

HYPERTENSION AND LONGEVITY

by

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The development of the interest in blood pressure may be
(1)
said to have begun in 1733, when Rev. Dr. Stephen Hales published a
book named "Statical Essays, containing Haemostaticks", in which he
told how he discovered the pressure of the blood in the vessels of a
horse. His method of measuring it was the most simple, direct
way. After tying the femoral artery, he connected it to a glass
tube and found that on opening the artery the blood rose to a height
of eight feet and three inches. The blood mounted twelve inches
in a tube connected to a vein. This discovery, Ludwig believed was
(2)
of more importance than the discovery of the circulation by Harvey.
After the publication of this book, other men began to take up the
work and improve on Hales' crude method of measuring the blood pres-
sure. Poiseville began to use the mercury manometer in
1828, Ludwig invented a recording manometer and kymographion in 1847
and Riva Rocci developed a more simple instrument in 1899. Now the
sphygmomanometer is a compact instrument which has become an integral
part of every physicians' bag. The patient constantly entertain-
ing a fear of high blood pressure, has come to consider the taking of
his blood pressure as an important detail in his examination. Since
there is this fear on the part of the lay people, it would be interest-
ing to find out if their fears have a sound basis and to learn how
high blood pressure affects the length of human life.

A good deal of work has been done on blood pressure to deter-
mine its normal limits and variations. One must have such work

as a basis for a study of hypertension in order to tell when a pressure is higher than normal. It is generally believed that there are several conditions which may determine the normal pressure, among which are race, age, sex, build, climate, and nervous instability. This would seem to disregard the old rule that one's blood pressure should be 100 plus his age. (3) This rule has been questioned on theoretical and practical grounds. Theoretically, because of no allowance for sex, weight, race, etc., and practically because a steady increase from year to year is not in accord with the statistics, as will be shown later. In spite of the fact that considerable work has been done to find a standard blood pressure, one is not yet able to say that the pressure for a man at such an age should be so much. It may never be possible to have such a formula because of the variation in the make-up of every individual. Each person will have his own blood pressure which will be determined by a study of his life. However, the work that has been done to find this pressure has been very instructive in that it has shown that the average blood pressure in apparently well and healthy people is much lower than it was generally believed to be. Most of this work has been done in the insurance companies and universities.

(4)

In a series of 146,992 cases, Frost has shown the relation of age to blood pressure. The average pressures found for the various age groups in five year periods, from 10 to 60, are shown below.

<u>AGE</u>	<u>SYSTOLIC BLOOD PRESSURE</u>	<u>DIASTOLIC BLOOD PRESSURE</u>	<u>PULSE PRESSURE</u>
10	103	70	33
15	113	75	38
20	120	80	40
25	122	81	41
30	123	82	41
35	124	83	41
40	126	84	42
45	128	85	43
50	130	86	44
55	132	87	45
60	135	89	46

Over a period of fifty years one finds a greater rise in the systolic blood pressure than in the diastolic, the rise being in the ratio of 32 to 19. One-half of this increase occurs in the 10 to 20 group, the rise from 20 to 60 being very gradual. Alvarez and (5) Stanley, after doing similar work on 6,000 prisoners and 400 prison guards, came to the conclusion that the level of pressure in most persons does not rise even in old age. Many of those who had hypertension in the fifth decade had had it in the second, they believe, because they found the percentage of men with pressures above 140 mm. of mercury to be the same at the ages of 15 and 40, but they do admit that the mortality might offset the increase which one expects in the later years.

(6)

Faber and James took readings on 651 boys between the ages of 6 and 16 to obtain an average pressure for these younger people.

Their averages were:

<u>AGE</u>	<u>SYSTOLIC BLOOD PRESSURE</u>
6	94.5 mm. Hg.
7	97.3
8	99.2
9	100.9
10	102.4
11	104.1
12	105.9
13	107.6
14	110.0
15	112.2
16	115.3

Similar work along this line was done on 1344 children by Judson and Nicholson, whose results were slightly lower than those of Faber and James. Their readings ranged from a systolic blood pressure of 91 mm. of mercury at four years to 99.6 mm. of mercury at 15 years, showing a gradual rise in systolic pressure from the third to the tenth years and an abrupt rise from the tenth to the fourteenth years.

