1944

Hypotension

Jack Michael Stemper
University of Nebraska Medical Center

HYPOTENSION

by

Jack M. Stemper

SENIOR THESIS

presented to the

COLLEGE OF MEDICINE

UNIVERSITY OF NEBRASKA

OMAHA, 1944

CONTENTS

INTRODUCTION

During my medical college years I have never heard a lecture or attended a quizz section in which the subject was hypotension. In fact, about our only contact with low blood pressure, exclusive of shock, was with a patient with Addisson's disease presented to one of our junior medicine clinics. So it happened that I was somewhat at a loss to answer a question of a friend of mine who has low blood pressure. He had asked me the significance of this finding. When I chose hypotension as my subject for a senior thesis it was this object in mind— to find out the significance of low blood pressure.

In reviewing the literature I became quite interested in a relitively new described syndrome, orthostatic hypotension, so that I devoted about one-half or more space to this subject and the remainder to the so-called "essential hypotension," hypotension in acute and chronic diseses, and a short discussion of the present views on shock.

Reference to Davis in the section on shock is from a lecture in Military Surgery given at the University of Nebraska College of Medicine by Dr. Herbert Davis.

HISTORY

Before 1733, blood pressure was merely a matter of conjecture on the part of the physicians of that period, and the meager amount of information acquired was by palpation of the peripheral vessels. In that year, however, Stephen Hales published the results of his important work on the mechanical relations of blood pressure. By fastening a long glass tube inside a horse's artery this physician devised the first manometer, with the aid of which he made quantitative estimates of the blood pressure, the capacity of the heart, and the velocity of the blood.(1)

Majendie (1) in 1821 demonstrated that the pumping power of the heart was the main cause of blood flow in the veins.

Poiseville in the 1830's improved upon Hales' original experiment by substituting a mercury manometer. He showed that the blood pressure rises and falls with expiration and inspiration.

Bishop (2), in 1905, was the first to refer to low blood pressure. He distinguished two types of low arterial tension--primary and secondary. The primary, he stated, existed in cases in which, for example, the heart has been damaged by disease. The secondary was

that occurring as an aftermath of high arterial tension when the circulatory apparatus breaks down.

This same author (3) a year later referred to constitutional low arterial tension (what is now called essential hypotension). Emerson (4) a few years later, in 1911, referred to the relationship of low blood pressure to tuberculosis. In 1927, Friedlander (5) presented an extensive review of the subject.

PHYSIOLOGY

Normal blood pressure is maintained by the combined effect of four factors:

1. Force of cardiac contraction.
2. Peripheral resistance to the blood stream.
3. The condition of the vessel walls.
4. The blood volume, and the physical state of the blood itself, its viscosity, etc.(5)

(1) Force of cardiac contraction: The means by which the cardiac contraction exerts its effect upon the arterial blood pressure is through the quantity of blood which it pumps into the aorta. When more blood is forced into the filled arterial system, the arterial walls become stretched to accommodate this "extra blood". "The pressure rises until the velocity of flow through the arterioles is great enough to balance again the outflow from the system with the inflow."(6)

"What relation exists between the integrity of the heart muscle and the pressure at a given moment is not easy to determine."(7) A heart that is obviously damaged can still maintain a blood pressure above normal up to the time of death. On the other hand, a patient may have a normal heart and have a systolic blood pressure of 100 millimeters of Hg. or below. This writer stated that diseased heart muscle is a

relatively negligible factor in the production of low blood pressure, and he explained this statement by Starling's work, who showed that when a heart is filling under the loed of a high blood pressure, reflex vasoconstriction takes place decreasing the vascular bed in proportion to the lessened output. This at the same time serves to maintain the blood pressure at the existing level.

(2) Peripheral resistance: Bowman (8) agrees with most authors when he states that peripheral resistance to the blood stream is the most important factor in the maintenance of normal blood pressure. The peripheral vascular resistance is determined by the total cross-sectional area of the smaller vessels--arterioles, capillaries, and probably the venules. Their caliber is regulated partly directly and partly by vasomotor nerves. They may react diffusely or locally to changes in temperature, dilating with heat and constricting with cold; and to chemical alterations in the blood or tissue fluids, dilating under the influence of certain blood-borne drugs or substances produced elsewhere in the body (histamine) and constricting under the influence of others (adrenalin, for example). The products of tissue metabolism or injury have a decided dilating

effect upon this portion of the vascular field. The most sensitive control is by vasomotor nerves, chiefly vasoconstrictor, from centers in the medulla and spinal cord.(9)

(3) The condition of the vessel walls: The chief resources for the sensitive control of blood pressure lies in the vascular field between the arteries and veins. There is little proof that changes in the elasticity of the larger arteries, such as develop with advancing age, contribute to hypotension. Friedlander (5), however, states that "hypotension is not inconsistent with a marked degree of arteriosclerosis." The massaging support to the veins by the action of the muscles of the extremities is of considerable importance in forwarding the return of the blood from the periphery.(9)

(4) The blood volume, and the physical state of the blood itself, its viscosity, etc.: The reduction of the total blood volume may occur without a fall in the blood pressure if there occurs enough constriction of the blood vessels. Beyond this point, however, the pressure may fall due to insufficient filling. But, with or without changes in the blood volume, changes in the distribution of blood may strikingly influence

the blood pressure. For example, if complete dilatation of the splanchnic were to occur, it would be possible for these vessels to hold all of the blood in the body, with a consequent drop in the blood pressure to zero.

According to Friedlander (5), it is doubtful whether the viscosity of the blood alone is a very important factor in the maintenance of blood pressure. An increase in the viscosity of the blood does increase the resistance to its passage through the vessels and would usually cause a slight increase in pressure.

It should be kept in mind that in the maintenance of the arterial pressure, the outward manifestations are the systolic pressure, the diastolic pressure, and the pulse rate. Normally, these three forces act in unison by reciprocating to each other. Thus, when the systolic pressure falls, the diastolic pressure and pulse rate tend to rise. When the diastolic pressure rises, the systolic pressure tends to recede and the pulse rate tends to slow. When both the systolic and diastolic pressure rise, the pulse rate tends to fall. "This adjustment occurs in health and in disease, and if for any reason this adjustment cannot be made, a breakdown

will sooner or later follow." (10)

It is a well-known fact that there are normal fluctuations in blood pressure. There is a diurnal shift of 5 to 10 millimeters normally, with the pressure being lowest in the morning, and at its peak in the afternoon. In the normal quiet individual in quiet dreamless sleep, there is a drop of 15 to 30 millimeters in systolic pressure during the first hour and a gradual rise during the night to the morning level. There is usually a rise in systolic pressure of 6 to 8 millimeters with digestion of a meal; there is little or no change in the diastolic pressure. This change in the systolic pressure may last an hour or so. It is a well-known fact that there is a rise in the blood pressure with exercise.(5)

There is also a variation in the blood pressure findings in different periods of life and between males and females. From infancy to old age there is a gradual rise in arterial pressure. According to Barach (10) the preasure levels tend to change at the epochal periods of life--puberty, maturity and menopause. From puberty onward it has been found that arterial pressure is lower in females than in males. "It is also true that the woman with disease involving her sex organs, the

sexually abnormal woman, will have a higher arterial pressure than will the woman with normal sex organs and sex characteristics."(12) Young women have a much higher incidence of low blood pressure than do men, and in old women the incidence is about the same as old men.(13)

It has also been found that there are racial differences in blood pressure. The orientals, generally speaking, have a lower blood pressure than do the occidentals.

