Kemp and Pillitteri, 1984:774; Kozier and Erb, 1979:260; Kozier and Erb, 1983:318; Narrow and Buschle, 1982:152; Rambo and Wood, 1982:430; Smith and Duell, 1982:161; Sorenson and Luckmann, 1979:684; Wolff, et al., 1983:343). The palpation technique was described and recommended in two nursing journals prior to 1979 (Jarvis, 1976:36; Schlotfeldt, 1961:20), but nursing textbooks published before 1979 (and some published later) instruct nurses to determine blood pressure using the auscultatory method alone (Atkinson and Murray, 1985:441; Curren, 1983:44; DuGas, 1977:164; Fuerst and Wolff, 1969:107; Henderson and Nite, 1978:471; Wood and Rambo, 1977:278). This technique instructs the nurse to inflate the cuff to the point at which sounds are no longer heard through the stethoscope placed over the brachial artery. According to the American Heart Association, this would certainly increase the chance of making incorrect determinations of blood pressure. If an auscultatory gap is present, the lower limit of the gap would be mistaken for the systolic pressure.

Most current fundamentals of nursing textbooks recommend using both the palpatory and auscultatory methods, but observations made by this investigator indicate that few nurses use palpation when assessing blood pressure in the clinical setting, even though it may be the initial blood pressure assessment being made. If the number of individuals with an auscultatory gap is small, then perhaps nurses are underestimating the blood pressure only occasionally. However, if there are large numbers of individuals with auscultatory gaps, nurses are at risk of making mass errors in blood pressure assessment. This study was undertaken to determine the incidence of auscultatory gaps. Are the numbers of individuals with auscultatory gaps so small that it is not essential for nurses to take the extra, time-consuming step of estimating the systolic blood pressure by palpation first, or are the numbers so great that nurses should always take this step as an integral part in the determination of blood pressure?

Problem Statement

The purpose of the study was to explore and describe the incidence of auscultatory gaps in blood pressure determined by sphygmomanometer in hospitalized adults and to ascertain whether a relationship exists between the presence of an auscultatory gap and other identified subject variables (age, sex, race and medical diagnosis).

Definition of Terms

The following definitions were used throughout this study:

Auscultatory gap. The temporary disappearance of sounds heard over the brachial artery that last at least 10 mmHg and that may occur in some individuals when arterial blood pressure is indirectly measured using a sphygmomanometer and a stethoscope as determined by the investigator.

Blood pressure. An indirect measurement of blood pressure as determined by the investigator using an aneroid sphygmomanometer and a stethoscope. Measurement was obtained using the standards recommended by the American Heart Association (Appendix A).

Assumptions

For the purpose of this study, it was assumed that auscultatory gaps, if present, could be perceived when assessing the blood pressure using the techniques of palpation and auscultation.

CHAPTER TWO

Review of Literature

Theoretical Framework

Roy's Adaptation Model

Roy's adaptation model for nursing was chosen as a framework for the study since the study is concerned with the practice of nursing. Roy describes the goal of nursing as "promoting man's adaptation in his physiologic needs, his self-concept, his role function, and his interdependence relations during health and illness" (Riehl and Roy, 1974: 139). She describes the patient or the recipient of nursing care "as an adaptive system receiving stimuli from the environment which are inside and outside his zone of adaptation" (p. 140). She describes man further as a "bio-psycho-social being" who must adapt to a changing environment using "both innate and acquired mechanisms, which are biologic, psychologic, and social in origin." She identifies man as having four subsystems or "four modes of adaptation: physiologic needs, self-concept, role function, and interdependence relations" (pp. 136-138). Using this model, nursing may occur in "any setting, any time, with man adapting in relation to situations of health and illness" (p. 140).

Although it is the patient "who does the adapting to reach the goal of nursing care," the nurse must "support and promote adaptation...as she assesses and intervenes to elicit the positive response from the patient" (Riehl and Roy, 1974: 142). To do this, the nurse uses the nursing process.

The nursing process is described as "the core and essence of nursing...sufficiently structured so as to provide a base from which all systematic nursing actions can proceed" (Yura and Walsh, 1978:1) and presents "a total picture of nursing care" (Riehl and Roy, 1974:236). It includes assessing the patient, identifying problems the patient may have or making a nursing diagnosis, setting realistic goals, planning and implementing nursing interventions, and evaluating the outcome of the interventions selected.

Each step of the nursing process is an important one, but since the entire process is based on the nurse's assessment of the patient, assessment must be viewed as a critical first step. The nurse must be able to assess the patient's biologic, psychologic and social needs accurately. This requires expertise in many skills. The nurse must have a sound knowledge base, be able to relate and communicate well, and have the necessary technical skills to examine the patient and make an appropriate assessment of the patient's health. An example of a necessary technical skill is the ability to determine the blood pressure accurately as one measure of the patient's physiologic needs.

Blood Pressure

Arterial blood pressure is a "measurement of the force that is exerted by the blood against the artery wall" (Groer and Shekleton, 1979:223). It is dependent on both the cardiac output and the total peripheral resistance. The following equation demonstrates the relationship between the two factors affecting blood pressure:

$$\text{Arterial Pressure} = \text{Cardiac Output} \times \text{Total Peripheral Resistance}$$

or

$$P = CO \times R$$

(Brown and Stubbs, 1983; Groer and Shekleton, 1979:223; Guytonl, 1985:475). The formula illustrates that changes in either the cardiac output or the total peripheral resistance will affect the blood pressure.

The blood pressure is maintained at a relatively constant level in the normal adult by a number of mechanisms controlled by the nervous systems, hormones, and the kidneys. All function to keep the mean arterial pressure around 90-100 mmHg (Brown and Stubbs, 1983; Guyton, 1985:475) in spite of rapid position change, changes in environmental temperature, ingestion of large quantities of fluids, exercise, or other events that might normally occur during the course of a day.

There are three types of regulatory mechanisms involved in the control of blood pressure, the rapid-acting mechanisms which include nervous control and hormonal control, the intermediate-acting mechanisms which include the capillary fluid shift, and the slow-acting mechanisms which include kidney control and blood volume control.

One of the most important nervous control mechanisms is the baroreceptor reflex (Groer and Shekleton, 1979:223). Baroreceptors are nerve receptors located in "almost every large artery of the thoracic and neck regions" (Guyton, 1982:173). There are especially large numbers present in the internal carotid arteries and the aortic arch. The baroreceptors are stimulated when stretched by pressure that exceeds 60 mmHg (Guyton, 1982:173). When stimulated, they send inhibitory impulses immediately (within seconds) to the medulla oblongata in the brain stem where the vasomotor center is located. The effect of these impulses is to "inhibit the vasoconstrictor center of the medulla" and to "excite the vagal center" (Guyton, 1982:173). This causes vasodilation of the peripheral circulation and a decrease in cardiac rate and strength of contractions. The baroreceptor reflex therefore lowers arterial pressure by reducing both the cardiac output and the total peripheral resistance.

The baroreceptor reflex operates under the principles of negative feedback. When the blood pressure returns to normal or below normal, the baroreceptors are no longer stimulated. This activates the vasomotor center and inhibits the vagal center causing vasoconstriction and increased heart rate.

Another reflex that helps control the blood pressure is the atrial reflex. The atria contain stretch receptors that "elicit reflexes parallel to the baroreceptor reflexes to make the total reflex system much more potent for control of arterial pressure" (Guyton, 1976:271). When the blood pressure rises, atrial pressure increases also. This causes the atrial receptors to stretch which then causes immediate reflex vasodilatation in both the peripheral vasculature and the kidneys. Peripheral vasodilatation results in reducing the blood pressure by reducing the total peripheral resistance. As more blood flows into the dilated capillaries, capillary pressure rises and fluid filters out of the circulation into the interstitial spaces. The net effect is a lowered blood volume.

Blood volume is decreased even further as more blood flows through the dilated vessels in the kidneys. Increased renal blood flow causes a rise in glomerular capillary pressure which increases filtration and loss of fluid into the urine. Lowered blood volume reduces the amount of blood returning to the heart and therefore lowers cardiac output.