(8)

Norris believes there is a definite relationship between puberty and blood pressure. According to him, preceding the onset of puberty

there is a tendency for the pressure to fall, during puberty there is a period of increased pressure and after puberty there is a slight increase. (9) In the opinion of Cadbury this lower blood pressure in children is due to the undeveloped condition of the heart and blood vessels and as the height and weight increase so will the pressure and, therefore, the child living under good conditions will have the higher pressure. He points out that the higher pressure in boys is due to their greater size.

It is generally known that the blood pressures of normal women before the menopause is lower than that of normal men. The difference in pressure occurs at adolescence, according to Alvarez. (10) At this time the average systolic blood pressure of a group of men was 127, and of women 118 mm. of mercury. At the age of 30 the pressures were 118 and 111 mm. respectively. His conclusions were that after adolescence the blood pressure of women remained about 11 mm. below that of men until the age of 40 when it rose sharply above the men's pressure. The big rise in men's life occurred five to ten years later.

As was mentioned, race is an important factor in determining one's normal blood pressure. Cadbury secured pressure readings on 774 Cantonese students, whose lives were very much like those of American students and who were apparently healthy. He reports the average blood pressure for the ages of 7 to 14 as 83 mm. of mercury, for

15 to 20 as 101 mm., and for 21 to 30 as 101. In comparison with the average American pressure, one finds that of the Cantonese to be about 20 mm. lower. One cannot find any definite cause for this condition, but several theories have been advanced, among them the use of opium, the decreased capacity for muscular effort, decreased muscular tone, small stature, deficient suprarenal and other hormones, large vegetable diet and simplicity of life.

(11)

Regarding Indians Harley Stamp says that the average pressure does not differ much from the white person, except that there seems to be a tendency to a reduced blood pressure at or near 45 years of age.

(12)

In Japanese it was found that the pressure ran from 72 mm. of mercury at 4 years to 122 mm. at 19. In Mexicans one does not find the

usual rise in pressure with age, but in negroes the rise is very much

(13)

more rapid than in the white race. Mo Coy has reported the average pressure of the adult male Benzalis for the ages 20 to 25 as varying from 90 to 105 mm. of mercury. In Calcutta he found the pressure to range from 115 to 130 mm. of mercury.

Climate, too, besides race, seems to affect the blood pressure.

(14)

It has been reported that residency in the tropics lowers one's pressure. A group of cases made the following interesting table;

Residence in Tropics

Systolic blood pressure

1 month to 1 year	124 mm. Hg.
1 year to five years	115
5 years to ten years	116
over ten years	113.

(15)

It is believed that the lowering of the blood pressure in the tropics is due to an increase in the secretory function of the skin or to a diminished normal surface resistance and vasomotor tension necessary to produce the required surface heat of temperate climates.

The foregoing material has shown that the normal or average blood pressure is not a set figure, but one that varies with age, sex, race, environment and build. Not only is this normal pressure individualistic, but also it has been shown that hypertensives seem to have certain features in common. It has long been known that (16) hypertensives are of sthenic or hypersthenic build, but Draper has furnished many definite characteristics of these persons. They have wide interpupillary spaces, long narrow faces, narrow jaws, highly arched feet and short necks and long trunks with relatively short lower extremities. Men have deep narrow chest, short ears and small heads with a low cephalic index.

The incidence of hypertension will vary depending on the pressure accepted as normal. The Metropolitan Life Insurance Company, after studying several thousand cases, has selected an average and any pressure 20 mm. of mercury or more above that is considered abnormal.

(17)

Norris believes that any persistent systolic blood pressure 15 mm. above the average is not normal. In a study of 16,662 white males, the (18) Metropolitan Life Insurance Company found that 7% have pressures 20 or more mm. of mercury above normal, 6.2% being 20 to 40 mm. above normal. The incidence increased with age slowly up to the age of 45, whereupon

the increase was much more rapid. In contrast to these figures, (4) Frost, after a study of 400 cases, declared that 2% of the general population were subject to hypertension, but that 53.5% of the hypertensives cases were between the ages of 41 and 65. Alvarez and his (19) co-workers found in 15,000 university freshmen that 45% of the males had a systolic blood pressure over 130 mm. of mercury, 22% of them being over 140 mm. The girls showed an incidence of 12% for pressures over 130 mm. and 2% over 140 mm.