ESSENTIAL HYPOTENSION

Most authors agree that essential hypotension is not necessarily a disease entity. A distinctly low blood preasure may be present in many instances with the individuals in perfect health. It is, however, "productive" of symptoms which oftentimes are quite disabling to the individual. How, then, is one to define such a condition? The following definition is perhaps the most accurate at the present time: Essential hypotension is a relatively common "syndrome", which may or may not be characterized by many and varied complaints, such as headache, vertigo, palpitation, exhaustion, fatigue, etc., in which the chief objective finding is a marked hypotension.

Andrus (9) is of the opinion that the term hypotension should best be reserved to designate a systolic blood pressure which is persistently less than 100 millimeters of Hg. The majority of the workers feel, however, that the lower level of normal blood pressure is 110 millimeters of Hg. Diastolic pressure values have not come into the calculation because changes in its levels seem to be relatively insignificant in this condition.

Robinson (13) states that between one-fourth and

one-third of the adult population have blood pressure readings under 110 millimeters of Hg. Pepper (14) is of the opinion that 20% of the population have a systolic pressure below 110. Barach (10), however, in a very thorough survey found that in a cross-section of the population (healthy subjects) at the ages of 17 to 30, the incidence of low blood pressure was 3.5 per cent, varying from 1.8 to 6 per cent. These values were obtained in students, Army recruits, etc. For example, in 1914, at the Carnegie Institute 30 out of 656 normals or 4% were found to have a systolic pressure below 110 millimeters of Hg. Roberts (15), however, found that in studying a group of apparently healthy people, such as bank clerks of the same ages as above, that 38 per cent of the males and 55 per cent of the females had a low blood pressure. This writer explained this "discrepancy" by saying that "The individual with a constitutional tendency to low blood pressure, is unable or unwilling to ape with the rugged issues of life, and, therefore, hunts seclusion in the protection given by inside work."

While the etiology of this condition is, as yet, unknown, Friedlander (5) was of the opinion that loss of vasomotor tone such as is found in focal and chronic

infection is the outstanding important factor. His theory was that there is capillary stasis due to the poisoning effect of histamine or histamine-like bodies.

Duffy (16) believes that the physical and psychical efficiency depends on the vitality of the somatic processes, and that vitality itself depends upon a state of metabolic equilibrium. He goes farther to state that disturbances of this equilibrium lead to vasomotor disturbances and so produce variations in arterial pressure. Dally's (17) biological law of low arterial pressure bears out this view: "Low arterial pressure, congenital or acquired, temporary or permanent, is always to be regarded as an expression of low vitality."

Barach (10) pointed out the fact that wherever low blood pressure occurred, there were suggestive evidences of defective respiratory function and defective oxygenation in these individuals. They are, for the most part, slender, undersized, undernourished, etc. And, this writer stated that these characteristics tend to produce deficient respiratory function and so defective oxidation.

Barach (10) is of the opinion that when unfavorable conditions arise, the 3.5 per cent of humanity is in the front line of attack, and that they will be the

first to show symptoms. These complaints may be in any organ or system of organs in the body.

According to Roberts (15), the most common symptom of low blood pressure is that there occurs a loss of their former sense of well being which is replaced by early fatigue and physical exhaustion. At times, they may have dizziness and motor instability. Symptoms referable to the nervous system, such as apprehensions, fears, nervousness and insomnia may be present. Some patients complain of ringing in the ears and generalized neuralgic pains which are short, sharp and which may occur in various parts of the body.

Some of these patients complain of symptoms referable to the cardiovascular system, such as cardiac pains, dizziness, palpitation, faintness, and syncope. Some complain of digestive symptoms such as indigestion, abdominal discomfort from "gas" in the stomach or intestine, spasticity and mucous colitis with its accompanying symptoms.(10) According to Pepper (14) these individuals used to be diagnosed as neurasthenics. It was in these patients that operations were performed to raise the kidneys and colon. Lawerence (18) also pointed out this error in his report of 20 cases of essential hypotension. All were between the ages of

15 and 35 years, 14 females and 6 males. There was no anemia or focal infection. They all slept poorly. They were markedly fatigued on arising; they improved during the day and usually felt best after meals, at which time the pressure was highest.

As Durant (19) has pointed out, however, all persons with low blood pressure do not have any of the above complaints. "Many, in fact, are in robust health, and would be unaware of their blood pressure level were it not for routine check-up examinations." The question is then at once asked as to why some patients with low blood pressure have symptoms and some do not. Durant (19) pointed out the one striking feature concerning the hypotensive person with symptoms in his general bodily habitus and condition. For, as Robinson (13) has stated, low blood pressure is commonest among the linear-built or narrow-chested type of build, and they are usually underweight. After considering these facts, Durant raises the question: "Is the symptomatology due to the hypotension, or, on the other hand, are both the symptomatology and the hypotension due to the constitutional make-up and physical condition of the individual?"

Durant (19) continued by remarking about clinical evidence which he believed to be quite pertinent. This

writer stated that it was possible to obtain complete alleviation of symptoms in most of these cases by means of graduated exercises and dietary measures to correct the weight deficiency. In these cases, it is interesting to note that the symptoms disappear without change in the blood pressure. It was also shown that drugs which produce a rise in blood pressure without psychic stimulation (for example, paredrine hydrobromide) do not completely relieve the complaints of these patients even when the pressure is raised to average levels. Durant (19) concluded, therefore, that "the hypotension is not the primary factor in the symptomatology, but is a symptom itself, a manifestation of subnormal body tonus."

Holt (20) is of the same opinion as Durant. The former writer pointed out that in the New York hospitals there were many nurses with low blood pressures. They lived strenuous lives but were in good health and complained of no symptoms. This author concluded that essential hypotension is not "evidence of an abnormal physical condition but is looked upon as an individual peculiarity."(20)

What, then, is the significance of this condition? It has been shown by the statistics of the insurance

companies that as a group these individuals with low blood pressure live longer than do those with normal or high blood pressure. There has been no explanation for this. Of course, if there is no disease entity, there is no treatment. As Durant (19) pointed out, however, its presence in the undernourished asthenic individual, complaining of fatigue, etc., should be a requisite for "building-up" that individual by exercise and diet.

ACUTE HYPOTENSION (SHOCK)

Since the question of the pathogenesis of shock is not, as yet, definitely settled, an acceptable definition of this condition is lacking in the literature. The best definition I have heard, however, is that "shock is acute peripheral vascular failure." (Davis)

Before proceeding further, it would perhaps be best to differentiate primary or neurogenic shock from secondary shock. Primary shock is that condition which occurs immediately after an injury, and is said to be due to anemia of the brain from some nervous or reflex condition. For example, a sudden fear may cause reflex vasodilatation of cerebral vessels with resulting symptoms (syncope, etc.). Secondary shock, on the other hand, developes hours after an injury. This paper will deal mainly with the latter condition.

It is known that trauma, burns, hemorrhage, etc. cause secondary shock, but the exact way that the pathogenesis of shock takes place is not known. Volumes have been written on the theories of this phenomenon, but it is not within the scope of this paper to cover all of these theories, so that this discussion will be limited to the more important findings at the present time.