One of the most powerful reflexes affecting blood pressure is the central nervous system ischemic response, a response that occurs only when the blood pressure reaches 50 mmHg or less (Guyton, 1982:174). With pressures this low, blood flow to the brain is inadequate. The rising carbon dioxide (CO_2) level in the brain tissue stimulates the sympathetic nervous system to activate the vasomotor center causing vasoconstriction of such magnitude that, within seconds, "some of the peripheral vessels become totally or almost totally occluded" (Guyton, 1982:174). Blood pressure increases as a result of the increased peripheral resistance.

Chemoreceptors in the carotid arteries and the aortic arch are also sensitive to CO_2 levels in the blood. When the CO_2 level increases and the oxygen level decreases in those areas, the chemoreceptor reflex stimulates the vasomotor center within seconds to increase peripheral resistance through systemic vasoconstriction (Guyton, 1976:273).

The veins throughout the body play a major role in all of the nervous mechanisms that control blood pressure. Whenever the vasomotor center is stimulated by any of the nervous reflexes discussed, venous constriction results. The veins, therefore, are unable to hold as much blood and blood is forced back to the heart, the pulmonary circulation, and the systemic arteries. This causes the heart to pump more effectively. Cardiac output increases and arterial blood pressure rises (Guyton, 1982:175). The venous mechanism functions conversely, as well, becoming dilated when the blood pressure becomes too high.

The most important hormonal mechanism that controls blood pressure is the renin-angiotensin vasoconstrictor mechanism (Guyton, 1985:471). When the blood pressure decreases, reduced blood flow through the kidneys stimulates the kidneys to release the enzyme renin into the blood where it converts the plasma protein renin substrate into angiotensin I. A converting enzyme present in the blood vessels in the lungs then changes angiotensin I into angiotensin II, "one of the most potent vasoconstrictors known" (Guyton, 1982:176). It takes about 20 minutes for the renin-angiotensin vasoconstrictor mechanism to become effective (Guyton, 1982:177). Once effective, however, it causes vasoconstriction which increases the blood pressure by increasing peripheral resistance. This also increases venous return which increases cardiac output.

Angiotensin II also stimulates the adrenal cortex to release aldosterone, a hormone that controls the output of water and sodium from the kidneys. Once released, aldosterone causes less water and sodium to be excreted, thereby increasing blood volume. Increased blood volume in conjunction with vasoconstriction further increases venous return and cardiac output.

Another hormonal mechanism affecting blood pressure is the norepinephrine-epinephrine vasoconstrictor mechanism. When the sympathetic nervous system is stimulated, norepinephrine and epinephrine are released from the adrenal medulla into the blood where they circulate for one to three minutes before being destroyed. While circulating, they stimulate the heart to beat faster which increases cardiac output and they cause vasoconstriction in most blood vessels, including those small vessels that do not receive sympathetic nervous stimulation. This results in increased peripheral resistance and increased cardiac output.

A third hormonal response stimulated by low blood pressure is the release of vasopressin, the antidiuretic hormone, from the hypothalamus. Vasopressin causes vasoconstriction and reduces the amount of fluid excreted by the kidneys. The resulting increase in peripheral resistance and blood volume act together to increase the blood pressure.

The major intermediate-acting mechanism that controls blood pressure is the capillary fluid shift. When blood pressure changes, changes in capillary pressure cause a fluid shift between the capillaries and the interstitial spaces. When the blood pressure is high, increased osmotic pressure forces fluid through the capillary membrane into the interstitial spaces. This shift lowers the blood volume and results in lowering the blood pressure. Blood pressure can also be increased by this mechanism. When the blood pressure is low, osmotic pressure causes fluid to shift back into the capillaries, increasing blood volume and blood pressure as well. The capillary fluid shift is categorized as an intermediate-acting mechanism because it does require 10 minutes to several hours to become effective (Guyton, 1976: 277).

The slow-acting mechanism involved in blood pressure control is the renal-body fluid system. Although it takes hours for the kidneys to become effective, they are "by far the most important of all organs of the body for long-term regulation of arterial pressure" (Guyton, 1985:479). The kidneys function to maintain blood pressure within normal limits by continually adjusting and readjusting the blood volume. When arterial blood pressure rises, renal artery pressure rises also. This increases glomerular pressure causing an increased glomerular filtration rate which decreases the amount of fluid reabsorbed from the tubules within the nephron. As a result, urine output increases and blood volume decreases. A decrease in the total blood volume reduces venous return to the heart and reduces cardiac output.

The kidneys function conversely when arterial pressure reaches levels that are too low. Low blood pressure causes the kidneys to retain fluid and electrolytes, increasing total blood volume and cardiac output. The kidneys may almost stop excreting urine altogether until the blood volume reaches a level that brings the blood pressure back to levels closer to normal.

One of the major advantages of the renal body fluid system is that it has "infinite feedback gain." That is, it can return the blood pressure to normal (Guyton, 1982:179). Other mechanisms that control blood pressure are able to return pressure to near normal levels, but are not able to return 100 percent. Another disadvantage of other mechanisms is that they "reset after a while to the new level of pressure and soon stop sending their signals indicating abnormality...and therefore become ineffective" (Guyton, 1985: 478).

Blood pressure is regulated by complex, interrelated mechanisms designed to maintain the blood pressure within a narrow range of normalcy. In spite of all the regulatory mechanisms discussed, abnormalities frequently occur causing hypertension, a very damaging condition that may result in either myocardial infarction or cerebral hemorrhage.

Hypertension

Hypertension is defined as "an elevation in the systolic blood pressure of over 140 mmHg and in the diastolic blood pressure of over 90 mmHg" (Groer and Shekleton, 1979: 11; Potter and Perry, 1985:583). It occurs in more than 20 million people in the United States, half of whom are undiagnosed and therefore untreated (Brunner and Suddarth, 1984:

676; Groer and Shekleton, 1979:243). Hypertension increases in frequency with age, usually occurring in people over the age of 40 (Guyton, 1985:481). It occurs more often in females than in males, and is found 50 percent more often in blacks than in whites (Groer and Shekleton, 1979:244). Hypertension is categorized as mild, in which the diastolic pressure ranges from 90 to 109 mmHg; moderate, in which the diastolic pressure ranges from 109 to 129 mmHg; and severe, in which the diastolic pressure is greater than 130 mmHg Groer and Shekleton, 1979:244).

Approximately 95 percent of all cases of hypertension are diagnosed as essential hypertension or hypertension of unknown etiology (Guyton, 1985:482). This is also known as primary hypertension. Although the etiology is not specified, it is believed that the disease is hereditary and may be caused by some kidney pathology since increased pressure is "essential for the normal excretory function of the kidneys to occur" (Guyton, 1976:290). If the blood pressure is reduced to normal range in the individual with essential hypertension, he will become oliguric and develop uremia, demonstrating that the higher blood pressure is necessary to sustain kidney function (Guyton, 1976:290).

The remaining cases of hypertension are called secondary hypertension because the hypertension is caused by an underlying condition. These include renal hypertension, neurogenic hypertension, hormonal hypertension, and hypertension related to pregnancy.

Renal hypertension results from some disease process in the kidneys such as infection, inflammation, or sclerosis of renal arterioles. The injured kidney is unable to excrete normal amounts of fluids and electrolytes causing an increase in blood volume. Increased blood volume increases cardiac output and arterial blood pressure. This initial increase causes more blood to flow through the tissues than is necessary. Therefore, the "tissue vessels slowly constrict" and "the total peripheral resistance increases while the cardiac output returns to normal" (Guyton, 1976:287). This is an important compensatory mechanism that lowers the workload of the heart, preventing possible heart failure.

