

1. When the heart contracts, blood is forced into the arterial system under pressure. The maximum pressure in the arterial blood during this phase is known as the **systolic blood pressure**. In the interval between contractions, the pressure reduces until the next cardiac contraction. The lowest level in the pressure in the arterial blood during this phase is known as the **diastolic blood pressure**.
2. Arterial blood pressure (both systolic and diastolic) increases with age, and exhibits a wide range in the normal individual both during a 24-hour period and from day to day. In the same individual transient marked variations in blood pressure are common in relation to physical stress, temperature, season, sleep, food intake or sexual activity.

### DEFINITION

3. Blood pressure, like height and weight, is a characteristic of the individual. As such blood pressure varies widely among individuals. Some people have blood pressure above the mean, others below. The distribution curve is slightly asymmetrical with a tail to the right particularly with age.
4. In a defined population, there is no dividing line between normal and abnormal blood pressure. The presence of a recordable blood pressure is necessary to sustain life. Two individuals may have the same absolute recorded blood pressure but only one may properly be considered hypertensive.
5. Hypertension is defined as a **sustained** level of blood pressure above the mean blood pressure in the population from which the individual is drawn allowing for age, sex and race. A single raised blood pressure reading is not hypertension.
6. The concept of hypertension as a disease is rather different from conditions such as gout, pneumonia or neoplasm, all of which are either present or absent, that is they are qualitative phenomena. Hypertension is quantitative.

### CLINICAL MANIFESTATIONS

7. Most cases of hypertension come to light at routine medical examination. Earlier this century, many symptoms including headache, dizziness and epistaxis were ascribed to high blood pressure. Evidence now shows that high diastolic arterial pressure alone, up to about 130 mmHg, does not cause symptoms. Even above this level it will remain asymptomatic until there is significant organ damage. It is this organ damage, much commoner in the period before 1960 when drug treatment of hypertension was more limited and less effective, which caused the dizziness, headache and epistaxis.
8. When diastolic blood pressure is sustained about 130 mmHg the condition is described as malignant hypertension. This is a medical emergency. It is characterised by retinal and renal damage caused by fibrinoid necrosis of the renal and retinal arterioles. The condition is fully reversible on treatment.

9. Hypertension matters not for itself but for its outcomes. These are:-
- 9.1. **Cerebrovascular disease.** Hypertensive subjects are much more likely to develop stroke - both cerebral haemorrhage and cerebral infarction - than those with normal blood pressure. In the Framingham study the increased incidence of stroke in hypertensive subjects was 6 fold. Blood pressure changes in retinal vessels may also produce scotomata, fundal haemorrhages and exudates and blurring of vision due to papilloedema.
  - 9.2. **Cardiac disease.** High blood pressure causes left ventricular hypertrophy. The Framingham study shows that blood pressure of more than 160/95 is associated with 3 times normal risk of coronary heart disease and chronic heart failure (left ventricular failure).
  - 9.3. **Peripheral arterial disease.** This is twice as common in hypertensives as in people with normal blood pressure. Smoking outweighs blood pressure as a risk factor but the 2 risks are additive.
  - 9.4. **Renal failure.** Antihypertensive treatment means that renal failure as a consequence of essential hypertension is now uncommon. However, of those presently entering renal transplant programmes 25% have high blood pressure as the cause of their renal failure. In patients with primary renal disease (pyelonephritis or glomerulonephritis) uncontrolled hypertension exacerbates renal failure.

## **TYPES OF HYPERTENSION**

10. Hypertension may be of 2 types - primary and secondary. The primary type accounts for 95% of cases. High blood pressure in relation to other pathologies is described as secondary.

## **SECONDARY HYPERTENSION**

11. If we discount hypertension associated with the oral contraceptive pill, renal hypertension accounts for about 90% of cases of secondary hypertension. Both renal disease, in all its forms, and hypertension of both types are common. The conditions frequently co-exist and are inter-related and causal. High blood pressure in its later stages is associated with reduced renal blood flow and, if very severe, may cause renal failure. End-stage renal failure causes hypertension and may then accelerate the destruction of remaining kidney function. From a practical viewpoint, three types of renal hypertension can be identified.