Before starting with a discussion of the pathogenesis of shock it might be fitting to review the physiology of the peripheral circulation. The exchange of material between the blood and tissue cells is accomplished by the capillaries. The hydrostatic pressure within the capillary tends to force water and solutes through the walls into the tissues, and the osmotic pressure of the particles in the blood has the opposite effect. Filtration usually occurs through the arterial segment of the capillary because the hydrostatic pressure exceeds the osmotic pressure at that point. On the venous side of the segment, however, the above relation is reversed and absorption occurs. These forces under normal conditions neutralize one another, because they are about equal. (21)

At the present time there are two main schools of thought as to the primary cause of secondary shock: (1) the toxemia theory of shock; (2) the theory of local fluid loss. (6)

According to the former theory, it is believed that a toxic agent is formed in the injured tissues and is carried throughout the body exerting a widespread effect upon the vascular system. The followers of this theory believe that histamine or a histamine-like substance is

picked up at the wound site and that it is this substance which exerts its depressor action on the circulation. It is known that histamine, besides causing a fall in blood pressure, also causes increased permeability of the capillaries. Certain clinical observations seem to support this theory. For example, it has been shown that a tourniquet applied to a damaged limb appeared to postpone the development of shock. It has also been shown that amputation of a contused part favored recovery from shock. These observations were explained on the basis that the toxic products of the wounded tissue were thus prevented from entering the general circulation.

Cannon and Bayliss (6) seemed to have finally established the toxemia theory when they published the results of their experiments. These men crushed the limbs of animals and reported that a fall in blood pressure did not occur as long as the vessels of the injured part were occluded. When the circulation was restored, the blood pressure dropped. Other workers have failed to corraborate these findings, however.

Gatch (21), however, is an advocate of the theory of local fluid loss in production of shock, and believes the total effect to be due to a combination of causes--hemorrhage, venous obstruction, and endothelial damage.

He stated that the trauma causes rupture of arteries and veins, from which blood is extravasated into the tissues. This blood will then produce venous obstruction and so cause increased filtration from the capillaries of the obstructed veins. Also, because of the added damage to these capillaries from anoxia, albumin will be lost into the area.

Blalock (6), also, believes that the reduction in blood volume and consequent fall in blood pressure can be entirely accounted for by the escape of blood and plasma from the vessels at the site of the trauma. His experiments consisted of bruising a limb with a hammer and then comparing the weight of the traumatized limb to the normal. He concluded that the quantity of blood which accumulated in the injured limb was sufficient to account for the fall in blood pressure. Clinically, however, it is known that not all cases of traumatic shock could be explained on this latter theory, for as McIntyre (22) has said, "Every surgeon has seen patients develop shock during an operation in which hemorrhage appeared negligible and trauma minimal or nil."

Gatch (21) regarded it as "an established fact that the symptoms following extensive burns are due to injury of the capillary and endothelium." He stated

that the theory of toxemia cannot account for the phenomena, and that it gives bad results when applied to treatment--that is, that it is dangerous to administer water to these patients in an effort to wash out the toxin or toxins as advocated by the exponents of the theory of toxemia. This writer went on to state that the symptoms seen after burns (edema appears first in the burned area, later appearing in other areas; patient, at first, has a normal color but later becomes cyanotic) are what would be expected, from Starling's hypothesis, to occur after injury to a large amount of capillary endothelium.

He brings out this relationship as follows:

> "1. The heat causes serious injury to a wide extent of capillary endothelium.
>
> 2. Blood plasma escapes in large quantities into the tissues around the injured capillaries, thus producing edema of the burned area.
>
> 3. The loss of protein by the blood at the site of the injury gradually lowers the osmotic pressure of the blood until it is no longer able to absorb water which has passed from the capillaries in unburned parts of the body, thus resulting in generalized edema. This process leads to concentration of the blood and cyanosis."

Phemister (23) has recently done some work on the mechanism of shock. He favors the theory of local fluid loss.

While the exact mechanism of the production of shock cannot be definitely stated, echeles (24) brings out an important physiologic factor. This is the so-called arteriovenous anastomoses. These anastomoses occur in many parts of the body, but are especially numerous in the small intestine. They are believed to be for the purpose of shunting the blood directly from the arteries into the veins in those areas in which metabolism is temporarily low.

The diameter of these anastomoses is quite a lot greater than the capillaries of the same region. If, in a large area of the body these anastomoses would stay open for some reason, the peripheral resistance would be low. Also, the capillary bed of this region would become anoxemic and might become permeable to plasma and finally to red blood cells.

Necheles (24) goes on to say that "if, in a large area like the splanchnic bed, the arteriovenous anastomoses would open, and if, furthermore, no vascular area comparable in size to the splanchnic would compensate by vasoconstriction, systemic blood pressure would drop to low levels." The writer also stated that "at the same time, venous return to the heart would increase at first, and even after some loss of plasma has

occurred it may not show much change for some time, a fact which has been found to occur in shock." As yet, very little is known concerning the physiology of the arteriovenous anastomosis, but this writer stresses the possibility of its importance in the production of shock.

McIntyre (22) is of the opinion that two or more disturbances operating together may be the answer to the complex chain of events present. He believes that blood-fluid loss, vasoconstriction, and anoxia may be the important factors, and that possibly cortico-adrenal function, capillary poisons, and heavy sedation are contributory causes.

He brings out the point that while there is no evidence that vasoconstriction alone produces shock, most surgeons are of the opinion that labile apprehensive patients are generally more prone to shock, than the phlegmatic. This author also states the pertinent fact that vasomotor effects due to anxiety are much more likely to be important factors in man than they are in experimental animals. McIntyre goes on to state that the unstable autonomic control of "nervous" patients may be a contributing factor in the production of shock.

A cold clammy skin, ashen cyanosis, and apathy following trauma, burns, etc., is said to be characteristic of secondary shock. While low blood pressure is one of the important signs of shock it must be remembered that this is a relatively late sign (25). Mahoney and Howland (35) state that the blood volume may decrease by as much as 50 per cent and the blood pressure remain normal because of vasoconstriction.

Since there is diminished blood volume and blood pressure, the pulse rate is fast and thready because of an attempt on the part of the heart to keep the tissues supplied with oxygen. The basal metabolic rate is usually lowered because of the fall in blood pressure and insufficient oxygen supply. The temperature is usually subnormal. A leucocytosis, often as high as 20,000, usually occurs after severe trauma. (27) Because of decreased blood volume, a hemoconcentration occurs (except in early hemorrhage). The red blood cell count may be 6 to 7 million; the hemoglobin may be up to 120.

Since low blood pressure, etc. are relatively late signs of shock, what are the means by which we can tell the condition of the patient with regard to prognosis? Necheles (24), working with laboratory animals, has found that one of the best indices of the condition of

the animal is the carbon dioxide content of the blood plasma. "This value indicates the degree of acidosis, which in itself is a function of the intensity and duration of the tissue ischemia and anoxia."

Probably, the most important part of the treatment of shock is the restoration of the blood volume and so the blood pressure. "At present, whole blood and blood plasma are the most effective available agents for increasing and maintaining the circulating blood volume." (6) The indications for whole blood are when the shock has resulted primarily from hemorrhage. Plasma is best for those cases in which the number of red blood cells is normal. Many cases of shock occur in which hemorrhage plays a part in the production of the syndrome. In these cases Bisgard (28) states that enough whole blood should be administered to replace that which was lost, and supplement with plasma.