Diseased kidneys may also exhibit constriction of renal arterioles. Reduced blood flow to the kidneys through these constricted vessels causes the kidneys to secrete large amounts of renin. Angiotensin formation and systemic vasoconstriction result. When such vasoconstriction occurs in conjunction with excess blood volume, severe hypertension or malignant hypertension results. Malignant hypertension is described as "a rapid and severe increase in blood pressure" (Groer and Shekleton, 1979:243) that is "rapidly fatal unless treated" (Luckmann and Sorenson, 1974:677).

Neurogenic hypertension is believed to be caused by "excessive nervous tension" (Guyton, 1985:482) that overstimulates the sympathetic nervous system causing vasoconstriction and increased heart rate. If the underlying tension or stress continues for prolonged periods, permanent hypertension may result due to vascular changes that can occur in the kidneys (Guyton, 1985:482).

Hormonal hypertension is caused by oversecretion of the hormones that raise blood pressure. This condition exists when tumors present in the adrenal cortex secrete large amounts of aldosterone. Increased amounts of aldosterone cause more reabsorption of water and sodium in the kidneys resulting in fluid retention and blood pressure elevation.

Another tumor that is responsible for hormonal hypertension is a pheochromocytoma, a tumor that is located in the adrenal medulla. When stimulated, this tumor releases additional amounts of epinephrine and norepinephrine causing excessive rises in blood pressure. The blood pressure may remain at normal levels, however, when sympathetic stimulation does not occur (Guyton, 1985:482).

Hypertension associated with toxemia is a condition that occurs only during pregnancy. It occurs after the twentieth week of pregnancy in six to seven percent of pregnant women in the United States (Reeder, 1983:761). Moore (1983:364) suggests that the cause originates with blood vessel spasm resulting in inadequate blood supply to tissues.

Such spasms could result in structural changes in the kidney. Guyton (1976:288) states that "thickening of the glomerular membranes...reduces the rate of fluid filtration" causing fluid retention and increased blood pressure. He does not indicate what may cause the glomerular thickening, however.

Hypertension is known as the "silent killer" because many individuals do not realize they have it. The major effects of hypertension on the body that may have devastating results are the increased workload on the heart and the damage to the arteries throughout the body. Hypertension is responsible for myocardial infarctions, cerebral vascular accidents, renal failure, blindness and deafness (Guyton, 1985:481).

Hypertension increases the workload on the heart because the heart must pump blood against elevated pressure. The left ventricle, in particular, must work harder to push the blood through the systemic circulation. The additional workload causes the heart muscle to hypertrophy. The coronary circulation then becomes inadequate to perfuse the larger muscle and ischemia results. Angina pectoris frequently occurs or the individual may suffer a myocardial infarction.

Constant elevated arterial pressure also causes arterial damage. Arteries become sclerosed as the vessel walls become thicker, more fibrous, and more rigid. Under such conditions, blood clots form more easily. Vessels may thrombose or rupture causing cerebral hemorrhage or renal hemorrhage. Many other organs in the body may also be damaged by varying degrees of arterial hemorrhage.

Because hypertension is so prevalent in our society and has such crippling and life-threatening effects, it is important for all health professionals to carefully evaluate their patients and assess blood pressure as accurately as possible.

Hypertension is a condition that affects man in all four subsystems described by Roy. It affects his physiologic needs, his self-concept, his role function, and his interdependence relations. The ways in which hypertension affect physiologic needs have been discussed. Hypertension affects the way the individual perceives himself. It may affect his ability to function in roles expected of him by himself, his family, and society. If myocardial infarction, cerebral vascular accident, renal failure, blindness or deafness result, the individual's interdependence relations will certainly be affected as he becomes more dependent on others to meet his needs.

The nurse may encounter the hypertensive individual in "any setting, any time." If the nurse is to "support and promote adaptation," a role identified by Roy, she must then be able to determine accurately the patient's health or illness status.

Review of Literature

There are two components of the literature review. The first reviews the evolution of the method for determining blood pressure beginning in 1896 with the invention of the Riva-Rocci armlet cuff and continuing to the present with the most recent recommendations from the American Heart Association. The second component reviews the few existing articles on the auscultatory gap and presents the characteristics of the gap that have been discovered.

Blood Pressure Determination

In 1896, Riva-Rocci made indirect blood pressure measurement in humans possible by introducing what is now known as the sphygmomanometer. He also introduced the palpatory technique for determining blood pressure, a technique in which one inflates the sphygmomanometer cuff on the upper arm while palpating the brachial or the radial artery below the cuff. It was felt that this technique was accurate for determining systolic blood pressure (the point at which pulsations in the artery could no longer be felt), but not accurate for determining diastolic blood pressure (Askey, 1974:94; Segall, 1975:562). Recent studies have indicated, however, that the diastolic pressure may actually be determined accurately with palpation because a "thrill" or "vibration" can be felt at that point (Enselberg, 1961; Putt, 1966). In another study, Putt (1966:315) demonstrated that palpatory readings are "largely within the acceptable limits set by the American Heart Association."

In an attempt to improve blood pressure assessment, Korotkoff, a Russian physician, introduced the auscultatory method nine years later (1905). Using Riva-Rocci's arm cuff, Korotkoff recommended quickly inflating the cuff on the upper arm "to the complete cessation of circulation below the cuff" (McCutcheon and Rushmer, 1967:150). Then, with a stethoscope placed over the artery just below the cuff, one should listen to the different sounds that occurred as the cuff was deflated. Korotkoff described three sounds that would be heard. He described the very first sounds that occurred as corresponding with the maximal or systolic blood pressure. He described these as the "first short tones" which changed in quality to murmurs, then back to tones before all sounds disappeared. He felt that the disappearance of sounds corresponded with the minimal or diastolic blood pressure (McCutcheon and Rushmer, 1967:150).

A few years after Korotkoff introduced the auscultatory method, a total of four sounds were described as Ettinger divided Korotkoff's second sound into two separate phases (Askey, 1974:95). These sounds are now called the Korotkoff sounds. The American Heart Association identifies five phases which are described as:

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

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

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

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

Phase V: The point at which sounds disappear (Kirkendall, et al., 1981:514A).

Korotkoff stressed that his method was more accurate than the palpatory method. Physicians did adopt his technique, but they continued to use the more familiar palpatory technique in conjunction with it. By using both methods, the auscultatory gap was discovered one year later. The auscultatory gap was unknown to Korotkoff because in his studies he had used only normal subjects (Askey, 1974:95).

Apparently, the importance of the auscultatory gap went unrecognized and by 1912, physicians no longer used palpation at all. The usual technique used was to apply the cuff, position the stethoscope, and inflate the cuff until sounds were no longer heard (Cook and Taussig, 1917:1088; Cowing, 1912:14). Gibson described the routine method for assessing blood pressure in 1927 in which the sphygmomanometer was rapidly inflated "to about 250 mmHg and then allowed to fall slowly and steadily while the observer listens with his stethoscope" (Gibson, 1927:1013). By 1938, a survey indicated that physicians were not assessing blood pressure in a uniform manner (Wright, Schneider and Ungerleider, 1938). Not only did they use different criteria for identifying both systolic and diastolic pressures, but they also interpreted the sounds they heard differently. The report of this survey recommended the development of a standardized technique for the determination of blood pressure. In response to this survey, the American Heart Association and the Cardiac Society of Great Britain and Ireland appointed a joint committee for the standardization of blood pressure readings. Their recommendations were first published in 1939 and have been revised three times since then.

The Auscultatory Gap

Krylov was the first to report the auscultatory gap which he noted in 1906 after measuring the blood pressures of cardiovascular patients using both the palpatory and auscultatory techniques (Askey, 1974:95). Swan (1914) also reported cases in which Korotkoff's sounds disappeared. The significance of these two reports was not appreciated at the time and physicians began to rely on the auscultatory method alone in the determination of blood pressure (Cook and Taussig, 1917:1088; Cowing, 1912:14). It was then that the importance of this silent period was identified as a possible cause of error in blood pressure determination. Cook and Taussig (1917:1088) reported "a period of complete silence" up to 50 mmHg which they estimated to occur in five percent of patients with hypertension. The importance of this phenomenon was clear to them--that patients with high hypertension could be diagnosed as having moderate hypertension, and that patients with moderate hypertension might not be diagnosed at all. The way to avoid such errors was also very clear to them--"We always make a preliminary, approximate estimate of the systolic pressure by the palpatory method" (Cook and Taussig, 1917:1088).