Hypertension is usually a permanent and progressive condition, but occasionally it is transitory. Transient hypertension due to emotion, physical exertion, prostatic hypertrophy and rarely to suprarenal tumors, usually disappears with the removal of the cause.

(20)

Permanent hypertension, according to Riesman, is not a unitary condition, but is due to a variety of causes which it is important to know as the cause to a large extent determines the prognosis, the longevity. The most important clinical types of this condition are (1) accidental, (2) nephritic, (3) arteriosclerotic, and (4) essential.

1. Accidental hypertension is associated with aortic insufficiency, heart block and some cases of hyperthyroidism and is more or less normal in these conditions.

2. Nephritic hypertension, is, as the name implies, associated with kidney disease and secondary to it. The disease begins in early life, between the ages of 25 and 30, and is more frequent in males. Important physical findings are rigid and thickened peripheral arteries,

enlargement of the heart, especially in the later stages, and a high systolic and diastolic pressures. Blood chemistry reveals nitrogen retention. Death occurs from intercurrent infection, cardiac de-
(20)
compensation, uremia and acute pericarditis.

3. Arteriosclerotic hypertension has aroused much debate as to the re-
(21)
lation of the sclerosis to the high blood pressure. Moschowitz believes that hypertension is perhaps the most important factor in the production of arteriosclerosis. He has found that sclerosis is relatively absent in veins in which the pressure is low, but in those veins in which the pressure is increased as in varicosities or an arteriovenous aneurysm, sclerosis is present. He also noted that extensive sclerosis of the arteries is infrequent in persons who have
(20)
hypotonia, as in tuberculosis. Riesman believes this type of hypertension starts out as a spastic arteriolar process and sclerosis gradually develops. This type is quite similar to the preceding one, nephritic hypertension, except that early in the disease there is no evidence of renal involvement although it may be present. The kidney function may remain normal and the blood chemistry usually does not show any nitrogen retention. There may be a complete absence of symptoms with a systolic blood pressure around 200 to 230 mm. of mercury and a diastolic from 115 to 145 mm. Headaches, visual disturbances, and various severe encephalopathies occur late. Death is usually from apoplexy, cardiac decompensation, coronary occlusion or uremia.

4. Essential hypertension exhibits the following characteristics. (20)

- A. Present in both sexes, about the midperiod of life.
- B. Not connected with primary heart or kidney disease.
- C. Palpable blood vessels are soft, temporals may be tortuous and brachial pulsations may be visible.
- D. Eye grounds are normal.
- E. Blood chemistry and renal function are normal.
- F. No symptoms with pressures over 200 mm. of mercury.
- G. Essential hypertension is compatible with long life and full mental and physical vigor. For this reason it is often discovered accidentally, i.e. during life insurance examinations, the individual considering himself a good risk.
- H. Symptoms are usually cardiac or cerebral, for example- shortness of breath, cardiac pain, vertigo, headaches, and encephalopathies such as monoplegia, hemiplegia, aphasia, or convulsions.

Essential hypertension has been known by various names, such as vascular, arterial and benign hypertension, hypertensive cardiovascular disease and hyperprisia. The etiology is not entirely understood. Riesman believes that it "has all the earmarks of being dependent on a vasoconstriction, a functional change affecting especially the arterioles and precapillary vessels, which for their size have the largest amount of muscular tissue in their walls. The vasoconstriction may be more pronounced in the kidneys. If what maintains the normal vascular tone were understood, the cause of the heightened tone

called hypertension might be known better." Increased viscosity of the blood has also been considered as a cause of the disease, but one does not find an increase in the viscosity in essential hypertension, nor does one find an increase in blood pressure in polycythemia rubra, where the viscosity of the blood is increased. Some believe that arteriosclerosis of the arteries of the medulla oblongata, with a consequent high blood pressure in order to maintain an adequate circulation through these arteries, is an important factor. (22) Many think that a chemical substance will be found to be responsible. Others are of the opinion that a nerve similar in function to the depressor nerve of dogs is to be considered in the etiology.