As an index of the amount of these fluids to be restored to the body, Dr. Herbert Davis, in a lecture at the University of Nebraska College of Medicine, offered the following: (1) for every point the hemoglobin is over 100, 50 cubic centimeters of plasma is needed; (2) for each point the hematocrit reading is above normal, 100 cubic centimeters of plasma is needed.

Besides the above important treatment, it is necessary to relieve these patients of pain; to see that they are kept warm. Bisgard (28), however, brings out the important fact that these patients must not be overheated; for with an increase in temperature there will be an increase of tissue metabolism resulting in an increased demand upon the circulation. One must also not forget that oxygen therapy is an important aid in the treatment of shock.

HYPOTENSION IN ACUTE INFECTIOUS DISEASES

In most of the acute infectious diseases, there usually occurs a drop in blood pressure, although the drop is more marked in some than in others. In general, the extent of the fall varies directly with the degree of the fever. There are, however, exceptions to the rule. The type of infection, the general condition of the patient before the infection, and the fact that in some instances the blood pressure is influenced more by the toxemia than by the pyrexia, all act to upset the above rule.(5)

Various factors enter into the production of hypotension in the acute infectious diseases. As Friedlander (5) points out, during the height of the fever the blood flow, especially in the capillaries, is slower than in health. Such relative capillary stasis, therefore, would be a factor. In those infections in which there occurs cloudy swelling of the heart muscle, the resultant weakened heart action would tend to cause a fall in blood pressure. During convalescence from prolonged fevers there often occurs a loss of splanchnic tone which would thus tend to produce a relative stasis of blood in the splanchnic vessels and so a decrease in the blood pressure.

1. Typhoid Fever:

Except for a slight transient rise at the onset of a relapse, the course of the blood pressure in this condition is progressively downward. Of course, with the advent of hemorrhage the pressure drops sharply. (Friedlander, 5)

2. Pneumonia:

According to this author hypotension is found more or less marked, in the majority of cases of pneumonia. Two factors are involved in its production: (a) from the mechanical embarrassment of the right heart due to the exudate in the lung, and (b) from the effect of the toxemia upon the vasomotor centers.

3. Influenza:

Borach (10) states that is is in this disease in which the blood pressure reaches its lowest levels. He reported that in 50 cases in 1918, the average systolic pressure was 89 and the average iastolic pressure was 53 mm. of Hg. He made the statement that while hypotension occurs in 3.5% of normal soldiers, it occurs in 100% of the soldiers with influenza. Friedlander (5) noted that the hypotension persisted for a long time after all of the acute manifestations of the disease had passed. The lowered blood pressure results from lack of vasomotor tone and decreased action of the heart.

4. Diphtheria:

There is usually a marked hypotension in the acute cases of diphtheria. (15) The causation of the decrease in pressure is from the same factors as those in influenza, namely, cardiac and vasomotor.

5. Cholera:

The systolic blood pressure falls markedly in the algid stage of this disease. The diastolic pressure does not fall proportionately so that a decrease in the pulse pressure occurs. The hypotension is due to a loss of plasma from the circulatory blood. The resultant polycythemia causes an increase in the viscosity of the blood, so that in this disease the causative factor of the hypotension is the change in the blood volume.(5)

6. Malaria:

Although marked hypotension has been found in many of the more severe cases of malaria, this finding is not always present. "It is, of course, much more common in chronic malarial cachexia."(5)

7. Typhus Fever:

Both the systolic and diastolic blood pressure are usually very low in this condition. Because the heart does not show as marked myocardial damage as in typhoid, Friedlander (5) is of the opinion that the hypotension is not of cardiac origin, but is probably

due to toxic vasomotor depression.

8. Trichinosis:

It has been found that marked hypotension commonly occurs in severe cases of trichinosis. Because Gruber (5) found that in the severe cases there was marked degeneration of the heart muscle, the lowered blood pressure is probably of toxic myocardial origin.

HYPOTENSION IN CHRONIC DISEASES

1. Tuberculosis:

While marked hypotension is the rule in advanced tuberculosis, it is a variable finding in the incipient stages. Samuel (29) is of the opinion, however, that low blood pressure is almost a constant finding in this disease. The exact pathogenesis of the low pressure is not known; Johnson (27), however, believes it to be due to the weakened heart muscle.

2. Syphilis:

Friedlander (5) presented clinical evidence which seemed to indicate that syphilis of the adrenals may produce marked hypotension. For the most part, however, there is nothing characteristic about the blood pressure findings in the majority of cases of cardiovascular syphilis.

3. Addison's Disease:

Marked hypotension is one of the outstanding clinical features of Addison's disease, although it is not present in every case.(15) The exact mechanism of its production is not known.

4. Bronchial Asthma:

Roberts (15) states the low blood pressure, which usually occurs in this condition, is due to a lack of vasomotor tone, and that this lack of tone is probably due to an anaphylactic reaction as a result of a toxic split protein circulating in the blood stream.

5. Focal Infections:

Chronic infections of the teeth, nasal sinuses, gall bladder, etc. are often accompanied by low blood pressure. According to Mortensen (50) there is a toxin produced in these infections which depresses the vasomotor system and lowers the arterial tension.

ORTHOSTATIC HYPOTENSION
(POSTURAL HYPOTENSION)

Orthostatic hypotension is a disease of unknown etiology, characterized by marked postural change in blood pressure with symptoms of weakness, dizziness, syncope, etc., which are relieved when the patient resumes the reclining position.

Since 1925, when Bradbury and Eggleston (31) first reported three cases of this syndrome, there have been about forty acceptable cases of orthostatic hypotension reported in the literature. This condition seemingly occurs at any age. There have been two cases reported in children, a boy 11 years of age and a girl 13 years of age.(32) There have also been numerous cases reported in elderly individuals, some with marked arteriosclerosis. Because of the small number of cases reported in the literature, it would seem that this condition is relatively rare. It has been suggested, however, that postural hypotension may be much more common than formerly thought, if one were to record the blood pressure of patients, exhibiting weakness, etc. on change of position, in both the supine and erect positions.(33)

"Man would have syncope while standing upright if it

were not for certain adaptive mechanisms which tend to maintain a constant cerebral blood flow.(34) When in the standing position the amount of blood present in the upper part of the body is decreased. This occurs because the vascular bed in that portion of the body below the heart is dilated by a high hydroatatic pressure, and because the high capillary pressure causes an increased filtration of fluid from the blood stream and a decrease in plasma volume.(34)

In the normal person, however, three adaptive mechanisms take place which prevents the above condition from happening. These are: (1) the central nervous system, from the vasomotor center, causes vasoconstriction of the peripheral arterioles. (2) the second adaptive mechanism is also a function of the nervous system, and consists of reflex acceleration of the heart rate. MacWilliam (35), while studying the case of Croll and Duthie, found that in normal individuals, "the slower heart rate in the horizontal position, as compared with the sitting, is essentially due to the action of the carotid sinus reflex, while the quicker rate in standing is mediated through afferent impulses from the lower limbs." He believes that, "both pulse rate and blood pressure adjustments in the standing posture are influenced by afferent impulses from the lower limbs,

apparently originating in some part of the vascular circuit in these limbs." (3) a third mechanism is also necessary, especially with prolonged standing. That mechanism is muscle tonus. These three mechanisms do not remain equally effective under all conditions. Their capability is greatly reduced when the temperature is raised. The circulation becomes impaired in people who stand for a long time on a hot day, because vasodilatation is needed to evaporate the heat, thus nullifying the peripheral vasoconstriction. There is also a variation of these mechanisms in some people during the day, the adaptation being more effective for these individuals in the evening. It seems that in these there is a loss of the normal responses during the long periods of recumbency at night and this is gradually regained during the day.(34)