Several French physicians were familiar with the silent gap or "trou auscultatoire." Their reports were summarized by Gibson (1927) who gave Tixier credit for being the first to discover the silent gap in 1918 (one year after it had been described by Cook and Taussig). Tixier described the gap as a "curious phenomenon" that was "extremely rare" (Gibson, 1927:1012). One of the French physicians in Gibson's report felt that the gap was an indication of aortic stenosis. His theory was refuted, however, when others found that it occurred without the presence of aortic stenosis. In 1921, Gaddavardin and Barbier determined that "in people over 60 with hypertension the phenomenon was not rare" (Gibson, 1927:1013). Barbier "had found it in one out of every two patients" in a French hospice (Gibson, 1927:1013).

Gibson described the gap as "a zone of silence" that "may extend over a range of 20-60 mmHg" (1927:1013). He reported that the gap was "in some way associated with hypertension" (p. 1013). He also noted that the gap was variable and that it could be present one day, but absent another day. Gibson recognized the significance of the gap as a potential cause for error in determining blood pressure. His recommendation, however, was "always raising the armlet pressure, to begin with, to well above 200 mmHg" (Gibson, 1927:1014). Others recommend that this practice not be carried out since raising the pressure so high may cause vasospasm and unnecessary pain, both of which could alter the blood pressure (Lancour, 1976:775).

There has been one in-depth study of individuals with auscultatory gaps. Mudd and White (1928) studied 30 cases and identified three types of gaps: the complete gap in which there is a period of absolute silence; the incomplete gap in which the sounds decrease for a certain period; and the variable type of gap in which the sounds decrease and increase inconsistently. Of the three types of gaps, the complete gap occurred most frequently in their subjects.

They noted that the gap usually occurred in the second phase of the Korotkoff's sounds and lasted for 10 to 50 mmHg with a mean of 27 mmHg. Twenty-eight (93%) of their subjects were hypertensive with systolic blood pressures ranging from 140 to 280 mmHg and diastolic blood pressures ranging from 120 to 150 mmHg. The upper limit of the auscultatory gap ranged from 110 to 200 mmHg and the lower limit ranged from 90 to 190 mmHg. Their subjects were 31 to 79 years of age with 13 (43%) males and 17 (57%) females (Mudd and White, 1928:252). In repeated observations, the gap was noted to vary in both its presence and location. It was also observed to occur unilaterally.

Mudd and White (1928) recognized the importance of the auscultatory gap in masking hypertension and recommended palpation as a means of avoiding incorrect blood pressure interpretations.

Eleven years later, the Joint Committee for the Standardization of Blood Pressure Readings of the American Heart Association and the Cardiac Society of Great Britain and Ireland incorporated the recommendations of Mudd and White and Taussig into the standardized method for the determination of blood pressure. The 1939 recommendations included palpating the radial artery to determine systolic blood pressure. The committee stated that "in all cases palpation should be used as a check on auscultatory readings....If the radial pulse is felt at a higher level than that at which the auscultatory sound is heard, the palpatory reading should be accepted as the systolic pressure" (Barker, et al., 1939:295). The most recent American Heart Association committee report continued to emphasize the need for a "preliminary palpatory determination of systolic pressure" (Kirkendall, et al., 1981:514A) to prevent underestimating the level of blood pressure due to the presence of an auscultatory gap.

In summary, the auscultatory gap has been identified as an interesting phenomenon since it was first reported in 1906. Those who have reported it have been unable to explain the reason it occurs, however. Most of the cases identified have occurred in conjunction with hypertension. Cook and Taussig (1917) reported that the auscultatory gap occurred in five percent of their patients with hypertension. There is no other known evidence of the frequency of its occurrence among other populations. Therefore, this study was undertaken to determine the incidence of auscultatory gaps in hospitalized adults.

CHAPTER THREE

Methodology

Research Design

A descriptive design was used for this study since the purpose was to determine how often auscultatory gaps occur and because the literature review revealed little information about them. Data were collected from randomly selected patients in a mid-Atlantic medical center.

Population and Sample

The target population for this study was hospitalized adults, 20 years of age and older; the accessible population was adults hospitalized in a 500-bed medical center in a small, mid-Atlantic city surrounded by a large rural area. Hospitalized adults were chosen because most nurses are employed by hospitals and because hospitalized adults consequently encompass the population that most nurses assess.

A probability sampling technique was used to help decrease bias. Using the treatment Kardexes from each unit, and excluding the critical care units (ICU, CCU, OR, PAR, and L & D) and the psychiatric unit, a stratified random sample was selected for the study. Patients were stratified according to age and gender into the following subgroups:

1. Females, 20 to 40 years of age.
2. Males, 20 to 40 years of age.
3. Females, 41 to 64 years of age.
4. Males, 41 to 64 years of age.
5. Females, 65 years of age and older.
6. Males, 65 years of age and older.

Ten subjects were selected for each subdivision of data in the design (Polit and Hungler, 1983:426). There were 12 subdivisions in the design since there were subdivisions for subjects with auscultatory gaps and for those without them. Therefore, 20 subjects were selected for each of the six subgroups making the total sample size 120 subjects. A disproportional sampling design was used in order to facilitate making comparisons among the subgroups.

Those subjects selected by stratified random sampling were included in the study if they:

1. gave consent to be in the study;
2. had palpable radial or brachial pulses;
3. were able to have blood pressure measured in both arms;
4. had audible blood pressures in both arms;
5. were accessible to the investigator and the research tools (i.e., not on strict isolation); and
6. were awake and alert.

Selection of Instruments

Personal Data Schedule

Personal data were collected from each subject using a structured interview developed by the investigator to determine each subject's age, height, weight, medications, and relevant medical history (Appendix B). An interview was appropriate in this study since the investigator had direct contact with each subject and since some subjects selected were unable to complete a questionnaire. Data were also collected from the subject's medical record. Data collected from the record included age, sex, race, height, weight, medical diagnosis, medications prescribed, and blood pressure ranges during hospitalization.

Blood Pressure

Blood pressure was determined in each subject with an aneroid sphygmomanometer and a stethoscope, following the standards for measurement recommended by the American Heart Association (Kirkendall, et al., 1981:510A) which include first estimating the systolic pressure by palpation (Appendix A). Blood pressure in both the right arm and the left arm were determined since they frequently differ. Both measurements were recorded. It was noted whether an auscultatory gap was present. If an auscultatory gap was present, the point at which it occurred and the duration of the gap were also recorded.

Reliability and validity. Reliability and validity depended on the investigator's audiovisual skills and technical ability to determine blood pressure. Errors can result from "sensory impairment, inattention, carelessness, or subconscious bias" (Kirkendall, et al., 1981:571A). Other errors may result from "defective apparatus" and "faulty technique" (Lancour, 1976:773). The investigator was aware of these hazards and paid particular attention to avoid them. Only one investigator determined all of the blood pressures taken in the study to promote consistency of the findings. The investigator has no known hearing impairment. Audiometric testing performed in 1956 and 1970 revealed normal hearing ability. A visual impairment, myopia, does exist but has been corrected with the use of glasses or contact lenses.

In order to assess the investigator's ability to measure blood pressure accurately, a preliminary study was done in which the investigator determined the blood pressure on 11 subjects in the intensive care unit. The investigator used the same technique and the same equipment that were used in the rest of the study. Each subject had an arterial line inserted. While the investigator determined the indirect blood pressure, an assistant recorded the direct blood pressure, being careful not to let the investigator know what it was. The indirect readings and the direct readings were then compared (Appendix D).