The disease is progressive in character. In its incipiency in early or middle adult life, it is usually transient, depending on exertion. If the disease is not corrected at this point, the attacks are brought on more easily and subside less rapidly. The high systolic pressure is associated with a low diastolic and, therefore, a high pulse pressure. Later the diastolic pressure rises to a higher level, lowering the pulse pressure. At this point we find that the rest level has been elevated. The increase in pressure in response to strain continues, but the return becomes more sluggish. Symptoms and signs of hypertensive disease, which may have been absent up to now, may make their appearance here. Ultimately hypertension goes into the terminal stage when the diastolic pressure remains high, the systolic is relatively low and the pulse pressure is also low.

It is then that the cardio-vascular system, unable to carry this burden any longer, becomes insufficient. This type of hypertension is the most frequent seen, Frost finding it in 74% of 400 cases of hypertension. (4)

Cases of hypertension that develop at the menopause are usually classed as essential. Culbertson thinks that this type is due to a relative overactivity of the hypophysis or adrenals occurring in conjunction with the menopause. He found hypertension in 25 of 29 menopausal cases. Sanes found that 46% of 102 patients had a systolic blood pressure over 150 mm. of mercury at the menopause. In the opinion of Maranon, hypertension in the climacteric is extremely frequent, more than half of the women showing a more or less marked rise of blood pressure. (23) (24) (25) Strassman found an average increase of 20 mm. of mercury at this stage.

(26)
Alvarez and Zimmermann believe that the sexual organs have some relation to high blood pressure. They found at the University of California that 3.6 times as many men as women had a pressure over 130; 7.5 times over 140; 14 times over 150 and 30 times over 160 mm. of mercury.

Hypertension seems to be an important factor in cases of obesity. Taking 20 mm. of mercury or more above average blood pressure as hypertension, Dublin and his co-workers found in the Metropolitan Life Insurance policy holders a definite relation between overweight and hypertension. (18) They compiled the following interesting table which

shows the percentage of persons in each age group with a systolic blood pressure 20 mm. of mercury or more above normal. Persons were classed as overweights when they were 20% or more overweight for height and age. Normal weights were allowed a variation of 5% over or under average for height and age.

<u>AGE</u>	<u>OVERWEIGHTS</u>	<u>NORMAL WEIGHTS</u>
All ages	15.7	6.1
Under 25	5.1	5.6
25 to 34	11.2	4.5
35 to 44	10.7	4.0
45 to 54	22.4	8.2
55 and over	32.0	23.1

Army statistics bring forth the same conclusions. With 140 mm. of mercury as the border for hypertension, it was found that high blood pressure was more than twice as common among officers 10% overweight (27) than among those of normal weight.

That there is a hereditary tendency to the disease is quite conclusively demonstrated in the liability of some families to develop cardio-vascular diseases and for their members to die of heart failure apoplexy and uremia. A family of hypertensives has been reported in which the father and mother died at the age of 45 of cerebral hemorrhages, one daughter and three sons developed hypertension and died at ages varying from 42 to 47. Four other daughters, between 40 and 50

years, at the time were suffering from hypertension, while two daughters below 40 and one granddaughter aged 20 had normal blood pressures. (28)

(29)
O'Hare and his associates studied 300 persons with hypertension and 436 without hypertension or other cardio-vascular renal diseases. In the first group they got a history of one or more relatives having died of apoplexy, heart disease, nephritis, arteriosclerosis or diabetes in 68% of the cases. In the second or control group the history was positive in only 37.6%. (30)

Alvarez says that he has noticed in many families in which there is hypertension a marked tendency of the disease to show itself in childhood and youth and then to leave the victim practically free from symptoms until he is past middle age.

Hypertension is an unusual disease in Japanese, Chinese and those who live in Calcutta. (3)
One would expect this after seeing the low pressure readings obtained from these people.

(31)
It is rather interesting to note that Quinlan found hypertension more common in left-handed persons.