While the exact etiology of this condition is, as yet, unknown, the majority of the authors agree that there is a failure of the normal vasomotor reflex to operate. That this condition occurs as a result of an abnormality of the sympathetic nervous system is suggested by the frequent occurrence of anhidrosis. And, since it has been shown that the disturbance is generalized, the lesion must be in a sympathetic center or an

afferent pathway controlling the entire reflex response, or it must be a widespread disturbance of the efferent pathways or nerve endings.(36)

Brown, Craig, and Adson (37) noted that postural hypotension developed in patients with hypertension after the sympathetic fibers have been removed from vessels below the diaphragm by resection of the anterior roots from the 6 thoracic to the 2 lumber vertebra. Evidence has shown, however, that the disturbance probably lies in the central nervous system. Christ and Brown (33) interpreted the disturbances in their cases as being due to a "lesion" of the nervous system affecting both the sympathetic and parasympathetic systems. In five of the six cases studied by Ellis and Haynes (36), however, all of the abnormal responses could be explained on the basis of a disturbance of the sympathetic nervous system alone, without the assumption that the parasympathetic system is involved. Failure of the heart rate to rise on assuming an erect posture was explained by an absence of sympathetic stimulation.

Further evidence that the lesion is centrally located is the frequent association of this syndrome with disease of the central nervous system, especially with tabes dorsalis. Of the 40 cases of this condition so

far reported, 15 have been associated with tabes dorsalis. Striscmer (36) was the first to point out this association. He considered it to be due to a disturbance of the vasomotor regulation, probably due to involvement of the centers in the spinal cord which regulate blood pressure.

Conclusive evidence, however, that the postural blood pressure reflex passes through centers in the brain and is not a spinal reflex is offered by Ellis and Haynes (36). One of their patients had a traumatic section in the upper part of the dorsal spinal cord. There was complete severance of the control of the brain from the spinal cord. "The fact that marked postural hypotension occurred in this patient indicates that the reflex arc was interrupted, this having undoubtedly taken place in the pathways leading from the brain." One of Jeffers' (38) patients showed marked impairment of reflex vasomotor function. He presented a classical picture of orthostatic hypotension and a definite lesion of the brain was found--communicating hydrocephalus.

The exact location of the disturbance in the brain is not known for certain. It is most likely in the hypothalmus, for it is generally held that this region is more concerned with the interrogative function of the body than the hindbrain.(36) Also, in the patients with

associated tabes dorsalis an Argyll-Robertson pupil was present in each case. And it has been shown in tabetic patients that the lesion producing the pupillary changes is in a region close to the hypothalmus.(36)

Recent studies by MacLean and Allen (39) suggested that the defect in postural hypotension is not a defect in arteriolar vasoconstriction but rather one in the maintainence of adequate return of venous blood to the heart. These authors stated that the vasoconstricting drugs have proven disappointing in the treatment of this disorder. They also stated, however, that these drugs, such as ephedrine and paredrine, have given symptomatic relief and that they have prevented the falling of the blood pressure to a low level when these patients stand. These beneficial results, however, were only temporary in two of their cases.

Besides measuring the blood pressure in different positions together with the recording of the heart rate, these authors performed the Flack test upon each of their subjects. This test consisted of blowing against a column of mercury, thus increasing the intrathoracic pressure; the venous return fails to the extent that there is a marked decrease of the filling of the heart, a decreased cardiac output and subsequent failure of the

peripheral pulse. A positive Flack reaction was considered one in which, with the subject erect, the radial pulse disappeared within a period of 10 seconds following the start of the blowing and did not return as long as the blowing could be maintained. Those subject exhibiting the symptoms of orthostatic hypotension gave a positive Flack test. These authors then suggested that a positive reaction of this sort showed that there was a defect in the "potential" of venous return to the heart when the patient stands.

Their supposition was that the site of the above defect was in the capillary-venous bed of the lower extremities, since the orthostatic symptoms and signs and positive Flack reactions are abolished when the lower extremities are separated from the general circulation by cuffs inflated about the thighs. They also stated that, because of the rapidity of the onset of the symptoms after the patients assume the erect posture, the rapid transudation of circulating fluid into the tissues of the lower extremities could not explain the circulatory defect. Their evidence, therapeutically, however, tends to show that this might be a factor. These writers made no attempt to explain the anhidrosis and hyphidrosis, which have occurred in most cases, by their theory.

While investigating different therapeutic procedures, MacLean and Allen (39) noted "that patients with orthostatic hypotension appeared to improve symptomatically and objectively during the daytime and that this improvement had disappeared in the mornings after sleep in bed at night." These authors implied from this observation that these patients had lost some of their ability to adapt themselves to changes in posture as a result of either sleep itself or as a result of the recumbent position in which they slept. These workers then suggested that these patients should lie in a semi-inclined or "head-up" position. Their results with this type of treatment were quite good. Not only were the subjective symptoms relieved but objectively the blood pressure and pulse rate did improve in some cases. They found that rest on an ordinary flat bed for a night or for several nights was sufficient to cause a recurrence of the symptoms. Some of the patients with orthostatic hypotension, however, were not benefitted at all by the so-called "head-up" position. The reason for this is not known.

These authors concluded that rest on the tilted-up bed prevented loss of postural adaptation which the patient had gained during the day. "Whether this gain

results from readjustments of activity of the autonomic nervous system to the muscles in the walls of the veins, whether there is a change in the tone of striated muscle, an increase in the content of extracellular fluid in the extremity, an increase in the volume of circulating blood, or an intrinsic increase in venous or capillary tone is at the present time impossible to say."(39) They now believe that the improvement is due to an increase in blood volume and a definite increase in the content of the extracellular fluid in the lower extremities. They assume that the increased pressure of the extracellular fluid would prevent in some degree the pooling of blood in the legs when the patients stand. These writers make the "tentative suggestion that the content of the extracellular fluid in the lower extremities is increased by the "head-up" posture and prevents pooling of venous blood in the legs as a result of increased tissue pressure. The return of venous blood to the heart is thus maintained in a fashion approaching normal."(39) Corcoran, Browning, and Page (40) treated a case of orthostatic hypotension with the "head-up" position. They confirmed MacLean and Allen's conclusions as to the effectiveness of this type of treatment. These authors were of the opinion, however, that the defect was due to

a lack of normal vasoconstrictor response when the patient assumed the upright position.

Laplace (41) presented a case of postural hypotension with signs of tabes dorsalis. There was recurrent complete disappearance of the hypotensive reaction in this case which caused the disorder to remain unrecognized for seven years. Of the experimental work performed on this case one was the effect of arresting the blood flow to active muscles. In normal individuals, active movements of an arm or leg to which the circulation has been arrested is followed by a rise of blood pressure. This is due to a vasoconstrictor reflex, the receptor endings of which are located in the muscles of the limbs (and probably elsewhere) and are presumably stimulated by the local accumulation of tissue metabolites. In Laplace's patient the rise in blood pressure was very great. For example, in the standing position the blood pressure was about 85 millimeters of Hg. systolic and 60 diastolic. After the circulation was arrested in the legs by compression of the thighs, the blood pressure rose to 210 systolic and 145 diastolic in two and one-half minutes. A similar though not so great a rise was noted when the circulation was arrested in the arm.