The product moment correlation coefficient or the Pearson r was computed to determine the relationship between the direct blood pressure measurements and the indirect blood pressure measurements obtained by the investigator. The correlation coefficient for the systolic pressures was .95 ($p = .0001$). The correlation coefficient for the diastolic pressures was .74 ($p = .0045$).

The results of the Pearson correlation indicated that there was a strong relationship between the direct systolic readings and the indirect systolic readings made by the investigator. The strong relationship demonstrated between the systolic readings and the indirect systolic readings indicated that the investigator was able to determine the blood pressure validly with the equipment selected. Although the relationship between the diastolic readings was weaker, the strong relationship between the systolic readings was more pertinent to this study since the presence of an auscultatory gap may cause the systolic blood pressure to be underestimated.

To reduce the risk of error caused by "faulty apparatus," the investigator used new equipment: a standard adult-sized aneroid sphygmomanometer and a standard stethoscope with a bell head. The same equipment was used with each subject to ensure reliability unless the subject was obese. If the subject was obese and had an upper arm circumference that was greater than 32 cm., a large adult cuff was used (Kirkendall, 1981:512A), rather than omit these subjects from the study since obese individuals tend to be hypertensive (Kirkendall, et al., 1981:515A). The investigator also followed the steps outlined by the American Heart Association for each subject (Appendix A).

In spite of the potential for error, determining blood pressure with a sphygmomanometer and stethoscope was appropriate in the study since the auscultatory gap appears to occur only when blood pressure is determined in this manner (Bordley, et al., 1951:509; Hurst, 1982:184; Kirkendall, et al., 1981:514A).

Procedure

Data were collected during October, November, and December, 1985 between the hours of 10:00 a.m. and 6:00 p.m. On data collection days, the investigator selected a sample category (example: females, 20-40 years of age), went to each of the seven units being used for the study in the medical center, and made a list of all the patients that were in that category, using the treatment Kardexes. The investigator followed the same sequence of units and Kardexes each time in making the patient lists. After determining which patients were appropriate based on gender and age, the investigator used information listed in the Kardex to determine if each patient was eligible to participate in the study.

Patients had to be excluded from the list for various reasons including patients with shunts (for renal dialysis), mastectomies, hemiparesis, arm casts, confusion and orders for isolation. The investigator then asked the charge nurse of each unit whether the remaining patients on the list could have their blood pressures taken in both arms, and if they were awake and alert in order to provide informed consent.

The charge nurses provided additional information that was not always recorded in the Kardex. Two requested that any patient with an IV infusing not be used in the study. Three other patients were excluded from the list because they were in terminal stages of illness, and the charge nurses thought that they and their families should not be disturbed for the purpose of research. One patient was omitted who could not speak or understand English. Another patient was excluded at the request of the head nurse because she had delivered a "sick baby" and was emotionally upset.

After the list of possible subjects was completed and verified with each charge nurse, the list was numbered, beginning with the number one. The investigator then made a blind start on a random number table and, moving in the direction from left to right on the random number table, selected the first 15 patients with numbers that matched the first 15 random numbers. The investigator intended to collect data on only the first 10 subjects identified each day. Five additional subjects were listed in case one or more of the first 10 were either unable or unwilling to participate in the study.

The investigator went to each subject's hospital room. If the subject was present and available, the investigator made a standardized introduction, read the informed consent form (Appendix C), and asked permission to take the subject's blood pressure, ask him a few brief questions, and look at his chart. If the subject agreed and signed the consent form, the investigator measured the circumference of the subject's upper arm to determine which blood pressure cuff to use. Then, using the appropriate cuff, and with the subject in a sitting or lying position (Lancour, 1976:774), the investigator palpated to estimate the systolic pressure, then measured the blood pressure in first the right arm and then the left arm, following the procedure recommended by the American Heart Association (Appendix A).

The subject's systolic and diastolic pressures were recorded for each arm. It was also noted if an auscultatory gap was present. If present, the point at which the sound disappeared and the point at which the sound recurred were recorded. After making certain that the subject was comfortable, the investigator reviewed the medical record and recorded the rest of the information needed on the Personal Data Schedule.

At this point, several subjects had to be omitted from the study. Three refused to sign the consent form, although each stated he would be willing to have his blood pressure taken. One refused to have her chart reviewed. One refused to have his blood pressure taken in his right arm because of "nerve damage." One informed the investigator that she had had a mastectomy (this was not recorded on the Kardex and the charge nurse was not aware of it). Fourteen patients had been discharged or transferred by the time the investigator arrived. One was found to have a heparin lock in the left antecubital space. One had an inaudible blood pressure in the left arm due to an old gunshot wound. One had radial and brachial pulses that could not be palpated by the investigator. Four had blood pressures that were too faint to be heard accurately in one or both arms. One was found to have an IV which the investigator thought to be too fragile.

Since this study was concerned primarily with the incidence of auscultatory gaps, the data were analyzed by determining the percentage of those subjects in the sample with an auscultatory gap. Other descriptive statistics were used to describe the mean age and the age range of the subjects in which auscultatory gaps occur.

CHAPTER FOUR

Data Analysis and Interpretation

Introduction

The purpose of this study was to determine the incidence of auscultatory gaps in hospitalized adults and to determine if there was a relationship between the presence of the auscultatory gap and one or more subject variables (age, sex, race, or medical diagnosis). A descriptive design was used to interpret the data collected. This chapter presents a description of the sample population, the data collected, and a discussion of the results.

Description of Sample

A stratified random sample was used for this study. One hundred-twenty subjects made up the total sample. The subjects were randomly selected and stratified into six subgroups determined by subject age and gender. The six subgroups were:

1. Females, 20 to 40 years of age.
2. Males, 20 to 40 years of age.
3. Females, 41 to 64 years of age.
4. Males, 41 to 64 years of age.
5. Females, 65 years of age and older.
6. Males, 65 years of age and older.

Each subgroup consisted of 20 subjects.

Of the total 120 subjects, there were 60 (50%) female and 60 (50%) male. Between the ages of 20 and 40 years, there were 20 (50%) females and 20 (50%) males. Between the ages of 41 and 64 years, there were 20 (50%) females and 20 (50%) males. At 65 years of age and older, there were 20 (50%) females and 20 (50%) males.

The subgroups were evenly distributed by gender and age. Even age group consisted of 20 females and 20 males. There was a total of 40 (33.3%) subjects between the ages of 20 and 40 years, 40 (33.3%) subjects between the ages of 41 and 64 years, and 40 (33.3%) subjects 65 years of age and older.

Additional information about the ages of the subjects is presented in Table 1 which illustrates the mean, the range, the median, and the mode for the total sample and for each subgroup.

Table 1

Mean, Range, Median and Mode of Ages for Subject Groups

			Age (in years)			
Age Group	Sex	N	Mean	Min.-Max.	Median	Mode
20-40 years	F	20	28.1	20-39	20	22
	M	20	28.5	20-39	25	None
41-64 years	F	20	57.95	47-64	60	60
	M	20	54.7	41-63	55.5	61
65 and older	F	20	76.1	66-94	75	75
	M	20	74.8	65-90	73	None
Total	-	120	53.4	20-94	60	None

For the total 120 subjects, ages ranged from 20 to 94 years of age. The mean age for the total sample was 53.4 years and the median was 60 years. There was no single mode for the total sample. Two modes were present for the total sample, however; 60 years and 61 years.

Of the total 120 subjects, 10 (8%) were black, one (1%) was American Indian, and 109 (91%) were white. The majority of each subject group was white.

Table 2 presents the diagnosis of subject groups by frequency and percent.