The secondary pathology in hypertension plays an important part in the mortality of these cases, depending on when this break in normal physiology occurs. This will be taken up more specifically later. These pathological changes take place in various structures, notably the heart, kidneys and brain. It is usually for diseases of these structures that the victim consults his physician. Frost has

compiled some figures on this subject after working up 400 cases. Out of the group of hypertensives he found that 6% were transient, 2.5% were accompanied by arterial degeneration, 16% by renal impairment, and 74% had no concomitant vascular or renal disease and hence were essential in type. In this last group, 79% showed abnormal cardiac signs of the following character:

Heart murmurs.....	66.9%
Rapid pulse (90).....	38.5%
Cardiac hypertrophy.....	23.4%
Irregular heart.....	9.3%

Interestingly enough he secured a family history of cardiac, vascular, or renal disease in 28% of the cases of hypertension.

What effect does this have on the longevity of a hypertensive? Before one discusses hypertension and longevity it would seem advisable to first learn something of longevity in general. Man has always sought to lengthen his days, as evidenced by the numerous attempts at rejuvenation. A life table based on the vital statistics of Northampton, England in the middle of the eighteenth century shows an expectation of life of about 30 years. The first such tables in the United States were from New Hampshire and Massachusetts at the beginning of the eighteenth century, showing a life expectancy of about 35 years. This age gradually rose to 40 by the middle of the last century in Massachusetts. By 1890 it was 44 and in 1930 it was 58. (32)

(33)

However, Stuglitz points out the interesting fact that an adult who survives to 45 cannot expect to live longer than persons who survived to that age in the eighteenth century. In this age period there is a heavy death rate from diseases of the heart, kidneys and blood vessels and one finds that the death rates from these diseases are not declining. Together, the three diseases - heart disease, Bright's

disease, and cerebral hemorrhage - shorten the expectancy of life by about four years. (34)

These may be the cause of death in hypertensive cases, but there are several other ways by which they may die.

Deaths may be due to any of the following sequels or complications in order of frequency. (35)

1. Cardiac failure

- a. Gradual myocardial insufficiency
- b. Paroxysmal acute pulmonary edema
- c. Angina pectoris.

2. Cerebral apoplexy

3. Uremia

4. Intercurrent infection (pneumonia)

5. Gradual increasing cachexia.

In classifying one hundred cases of hypertension by causes of death, Janeway presents the following figures. (30)

Gradual cardiac insufficiency	29
Uremic convulsions or sudden coma	15
Chronic uremia	20
Uremic psychosis	1
Cerebral apoplexy	14
Acute edema of the lungs	4
Angina pectoris	3
Sudden death (unclassified)	4
Progressive anemia	2
Acute pneumonia	4
Unrelated diseases	4

Thus one finds that 78% of the deaths are accounted for in heart and kidney diseases and cerebral apoplexy. (4) In Frost's series of cases similar percentages were found. However, he classified the deaths under those headings - (1) circulatory, which includes deaths from angina pectoris, arteriosclerosis, apoplexy and heart disease, (2) nephritis, and (3) miscellaneous. 50.7% of the deaths were circulatory, 20.9% were nephritic and 28.4% were in the miscellaneous group. Generally speaking one could deduce from the statistics that 50 to 55% of all hypertensives die from heart disease, 35 to 40% from apoplexy, and 10% from uremia. (37) (37) George Fahr compiled some very striking figures from the mortality rates of 1924 on persons who had died past the age of 50 years. He classified the deaths as those with and those without hyperpiesia. He defines hyperpiesia in the words of Sir Clifford Allbutt as a high blood pressure not associated with nephritis, but with

some degree of arteriosclerosis of the renal arteries. During 1924 78,000 persons over 50 years of age died of apoplexy, 60% of which Fahr says had hyperpiesia. That would be 47,000. Chronic nephritis claimed 65,000 deaths, 50% of which, or 32,000, must have had hyperpiesia, Fahr believes. Heart disease caused 140,000 deaths, 92,000 of them having primary disease of the heart muscle. Of this latter number, 70% or 64,000 would have hyperpiesia, according to Fahr. This makes a total of 143,000 who had hyperpiesia and accounts for 23% of all the deaths for that year in persons over 50 years of age.

These figures are evidence of the magnitude of the mortality of persons with hypertension. Now the question of longevity.