Laplace's findings in this case seem to support Ellis and Haynes' theory as to the nature of orthostatic hypotension as against that of MacLean and Allen. Laplace stated that it is very unlikely that simply arresting and releasing the circulation in the forearm could produce such extreme and rapid changes in the blood pressure except by means of reflex effects upon the arterioles.

Additional evidence presented by Laplace as being in favor of a defective reflex vasoconstrictor mechanism was as follows: with fluoroscopy of the patients he noted that the size of the cardiac silhouette were less than might reasonably be expected if the volume of venous return to the heart was the only factor involved in producing the fluctuations in blood pressure noted above. He also noted that sweating disappeared in his patient with orthostatic hypotension, which, he stated, is in contrast to the profuse sweating which occurs in normal subjects when venous return to the heart is decreased to the point of critically lowering the arterial pressure.

As to the site and nature of the lesion which interrupted the vasoconstrictor-accelerator reflex, Laplace offered no explanation. He pointed out that the interruption was neither complete nor permanent in his case

as evidenced by the subsidence and then recurrence of the symptoms at varying intervals. He is of the same opinion of other writers who presented cases of orthostatic hypotension associated with tabes dorsalis that the lesion is in the hypothalmic region involving the autonomic reflex center. Laplace stated that "the rise in blood pressure, induced by the above method, would seem to result, under the circumstances, from a "breaking through" of stronger afferent impulses when weaker ones were ineffective. Likewise the gradual disappearance of the hypotensive syndrome (as occurred in this case) might result either from a progressively increasing number of physiologic afferent impulses or from fluctuations in nerve conductivity at the site of the lesion due to local metabolic changes."(33)

Stead and Ebert (34) proved that the primary cause of orthostatic hypotension was not the pooling of an abnormal amount of blood, but was presumably an abnormal response to the pooling of a normal quantity of blood. Their method of determination of the basal blood volume consisted of the use of the photoelectric microcolorimeter which, combined with the application of arterial tourniquets, measured the volume of blood in the lower extremities with the subject in the horizontal and in the standing position. Two normal

subjects and two patients with orthostatic hypotension were used for the test. In the recumbent position the lower extremities of the two patients with postural hypotension contained 13 and 20 per cent respectively of the total blood volume. Under similar conditions, the lower extremities of two normal subjects contained 13 and 19 per cent respectively. On standing, there was no significant difference in the amount of blood in the lower extremities of the subjects.

Stead and Ebert (34) concluded that "in orthostatic hypotension there is a fall in arterial pressure when the patient is in the upright position because normal vasoconstriction does not occur when blood is pooled in the portion of the body below the heart. They presented the following observations as proof of the absence of normal vasoconstriction: (1) A marked drop in diastolic pressure occurs when the patient is in the upright position; (2) marked pallor does not occur in patients with orthostatic hypotension; (3) the shunting of a given amount of blood into the extremities produces a much greater fall in arterial pressure in patients with postural hypotension than in normal subjects.

This failure of vasoconstriction in response to a fall in blood pressure could result from: (a) loss of

intrinsic tone in the capillaries and arterioles, or (b) interference with the reflexes which regulate the arterial pressure. Stead and Ebert presented evidence that the arterioles and capillaries were functioning normally by the fact that, when heat was applied locally vasodilatation occurred in the vessels of the extremities, and when cold was applied locally, vasoconstriction resulted. "Postural hypotension in these subjects is, therefore, a disease of the sympathetic nervous system, in which the reflexes that control the level of the arterial pressure do not function properly."(34) Although it cannot be definitely stated whether the lesion is central or peripheral in the sympathetic system, these authors were of the opinion that the defect was centrally located.

The relationship of orthostatic hypotension to dysfunction of the endocrine glands has been brought out quite frequently in the literature. Duggan and Barr (42) reported a case of a negro with Addison's disease in which there was a marked drop in blood pressure, associated with vomiting and extreme dizziness when the patient assumed the erect position. Ghrist (33) showed that some patients with Addison's disease showed a marked drop in blood pressure when they stood.

Schellong (36) brought out the association of some cases of postural hypotension with disease of the pituitary gland. He found that the orthostatic syndrome has occurred with patients showing the clinical manifestations of Simmonds' disease and may be relieved by the injection of a preparation of the anterior lobe of the pituitary gland. His evidence was decided not to be satisfactory enough, however, to definitely link up the condition with this gland. "It is possible, however, that certain disturbances of the glands of internal secretion may so affect the functioning of the vasomotor system that postural hypotension occurs."

Croll and Duthie (35) observed in their case that the patient showed signs of a latent pulmonary tuberculosis (occasional hemoptysis and a dense X-ray shadow of probable calcareous nodes in the left lung). Bradbury and Eggleston (31) noted the presence of pulmonary tuberculosis in an autopsy of one of their patients. It is interesting to note that as far back as 1916 Sewall (43) noted the apparent relationship between the instability of the blood pressure and the "potentially tuberculous individual."

According to Bradbury and Eggleston (31) in their report of the first case of orthostatic hypotension, the

diagnosis of this condition is dependent upon the following signs and symptoms: (1) syncopal attacks on changing from a supine position to a sitting or upright position with a drop of the systolic blood pressure to shock levels; (2) anhidrosis; (3) increased distress during the heat of the summer months; (4) slow and unchanging pulse rate with the marked variation in blood pressure; (5) slight decrease in the basal metabolic rate; (6) signs of slight and indefinite changes in the central nervous system; (7) blood urea at the upper normal level. Other symptoms in Bradbury and Eggleston's cases were: (1) more urine excretion during the night than during the day; (2) loss of sex desire and impotency; (3) a false general appearance of youth in comparison to the true age; (4) secondary anemia.

The essential points in the diagnosis of this condition are the complaints of dizziness upon changing from a supine to an erect position and the prompt relief of symptoms by resuming a reclining posture. This type of symptom varies from slight vertigo to actual fainting. The diagnosis is confirmed by taking blood pressure readings in both the supine and erect positions. Other associated symptoms as found by Rieker and Upjohn (44) were temporary blurring of vision and involuntary

closing of the eyes. They noted that in one case the hands and feet became cyanotic during the erect posture. There was also present numbness, tingling, and slight convulsive jerking of one of the arms.

Allen and Magee (45) explained some of the symptoms occurring in their cases. The nocturia was explained by the fact that the amount of urine excreted at night was greater because of the higher level of blood pressure when the patient was recumbent. A number of workers ran phenosulphopthalein tests on many of their subjects. The results of Rieker and Upjohn are quite typical: supine excretion in 2 hours, 35 per cent; in the sitting position 11 per cent. These findings can be explained upon the same basis as that for the nocturia. Allen and Magee explained the increased sweating of the left upper extremity as probably being due to the hypohidrosis in other regions of the body. The deficiency in vision, which occurred when the patients would stand quietly, was apparently due to cerebral anemia. The improvement which resulted on walking was because of an increase of blood pressure and pulse rate. The writers did not explain the patient's attacks of hemianopsia and aphasia alone, but rather on the basis that possibly there were patchy areas of sclerosis of the cerebral arteries present, the patient being 68 years old.