### **11.1. Acute transient reversible hypertension**

This is now uncommon and is found in children and young adults with acute glomerulonephritis. The blood pressure may be so high that patients present in heart failure or with an acute encephalopathy. It is thought to be an auto-immune phenomenon and is reversible.

## 11.2. Surgically reversible chronic renal hypertension

Acute pyelonephritis does not cause hypertension. Chronic unilateral or bilateral infection of the renal tract with or without outflow obstruction may do so. The reason for this is again unknown. Renal artery stenosis and renal tumours may cause hypertension. The mechanism is unknown. In unilateral disease surgical removal of the affected kidney will not necessarily restore normal blood pressure.

## 11.3. Surgically irreversible chronic renal hypertension

Chronic obstructive uropathy due to ureteric, prostatic, urethral and bladder problems and every kind of renal anomaly are more common in hypertensives. Renal changes may occur as a result of diabetes mellitus and lead to hypertension. Both type 1 and type 2 diabetes may be involved. Polycystic kidneys are presently a leading clinical cause of hypertension.

12. In summary, renal disease may cause high blood pressure which may in turn compromise renal function.

### **Other secondary causes include:-**

#### **Adrenal causes**

13. Rarely high blood pressure may be secondary to an adrenal phaeochromocytoma, where in response to secreted noradrenaline there is unstable paroxysmal hypertension.
14. Another rare but potentially curable cause occurs in Conn's syndrome where inappropriate aldosterone secretion occurs together with hypokalaemia and raised urinary potassium.
15. Hypertension may occur in Cushing's syndrome where there is excess cortisol production. This may be due to adrenal adenoma, metastatic adrenal tumour (most commonly from primary bronchial carcinoma) or adrenal hyperplasia.

#### **Iatrogenic causes**

16. These are important - with the oral contraceptive pill being most frequently involved. Other commonly used drugs which may cause hypertension, are antidepressants of the monoamine oxidase group, non-steroidal anti-inflammatory drugs and liquorice and the anti-peptic ulcer drug, carbenoxolone. The role of corticosteroids in causing or worsening secondary hypertension, has recently been the subject of debate. The current consensus is that both systemic and prolonged use of topical corticosteroid preparations can cause hypertension. Aerosol preparations do not. Other drugs including cyclosporin, vasopressin, oxytocin and mitomycin may also be involved.

#### **Other causes**

17. These include lead and cadmium poisoning, acromegaly, porphyria, coarctation of the aorta and conditions where there is bulbar palsy resulting in respiratory paralysis.

## **ESSENTIAL HYPERTENSION**

18. A patient presenting with persistently elevated or sustained high blood pressure and in whom appropriate investigation reveals none of the secondary causes is deemed to have primary or essential hypertension.

### **AETIOLOGY**

#### **Inherent Biological Traits**

##### **Heredity**

19. Current authoritative British medical opinion considers essential hypertension to be a constitutionally determined condition. A family history of hypertension is common. Thirty years ago, Pickering proposed that essential hypertension reflected a multiple genetic influence on arterial pressure and subsequent findings have supported this view.
20. In a classical study of London bus drivers and conductors in 1959, it was shown that in the drivers, the average systolic blood pressure increased with age. However this occurred only in drivers whose parents had died in middle life. In those whose parents died in old age, the distribution of systolic blood pressure was identical to what it had been at a younger age.
21. Population studies confirm that blood pressure distribution is unimodal. This pattern precludes inheritance via a single gene and is consistent with polygenic inheritance similar to height. Polygenic inheritance reflects nature and nurture shared within families. As early as 1955 it was shown that the resemblance of blood pressure between relatives is the same at all pressure levels not just at high levels. Close relatives of subjects whose systolic blood pressure is 50 mmHg above the population mean will themselves have blood pressures above the mean. In addition, siblings resemble one another more than they resemble their parents.
22. There is evidence that the future blood pressure levels of an individual are programmed from an early age. In older individuals it has been shown that those in the upper or lower 10% blood pressure for their group will remain in this percentile over the years. This phenomenon is referred to as tracking.
23. Attempts to separate and measure the independent contributions of inheritance and environment have been made. The concept is questionable as the two are by definition interdependent. A few studies of adoptive children have been undertaken and these show no correlation between blood pressure levels in the children and their adoptive parents. The expected correlation between parent and natural children in the same household was confirmed.
24. Advances in molecular biology have given added impetus to research into the genetic and molecular basis of hypertension. In spontaneously hypertensive rat strains, chromosome regions carrying blood pressure regulating genes have been identified. These regions are collocated with genes coding for enzymes operating in the kidney renin angiotensin system. Genes contributing to essential hypertension in man are not yet identified. A family linkage with angiotensinogen genes has been found.