Table 2

Diagnosis Subject Groups by Frequency and Percent

			Diagnosis		
Age Group	Sex	N	Hypertensive Cardiovascular Disease	Nonhypertensive Cardiovascular Disease	Noncardiovascular Disease
20-40 years	F	20	2 (10%)	0 (0%)	18 (90%)
	M	20	1 (5%)	1 (5%)	18 (90%)
41-64 years	F	20	5 (25%)	4 (20%)	11 (55%)
	M	20	6 (30%)	4 (20%)	10 (50%)
65 and older	F	20	10 (50%)	7 (35%)	3 (15%)
	M	20	5 (25%)	11 (55%)	4 (20%)
Total	-	120	29 (24%)	27 (23%)	64 (53%)

Of the 120 total subjects, 29 (24%) had a reported diagnosis of hypertensive cardiovascular disease, 27 (23%) had a reported diagnosis of nonhypertensive cardiovascular disease, and 64 (53%) had a reported diagnosis of noncardiovascular disease. The group with the largest number of subjects having a diagnosis of hypertensive cardiovascular disease was the females, 65 years of age and older, in which there were 10 (50%). The subgroup with the smallest number of hypertensive subjects was the males, 20-40 years of age, in which there was only one (5%).

The two youngest groups, females, 20-40 years of age, and males, 20-40 years of age, had the largest number of subjects with noncardiovascular disease, each having 18 (90%).

Results

Table 3 presents the mean, range, and standard deviation of right arm blood pressures for the total sample and for each subject group.

Table 3

Mean, Range, and Standard Deviation of Right Arm Blood Pressures for Subject Groups

			Right Arm Blood Pressure (mmHg)		
Age Group	Sex	N	Mean	Min.-Max.	S.D.
20-40 years	F	20	122.8 / 70.1	100-140 / 50-90	10.53 / 11.08
	M	20	130 / 72.5	104-160 / 40-100	16.72 / 14.49
41-64 years	F	20	123.7 / 70.3	106-160 / 50-88	14.24 / 11.5
	M	20	131.1 / 75.9	90-200 / 54-130	26.27 / 17.38
65 and older	F	20	139.4 / 66.8	98-180 / 42-90	23.5 / 13.23
	M	20	132.2 / 69.6	90-180 / 50-96	21.32 / 12.54
Total	-	120	129.9 / 70.8	90-200 / 40-130	20.05 / 13.5

For the total sample, right arm systolic blood pressure ranged from 90 to 200 mmHg with a mean of 129.9 mmHg and a standard deviation of 20.05. The group with the highest mean systolic blood pressure, 139.4 mmHg, was the females, 65 years and older. The group with the lowest mean systolic blood pressure, 122.8 mmHg, was the females, 20 to 40 years of age.

For the total sample, right arm diastolic blood pressure ranged from 40 to 130 mmHg with a mean of 70.8 mmHg and a standard deviation of 13.5. The males, 41 to 64 years of age had the highest mean diastolic pressure, 75.9 mmHg. The females, 65 years of age and older had the lowest mean diastolic pressure, 66.8 mmHg.

Figure 1 presents the frequency of right arm systolic blood pressure readings for the total sample of 120 subjects.

A systolic blood pressure reading between 120 and 129 mmHg occurred with the greatest frequency, occurring 40 times (33%).

Figure 2 presents the frequency of right arm diastolic blood pressure readings for the total sample of 120 subjects.

A diastolic blood pressure reading between 70 and 79 mmHg occurred with the greatest frequency, occurring 36 times (30%).

Table 4 presents the range, mean, and standard deviation of left arm blood pressures for the total sample and for each subject group.

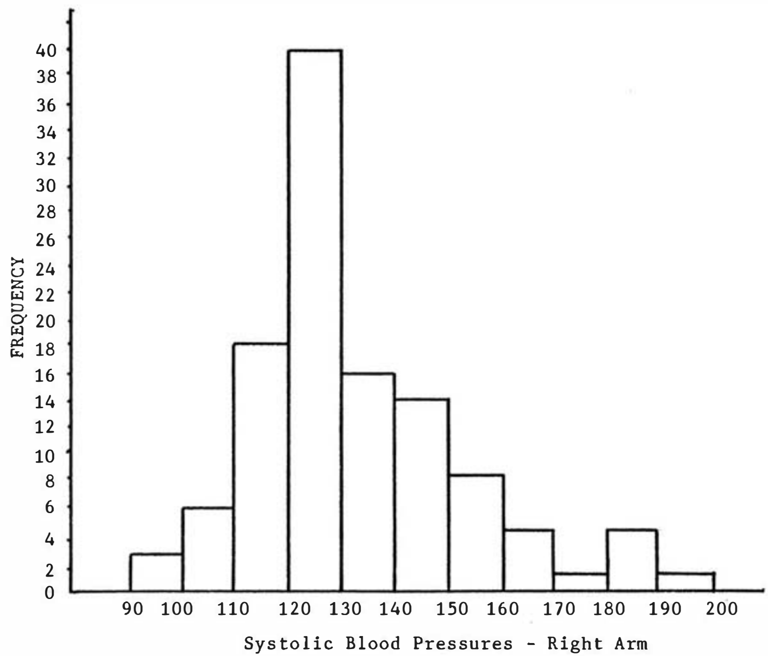

Figure 1

Frequency of Right Arm Systolic Blood Pressures for Sample (N=120)

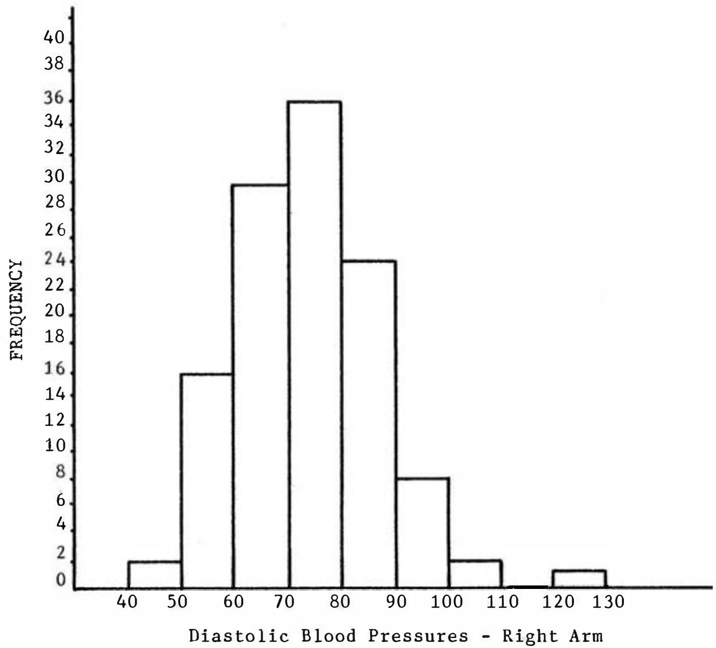

Figure 2

Frequency of Right Arm Diastolic Blood Pressures for Sample (N=120)

Table 4

Mean, Range, and Standard Deviation of Left Arm Blood Pressures for Subject Groups

			Left Arm Blood Pressure (mmHg)		
Age Group	Sex	N	Mean	Min.-Max.	S.D.
20-40 years	F	20	119.6/72.6	100-140/50-90	10.07/10.55
	M	20	132.7/75.1	110-150/50-100	15.56/13.35
41-64 years	F	20	122.7/70.5	100-170/48-90	17.28/10.89
	M	20	130.7/77.2	100-180/50-120	21.53/14.22
65 and older	F	20	143.8/68.1	94-200/40-90	26.42/11.14
	M	20	128.1/69.4	80-180/50-100	23.42/13.24
Total	-	120	129.5/72.1	80-200/40-120	21.08/12.41

For the total sample, left arm systolic blood pressure ranged from 80 to 200 mmHg with a mean of 129.5 mmHg and a standard deviation of 21.08. Females, 65 years of age and older had the highest mean systolic blood pressure, 143.8 mmHg. Females, 20 to 40 years of age had the lowest mean systolic blood pressure, 119.6 mmHg.

For the total sample, left arm diastolic blood pressure ranged from 40 to 120 mmHg with a mean of 72.1 mmHg and a standard deviation of 12.41. Males, 41 to 64 years of age had the highest mean diastolic blood pressure, 77.2 mmHg. Females, 65 years of age and older had the lowest mean diastolic blood pressure, 68.1 mmHg.