For some years Thomas (46) observed two cases of transient aphasia and paralysis from orthostatic hypotension. Both patients were elderly and had advanced arteriosclerosis. The attacks could be produced by tilting the patient from a recumbent position upward. The writer concluded "that the patient suffered from arteriosclerosis which was particularly marked in the cerebral artery supplying the area of the brain which controls the right arm and right leg (the regions of paralysis). When he arose from the lying or sitting position to the erect posture, his blood pressure fell, and when this fall reached a certain level, ischemia of the brain occurred." This manifested itself by paralysis in the area corresponding to that supplied by the most sclerosed vessels.

Chew, Allen, and Barker (47) presented six cases and reviewed the literature on orthostatic hypotension. They presented the following chart of the symptoms and signs of this syndrome:

(See Next Page)

		Cases studied	Cases in which feature was noted	
			Number	Percent
Orthostatic Hypotension, 50 mm Hg. or more		26	24	92
" Syncope with loss of Consciousness		26	15	58
Mild orthostatic syncope or Weakness		26	25	96
Variations in Pulse Rate with change in Posture	15 beats/min. or less	23	16	70
	more than 15/min	13	7	30
Anhidrosis or Hyphidrosis		21	18	85
Increased Distress in Summer mos.		14	11	79
B.M.R. -10% or more		17	10	59
Blood Urea 40 mg. or more /100 cc.		11	6	55
Greater Urinary Excretion at Nite		20	15	75
Loss of Libido		11	7	64
False Appearance of Youth		17	7	41
Pallor		18	9	50
Secondary Anemia		20	10	50
Neurologic Signs		22	5	23

Davis and Schumway presented a case report which is quite typical of patients with orthostatic hypotension:

> J.L., white male, age 40, complained of profound weakness, dizziness, light-headedness, staggering, and dry skin. He was worried because he had been told he had a "hidden" cancer. He had been physically tired for the past 7 years and profoundly weak for the past 18 months. He stated he always felt better during the winter months. He rested a great deal of the time because he felt better while recumbent. When he arose and walked around he felt light-headed and noticed blurring of vision and staggering. He had been troubled with severe constipation all of his life. History by systems negative.
>
> 67 inches tall and weighed 155 pounds. Was no evidence of myasthenia gravis or Addison's disesse. Physical and neurological examinations were negative except for the change in blood pressure and pulse rate on change in posture. BMR record: -16 and -10. Laboratory negative. X-ray of gastro-intestinal tract negative.

	Blood Pressure in mm. of Hg.					
	Supine		Sitting		Standing	
1st Exam.	96	60	88	58	55	?
After Benzedrine Sulphate	126	74	102	64	83	40
	Pulse Rate/min.					
1st Exam.	68		69		80	
After Benzedrine Sulphate	96		93		100	

After use of benzedrine sulphate the patient's symptoms were relieved somewhat.

Stead and Ebert (34) brought out the differences between patients with orthostatic hypotension and those patients who show postural fainting following acute infections (this symptom probably occurs in these instances because of poor muscle tone following the illness) or loss of blood. The fall in systolic and diastolic pressure before the onset of symptoms is more rapid and much greater in orthostatic hypotension. In postural fainting the diastolic pressure tends to remain much the same until just before the onset of syncope. The heart rate in orthostatic hypotension is unchanged or shows a moderate increase, while the heart rate increase in postural fainting is usually greater. Also, "subjects with postural hypotension may remain symptom free while standing as long as the systolic pressure remains as high as 60-70 mm. of Hg." while normal individuals with postural fainting are frequently uncomfortable if the systolic pressure is lowered from 120 to 90 mm. of Hg., and marked symptoms usually develop when the systolic pressure falls to 80 mm. Hg. Syncope occurs in subjects with postural hypotension usually without the extreme pallor, nausea, and sweating which usually characterizes other types of postural fainting.

Bradbury and Eggleston (31), in evaluating their

patients, first thought of Addison's disease. They eliminated this condition, however, by the absence of the typical features (pigmentation of the skin, extreme asthenia, etc.) and, by the fact, the condition did not progress during the several years their patients were under observation. Partial or complete heart block was ruled out by an electrocardiogram. "The ordinary syncopal attacks are usually due to transitory vagus stimulation from emotional or other temporary reflexes and are not dependent upon the effort to maintain the erect posture." Transitory cardiac disturbances as a cause for the cerebral anemia was ruled out by the electrocardiogram. Epilepsy was rather easily ruled out by the relationship of syncope to posture; hysteria ruled out in a similar manner. Orthostatic hypotension must be ruled out from Stokes-Adams syndrome; this accomplished by the electrocardiogram.

No cure, as yet, has been found for this condition. Palliative therapy, therefore, is the only thing to be done for these patients at the present time.

While Allen and Magee (45) reported that vasoconstrictor drugs were of little value in treating this condition, most authors seem to agree, however, that vasoconstricting drugs such as ephedrine, amphetamine,

and paredrine are quite successful in alleviating, at least in part, the symptoms of orthostatic hypotension.

Durant (19) has used ephedrine sulphate in dosages of 3/8 to 3/4 grain, three times a day, quite successfully. Its undesirable side effects in some patients, however, was such as to stop its use. This writer believes that amphetamine sulphate is more often the drug of choice, because it is more frequently effective without any unpleasant side actions. He used this drug in dosages of 10 to 20 milligrams upon arising and again at noon. He found that in some cases it was necessary to give an added amount later in the day. This, however, sometimes caused insomnia in some of the patients.

It has been found that paredrine hydrobromide acted only on the peripheral sympathetic mechanisms and so caused no cerebral stimulation with resultant insomnia. This latter drug may be given in 20 milligram doses every two hours during the day, and may be used in addition to the two-dose amphetamine schedule mentioned above. One must remember, however, that vasoconstricting drugs should not be used in elderly patients with vascular disease. In these patients non-medicinal therapeutic measures, such as rest in the "head-up" position referred to previously, may be tried.

Some authors have used benzedrine in the treatment of this condition with fairly good results. Peoples and Gettman (49) used this drug in their cases and obtained an average increase of 24 mm. of Hg.

CONCLUSIONS

While essential hypotension is not considered a disease entity--in fact, it may be compatible with robust health and longevity--one should not forget, nevertheless, that underweight individuals complaining of fatigue, etc. with low blood pressure the only subjective finding, can often be aided greatly by graduated exercises and dietary measures.

Low blood pressure is a common finding in a number of acute infectious diseases--for example, typhoid fever, pneumonia, influenza, diphtheria, cholera, malaria, typhus fever, and trichinosis.

Several chronic diseases show a lowered blood pressure as part of the syndrome--namely, tuberculosis, syphilis, and Addison's disease.

It is very essential to begin treating acute hypotension (shock) early, and probably the most important part of this treatment is the restoration of the blood volume by the administration of both plasma and whole blood.

Because of the small number of cases reported in the literature, orthostatic hypotension is considered to be a quite rare condition. If, however, one were to record the blood pressure of patients complaining of

orthostatic weakness, fatigue, etc., in both the supine and erect positions, more cases of this syndrome might be diagnosed. While the etiology of this condition is, at present, unknown, the evidence seems to show that the defect is in the central sympathetic nervous system. The treatment of orthostatic hypotension is unsatisfactory, but should, nevertheless, consist of both medicinal and non-medicinal treatment.