(38)

Blackford, in conjunction with Bowers and Baker, has reported a very fascinating follow-up study of hypertensives. In 10,000 cases seen in private practice, 401 (16%) showed a blood pressure of over 175 mm. of mercury. Of this number 222 (55%) were followed up. 20 of these died shortly after their first examination, leaving 202 who were followed over a period of from five to eleven and a half years. The following table was prepared by Blackford and his co-workers.

DEGREE OF HYPERTENSION

	Moderate (175-200 mm.Hg.)	Marked (201-225 mm.Hg.)	Extreme (226 mm. Hg.)	Totals
<u>MALES</u>				
Living	7	13	2	22
Dead	15	19	17	51*
Unknown	<u>27</u> 49	<u>14</u> 46	<u>16</u> 35	<u>57</u> 140

	Moderate <u>175-200 mm.Hg.)</u>	Marked <u>201-225 mm.Hg.)</u>	Extreme <u>(226 mm.Hg.)</u>	Totals <u> </u>
<u>FEMALES</u>				
Living	32	38	9	79
Dead	10	18	22	50*
Unknown	<u>53</u>	<u>42</u>	<u>27</u>	<u>122</u>
	144	145	192	401

* Plus 10 moribund.

Of the 101 who died, the cause of death was known in 74 cases. Cerebral complications accounted for 31 deaths, heart disease for 25, and uremia ofr 18. Blackford et al come to the following conclusions. The gross mortality was 50%; the mortality being about the same for moderate and marked hypertensives, but twice as great in extreme cases. The average duration of life after the first examination was 32 months for males, and 44 months for females. The average time since the first examination of the 101 living was 81 months. It is their opinion that there is no tendency in these cases to recovery, but that women with hypertension sometimes outlive their expectancy; men almost never do.

(36)

Janerway also did some work along this line. In his study of the causes of death in 100 hypertensives, he made a table showing the duration of illness from the earliest symptom, as by causes of death.

<u>CAUSE OF DEATH</u>	<u>CASES</u>	<u>DURATION OF ILLNESS</u>
Cardiac insufficiency	26	3 yrs. ten months
Acute uremia	14	3 years.
Chronic uremia	21	3 years, one month
Cerebral apoplexy	14	4 years, six months
Angina pectoris	3	4 years, three months
Acute edema of lungs	4	3 years.

(4)

Frost has some more definite figures showing the relation of hypertension to longevity. He made the following table showing the relation of the extra mortality to the degree of hypertension.

<u>MM. Hg. over average systolic blood pressure for the age.</u>	<u>Mortality</u>	<u>Extra mortality</u>
10 to 14	136.1%	36.1%
15 to 24	183.8	83.8
25 to 34	204.4	104.4
35 to 49	248.5	148.5
50 plus	414.7	314.7

In the table 100% represents the average mortality, and the extra mortality shows the increase over the average. As an example, according to the American Experience Table the average number of deaths at the age of 40 is 9.79 per 1000 persons. If they all had hypertension we would have the following mortality rates:

<u>Mm. Hg. over average systolic blood pressure for age.</u>	<u>Extra mortality</u>	<u>Average number of deaths.</u>	<u>Actual number per 1000 with hypertension</u>
10 to 14	36.1	9.79	13.32
15 to 24	83.8	9.79	17.98
25 to 34	104.4	9.79	20.01
35 to 49	148.5	9.79	24.04
50 plus	314.7	9.79	40.59

(4)

Both Dr. Fisher of the Northwestern Life Insurance Company and Frost

are agreed that there is a definite relationship between an increase in the systolic blood pressure and the mortality, the latter being in direct proportion to the degree of pressure elevation.

The mere presence of a pressure above 160 mm. of mercury in a person is sufficient to say that he is no longer in perfect health and is one the downgrade of life. Hypertension is a manifestation of aging and its victims are predestined to an ultimate cardiac, vascular or renal termination. However, if the disease is discovered early and the daily life modified, there is every reason to believe that the patient will enjoy the normal span of life, but rational living is becoming increasingly difficult. (20) Riesman thinks that if we changed our mode of living to follow that of the European, who strives for contentment, not riches, we would have an ideal civilization. The rapid pace of our life involving abnormal mental strain, neglect of hygiene and proper apportionment of rest, work, recreation and exercise demands a heavy toll of our cardio-vascular system. The result is the great disease of American life - hypertension.

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