Figure 3 presents the frequency of left arm systolic blood pressure readings for the total sample of 120 subjects.

A systolic blood pressure reading between 120 and 129 mmHg occurred with the greatest frequency, occurring 29 times (24%).

Figure 4 presents the frequency of left arm diastolic blood pressure readings for the total sample of 120 subjects.

A diastolic blood pressure reading between 70 and 79 mmHg occurred with the greatest frequency, occurring 37 times (31%).

Table 5 presents the mean right and mean left arm blood pressures for the total sample and for each subgroup.

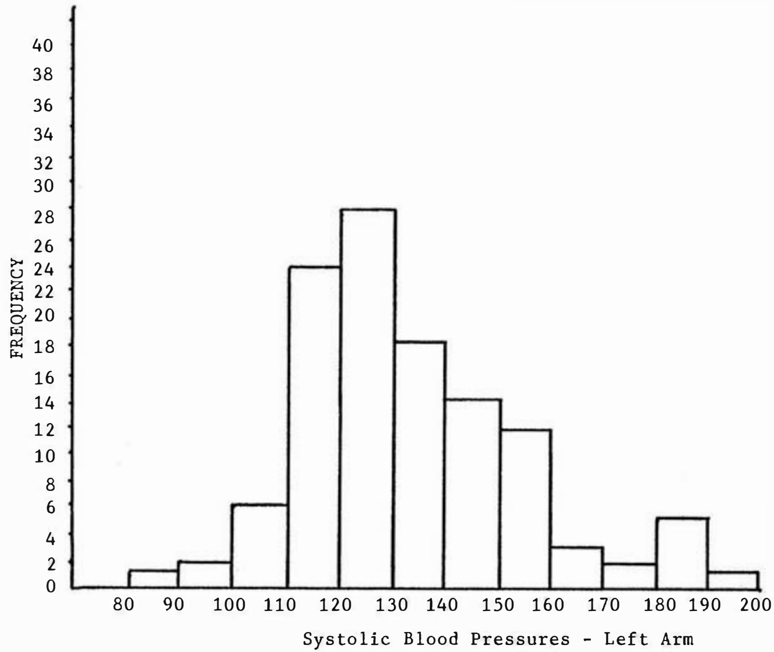

Figure 3

Frequency of Left Arm Systolic Blood Pressures for Sample (N=120)

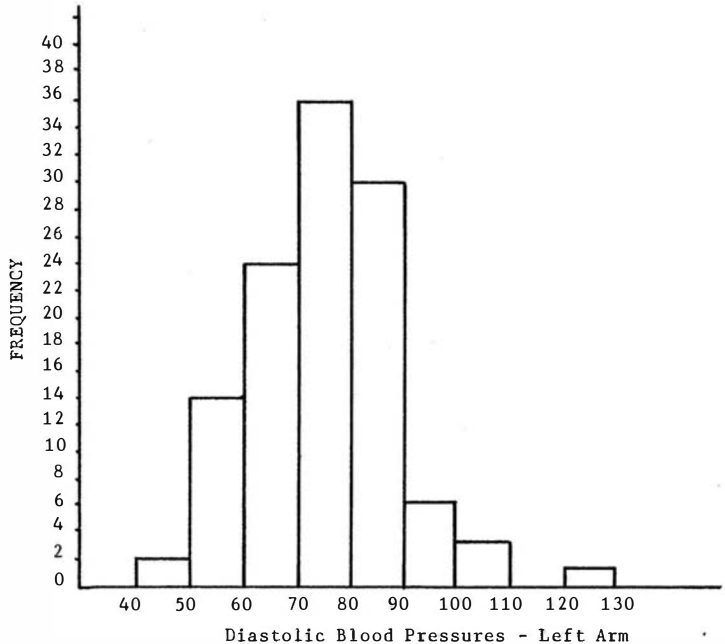

Figure 4

Frequency of Left Arm Diastolic Blood Pressures for Sample (N=120)

Table 5

Mean Right Arm and Left Arm Blood Pressures for Subject Groups

Age Group	Sex	N	Mean Blood Pressure: Right Arm	Mean Blood Pressure: Left Arm
20-40 years	F	20	122.8/70.1	119.6/72.6
	M	20	130/72.5	132.7/75.1
41-64 years	F	20	123.7/70.3	122.7/70.5
	M	20	131.1/75.9	130.7/77.2
65 and older	F	20	139.4/66.8	143.8/68.1
	M	20	132.2/69.6	128.1/69.4
Total	-	120	129.9/70.9	129.9/72.2

The mean systolic blood pressure for the total 120 subjects was only slightly higher (.3 mmHg) in the right arm compared to the left arm. The mean diastolic blood pressure for the total sample was 1.3 mmHg lower in the right arm.

The auscultatory gap was not present in any of the subjects in the total sample of 120 subjects.

Discussion of Findings

This study was undertaken to determine the incidence of auscultatory gaps in hospitalized adults. After measuring the blood pressure on 120 randomly selected hospitalized adults, the researcher found no auscultatory gaps present.

Cook and Taussig (1917:1088) estimated that the auscultatory gap occurred in five percent of patients with hypertension. Twenty-nine (24%) subjects in the sample studied had a reported diagnosis of hypertension. According to Cook and Taussig's estimation, one might anticipate finding one subject (5%) in the hypertensive group with an auscultatory gap present. This did not occur, however.

Gibson (1927:1013) reported a study by Gaddavardin and Barbier that stated that the auscultatory gap "was not rare...in people over 60 with hypertension." In this study, there were 19 (16%) subjects 60 years of age and older with a diagnosis of hypertension. The auscultatory gap was not present in any of these subjects. This finding fails to support the findings of Gaddavardin and Barbier.

In Mudd and White's (1928) study of 30 individuals with an auscultatory gap present, they determined that 93 percent of their subjects had hypertension. Although this indicates that the majority of auscultatory gaps occur in conjunction with hypertension, presence of the gap is not restricted to this condition alone. Mudd and White also described their subjects as being between the ages of 31 and 79 years of age. They do not provide information concerning the mean, median, or mode of their subjects' ages, but they do indicate that the gap is not limited to those who are 60 years of age and older.

In this study there was a larger age range (20 to 94 years of age) than that reported by Mudd and White. Only 24 percent of this sample had hypertension, however. There were no known data concerning the incidence of auscultatory gaps among normotensive individuals with which to compare the findings of this study.

Limitations of the Study

The results of this study may have been affected by the size and the characteristics of the sample, even though the subjects were randomly selected.

The sample was restricted to 120 adults in a 500-bed medical center in a small mid-Atlantic city surrounded by a large rural area. Although there is no evidence to indicate that auscultatory gaps occurs with greater frequency in large urban areas, the location of the sample may inhibit the ability to report the findings as being representative of the general population.

Only 24 percent of the sample had a reported diagnosis of hypertension. Approximately 20 percent of the adult population in the United States has hypertension (Brunner and

Suddarth, 1984:676). Although the percentage of subjects with hypertension in the study is slightly higher than that in the general population, research does indicate that auscultatory gaps do occur with greater frequency among hypertensive individuals. A sample that included more hypertensive individuals may have had different results.

Only eight percent of the sample was black, due to the nature of the hospital population. Approximately 11.9 percent of the population in the United States is black (Bureau of Census, 1982:32). Research indicates that more blacks develop hypertension. A similar study in a hospital with a larger black population may have yielded different results.

Only subjects who were awake, alert, and oriented were included in the study. This was necessary because only alert and oriented subjects were able to provide informed consent to be included in the study. This did eliminate some hypertensive patients who had suffered cerebral vascular accidents and were confused or unconscious.

Another group of possible hypertensive patients that had to be eliminated from the sample were all of those patients with renal failure who had an arteriovenous shunt, fistula, or graft for hemodialysis. These patients had to be excluded because they could not have blood pressures taken in both arms and therefore did not meet the criteria for the study.

Limitations of the Method

One method limitation was that only one observer collected all of the data over a period of three months. Although a preliminary study was done to determine the observer's reliability and validity in determining blood pressure, there was no continuous validation of the observer.