BIBLIOGRAPHY

1. Garrison, F.H. "History of Medicine", Baltimore, Williams and Wilkins, 1929

2. Bishop, L.F. "Three Vices of Blood Pressure", Med. J. 82:962, Nov. 1905

3. Bishop, L.F. "Constitutional Low Arterial Tension and Its Relationship to Life of the Individual", N.Y. Med. Jr. 83:967, Oct. 1906

4. Emerson, H. "Blood Pressure in Tuberculosis", Arch. Int. Med., 7:441, Apr. 1911

5. Friedlander, A. "Hypotension", Baltimore, Williams and Wilkins, 1927

6. Best, C.H. and Taylor, N.B. "The Physiological Basis of Medical Practice", Baltimore, Williams and Wilkins, 1939

7. Greaves, A.V. "Low Systolic Blood Pressure", Canadian M. Assoc. J., 15:174-177, 1925

8. Bo man, J.E. "Arterial Hypotension", M. Ann. Dist. of Co., 6:175-179, June 1937

9. Andrus, E.C. "Significance of Acute Hypotension: Its Etiology and Treatment", M. Clin. N. Am., 21:1513-1522, Sept. 1937

10. Barach, J.H. "Arterial Hypotension", Arch. Int. Med., 35:151, 1925

11. Bennett, A.L. "Normal Pressure; Physiologic Variations", J. Omaha Mid-West Clin. Soc., 4:1-4, Jan. 1943

12. Alvarez, .C., Mulzen, R., and Mahoney, .J., "Blood Pressures in 15,000 University Freshmen", Arch. Int. Med., 32:17, 1923

13. Robinson, S.C. "Hypotension: The Ideal Normal Blood Pressure", N. England Jr. Med., 223:407, 1940.

14. Pepper, O.H. "Growing Appreciation of Importance", Northwest Med., 34:325-330, Oct. 1935

15. Roberts, S.R. "A Study of Hypotension", J.A.M.A., 79:262, 1922

16. Duffy, A.L. "Some Aspects of Low Blood Pressure", Arch. Int. Med., 33:425, 1924

17. Dally, J.F.H. "Low Blood Pressure", London, William Heinemann, 1928

18. Lawerence, C.H. "Some Aspects of Hypotension", Interstate M.J., 23:115, 1916

19. Durant, T.M. "Arterial Hypotension", Pennsylvania M.J., 45:1188-1191, Aug. 1942

20. Holt, E. "Arterial Hypotension", M. Clin. N. Am., 19:865-871, Nov. 1935

21. Gatch, W.D. "Disturbances of Peripheral Circulation: Considerations on Definition of Shock", Illinois M.J., 84:12-17, July 1943

22. McIntyre, A.R. "The Mechanism of Shock", Nebr. State Med. Jr., 29:69-73, March 1944

23. Phemister, P.B. "Role of Nervous System in Shock", Ann. Surg., 118:256-267, Aug. 1943

24. Necheles, H. "Physiology of Shock and of Blood Substitutes", N.Y. State J. Med., 43:1601-1606, Sept. 1943

25. Meakins, J.C. "Present Views", Address in Medicine before Royal College of Physicians and Surgeons of Canada, Canad. M.A.J., 49:21-29, July, 1943

26. Mahoney, E.B. and Howland, J.W. "Physiologic and Clinical Aspects", Surgery, 13:188-198, Febr. 1943

27. Johnson, A.C. "The Symptoms of Impending Shock", Nebr. State Med. Jr., 29:73-76, March 1944

28. Biagard, J.D. "The Treatment of Shock", Nebr. State Med. Jr., 29:76-79, March 1944

29. Samuel, John "Hypotension and Its Significance", J. Ark. Med. S., 35:108, Nov. 1938

30. Mortensen, M.A. "Arterial Hypotension", J. Michigan . Soc., 30:616-619, Aug. 1931

31. Bradbury, A.C. and Eggleston, C. "Postural Hypotension", Am. Ht. Jr., 1:73-86, 1925

32. Gillespie, D.L. and Barker, N.W. "Orthostatic Hypotension: Report of Two Cases in which the Patients were Children", J. of Pediatrics, 12:772, June 1938

33. Christ, D.H. and Brown, G.E. "Postural Hypotension with Syncope", Ann. Jr. Med. Sci., 93:336-349, 1928

34. Stead, E.A. and Ebert, R.V. "Postural Hypotension; Disease of the Central Nervous System", Arch. Int. Med., 67:546-562, March 1941

35. Croll, W.F., Duthie, R.J. and MacWilliam, J.A. "Postural Hypotension; Report of a Case", Lancet 1:194-198, 1935

36. Ellis, L.B. and Haynes, F.W. "Postural Hypotension; with Particular Reference to its Occurrence in Disease", Arch. Int. Med., 58:773-798, Nov. 1938

37. Brown, G.E., Craig, W. and Adson, A.A. "The Treatment of Severe Essential Hypertension: Effects of Surgical Procedures Applied to the Sympathetic Nervous System," Minn. Med., 18:134, 1934

38. Jeffers, W.A., Montgomery, H. and Burton, A.C. "Types of Orthostatic Hypotension and Their Treatment", Am. J. M. Sc., 202:1-14, 1941

39. MacLean, A.R., and Allen, E.V., and Magath, T.B. "Orthostatic Tachycardia and Orthostatic Hypotension, Defects in Return of Venous Blood to the Heart", Am. Ht. Jr., 34:145-162, Febr. 1944

40. Corocan, A.C., Browning, J.S. and Page, I.H. "Renal Hemodynamics in Orthostatic Hypotension; Effects of Angiotonic and Head-Up Bed", J.A.M.A., 119:793, 1942

41. Laplace, A. "Orthostatic Hypotension; Report of a Case Associated with Tabes Dorsalis", N. England Jr. Med., 242:506, 1943

42. Duggan, L.B. and Barr, .P. "Postural Hypotension; Occurring in a Negro with Addison's Disease", Endocrinology, 15:531, 1931

43. Sewall, . "Clinical Relations of Gravity, Posture, and Circulation", Am. J. Med. Sc., 41:499, 1916

44. Rieker, H.H. and Upjohn, E.G. "Postural Hypotension; Case Report", Am. Ht. Jr., 6:225-229, 1930

45. Allen, E.V. and Magee, H.R. "Orthostatic Hypotension with Syncope", Med. Clin. N. Am., 18:585-595, 1934

46. Thomas, enry "Transient Paralysis from Postural Hypotension", Bull. Johns Hopkins Hosp., 45:329, Oct. 1939

47. Chew, E.M., Allen, E.V. and Barker, N. . "Orthostatic Hypotension; Report of 6 Cases and a Review of the Literature", Proc. Mayo Clin., 28:639-641, Apr. 1936

48. Davis, C.A. and Schumway, M. "Orthostatic Hypotension; Treatment of Two Cases with Benzedrine Sulfate", J.A.M.A., 108:1247-1249, Apr. 10, 1937

49. Peoples, A.H. and Gettman, L.C. "A Case of Orthostatic Hypotension", Ann. Int. Med., 36:200-202, 1935