Another limitation was that each subject's blood pressure was determined bilaterally, but only one time. In Mudd and White's (1928) study, several observations of each subject were made and the investigators noted that the gap was present at times and absent at others. Repeated blood pressure readings on each subject in the sample may have provided different results.

CHAPTER FIVE

Summary, Conclusions, Implications and Recommendations

Summary

A descriptive study was conducted to determine the incidence of auscultatory gaps in hospitalized patients and to determine if a relationship existed between the presence of the auscultatory gap and the patient's age, sex, race, or medical diagnosis. The sample of 120 subjects was randomly selected from the patient population in a 500-bed medical center in a small mid-Atlantic city. A stratified random sample was selected, dividing subjects equally into six subgroups according to gender and age: females, 20 to 40 years of age; males, 20 to 40 years of age; females, 41-64 years of age; males, 41 to 64 years of age; females 65 years of age and older; and males, 65 years of age and older.

Each subject was interviewed following the Personal Data Schedule developed by the investigator. After the interview, the investigator determined if the subject had an auscultatory gap present by taking an indirect measurement of the blood pressure in both arms using an aneroid sphygmomanometer and stethoscope, following the procedure recommended by the American Heart Association. The investigator then reviewed the medical record to obtain the remaining data needed for the Personal Data Schedule.

The data were analyzed descriptively. None of the subjects studied was found to have an auscultatory gap present. Because there were no subjects with auscultatory gaps present, it was not possible to determine any relationship between the presence of the gap and the subject's age, sex, race, or medical diagnosis. This finding was inconsistent with previous research that indicated that the auscultatory gap was not uncommon among people over 60 years of age with hypertension.

Conclusions

The results of this study indicated that auscultatory gaps did not occur in the subjects selected. It was not possible to determine any relationship between the presence of the auscultatory gap and patient age, sex, race, or medical diagnosis.

Implications for Nursing

This study added some information to the knowledge of auscultatory gaps, indicating that it is a phenomenon that does not occur with great frequency among hospitalized adults.

This study also indicated that further research is needed to determine under what circumstances the auscultatory gap does exist.

Although this study indicated a low incidence of auscultatory gaps in the research sample, the investigator cannot imply that nurses do not need to estimate the systolic blood pressure by palpation when determining blood pressures. Auscultatory gaps are known to exist in some individuals. It is also recognized that the presence of an auscultatory gap can mask hypertension and that hypertension, when undiagnosed and untreated, has many life-threatening effects, including myocardial infarctions, cerebral vascular accidents, and renal failure.

Recommendations

The investigator recommends continued nursing research on auscultatory gaps and suggests that nurses replicate the study:

1. using a larger sample with more black subjects;
2. in a larger urban center;
3. using equipment to record the amplitude of the Korotkoff sounds;
4. in a population of patients, 60 years of age and older;
5. using a sample that includes patients in the critical care areas, and
6. including those patients who may have blood pressures determined in only one arm (patients with shunts for renal dialysis).

Although the study indicated that the auscultatory gap is not common among adults hospitalized in a medical center in a small, mid-Atlantic city, the research question concerning the incidence of auscultatory gaps remains unclear. More nursing research is needed in this area to provide a more specific answer.

The investigator found no auscultatory gaps in the sample studied, but the investigator did find that it was very easy to palpate the radial artery while inflating the blood pressure cuff. With little practice, the systolic blood pressure was easily estimated with palpation during the initial inflation of the cuff for the auscultatory reading. Because of the physiological hazards caused by hypertension, the investigator recommends that health professionals always estimate the systolic blood pressure first using the palpation technique whenever determining blood pressure.

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APPENDIX A

BLOOD PRESSURE DETERMINATION
AMERICAN HEART ASSOCIATION

Recommendation Made by the American Heart Association for the Determination of Blood Pressure

1. The patient should be comfortably seated, with the arm slightly flexed and with the whole forearm supported at heart level on a smooth surface.

2. The patient should be in a quiet room at a comfortable temperature, with the arm unconstricted by clothing or other material. The subject should avoid exertion, exposure to cold, and eating or smoking for a half hour before the measurement; there should be no postural change for five minutes before the recording.

3. The deflated cuff should be applied with the lower margin about 2½ cm. above the antecubital space.

4. The center of the bladder is applied directly over the medial surface of the arm.

5. The bell stethoscope should be applied to the antecubital space over the previously palpated brachial artery.

6. With the stethoscope in place, the pressure is raised approximately 30 mmHg above the point at which the radial pulse disappears, and then released at a rate of 2 to 3 mmHg/second.

7. The systolic pressure is the point at which the initial tapping sound is heard....When the palpatory pressure is higher, it should be recorded and noted as systolic pressure.

8. The fifth phase occurs when sounds become inaudible and should be regarded as the best index of diastolic pressure in adults.

9. One to two minutes should elapse...before further determinations are made.

Source: Kirkendall, et al., 1981:513A-514A.

APPENDIX B

PERSONAL DATA SCHEDULE

Personal Data Schedule

Identification number ____________

Age _____

Sex _____M _____ F

Race ___________

Height _________

Weight _________

Admitting Diagnosis:

Other Diagnoses:

Current Medications:

Medications taken prior to admission:

Medications taken during hospitalization:

Blood pressure range during hospitalization: Systolic ______
Diastolic ______

Length of hospitalization: _____day(s)

Arm circumference: _____________ cm

Cuff size: _______adult ________ large adult

	Right Arm		Left Arm	
Blood pressure:				
AG present:	Y	N	Y	N
	Range: _______mmHg		Range:______mmHg	
	Duration: _______mmHg		Duration:_____mmHg	

Position: _____Lying _____Sitting

Time: __________AM/PM

APPENDIX C

CONSENT FORM

Informed Consent

My name is Elizabeth Courts. I am a registered nurse and a graduate student at the Medical College of Virginia. In completing the requirements for the Master of Science in Nursing degree, I am conducting a research study on blood pressures of hospitalized adults. The purpose of the study is to determine the incidence of auscultatory gaps--a brief pause in the sounds the nurse hears when taking the blood pressure.

There are no direct or immediate benefits in participating in the study, but it is hoped that the results of the study may be used by nurses to improve their technique in taking blood pressures. The only participation requested is that you allow me to take your blood pressure in both arms and answer a few brief questions. This should take about 15 minutes. I would also like to look in your chart to see what medications you have been taking and to see what your blood pressure has been since you have been hospitalized.

There are no risks involved in participating in the study. Your name will not be used in any written document and all information obtained is strictly confidential. Participation in the study is voluntary and you may decide not to participate at any time without your care being affected. You may withdraw at any time simply by notifying me.

If you have any questions about the study or about your participation in the study, please ask me. If you have any questions concerning the study that you think of later, you may contact me at Shenandoah College, School of Nursing, Winchester, Virginia (phone: [redacted]).

My signature indicates my willingness to participate in the study.

_______________________________ Patient's Signature

_______________________ Date

APPENDIX D

INDIRECT AND DIRECT BLOOD PRESSURES

Indirect and Direct Blood Pressures

	Systolic Blood Pressure	
	Indirect	Direct
Case		
1	110	105
2	100	95
3	160	156
4	120	130
5	122	133
6	110	100
7	110	120
8	100	115
9	130	140
10	180	187
11	120	119
Item		
N	11	11
Mean	123.82	127.27
Standard Deviation	24.99	26.74
Correlation	0.9476	
Significance One-tailed	0.0001	

Indirect and Direct Blood Pressures

	Diastolic Blood Pressure	
	Indirect	Direct
Case		
1	68	60
2	58	52
3	84	68
4	60	48
5	70	66
6	60	60
7	72	70
8	58	56
9	68	66
10	75	85
11	62	60
Item		
N	11	11
Mean	66.82	62.82
Standard Deviation	8.21	9.99
Correlation	0.7412	
Significance One-tailed	0.0045	

VITA

[redacted]