## **Age**

25. Perinatal factors may be important in blood pressure. Recent work suggests that subjects with a low birth weight and high placental weight have higher blood pressures in middle age.
26. In all races and societies blood pressure rises through childhood and adolescence until physical maturity is reached. Thereafter in industrialised societies the rise continues with age. In undeveloped communities there is no such rise and indeed blood pressure may fall with age. If migration to a Western country occurs the more usual pattern of rise of blood pressure with age is seen. It is also noted that the higher the pressure, the more rapidly it rises with age. These observations confirm that as well as constitution, environmental factors have an influence.

## **Behaviour**

### **Obesity and physique**

27. The association between obesity, particularly central obesity, and hypertension, is well known. The effect of arm circumference on blood pressure readings is established and renders many early studies invalid but it is accepted that obesity is a risk factor for essential hypertension. If weight reduction is undertaken blood pressure falls.

### **Sodium and potassium intake**

28. Drastic reduction of salt intake is effective in controlling even high blood pressure levels in all societies. Below a threshold much lower than the normal circumstances of any economically developed community, salt intake may be a main determinant of the distribution of arterial pressure in the population. However epidemiological studies in the UK have shown no consistent statistical relationship between blood pressure level and salt intake. The current view is that the contribution of excess sodium intake and inadequate potassium intake to hypertension in Western society is small.

### **Alcohol, coffee and cigarettes**

29. There is now good evidence that even moderate alcohol intake raises blood pressure. Drinking coffee causes a short term rise in blood pressure and a similar short term rise is seen with cigarettes. The combination of the two causes a greater and longer term rise. However overall studies over time show a lower blood pressure in smokers than non-smokers.

### **Vegetarian Diet**

30. Vegetarians have lower blood pressure at all ages than omnivores. If omnivores switch to a vegetarian diet blood pressure falls. There is some suggestion that dietary fibre may be the link but the mechanism remains unknown.

## **Environmental factors**

### **Trace elements**

31. Hypertension is an important risk factor for atherosclerosis. It is known that the incidence of coronary artery disease is higher in soft water areas. Studies of the mineral content of such water suggests that in men, but not in women, there may be an association between blood lead and blood pressure and there is also some evidence that blood cadmium, calcium or magnesium levels, may affect blood pressure.

### **Environmental stress**

32. This is the most popular hypothesis of causation of essential hypertension. The actual term hypertension suggests a disorder initiated by personal and social stretching beyond the limits of tolerance. It is popularly believed that high blood pressure is a disease of a high pressure society.
33. Stress may be of two types. The acute **classical** "flight or fight" response which is found in all humans in reaction to painful or frightening stimulus and **psychosocial** stress, which is now regarded as part of life in developed society.
34. The physiology and biochemistry of the acute stress response is established and it can be seen that catecholamine release, in relation to fear or pain, might raise blood pressure.
35. The concept of psychosocial stress is nowhere clearly defined and is unique to individuals. It is a matter of common experience that one man's stress is another's stimulus.
36. Blood pressure measurement itself elicits an alerting response in some subjects. In most studies this is less marked when blood pressure is taken by a nurse as opposed to a doctor. No correlation has however been observed between doctor induced blood pressure levels and that induced in relation to laboratory stress tests.

### **Relevant studies into stress and hypertension include:-**

#### **37. Animal studies**

In dogs sustained application of unconditioned stimuli can result in sustained hypertension. Mice which have to compete for food ultimately develop fatal hypertension but rats and primates subject to the same conditions are resistant to hypertension.

#### **38. Occupational/social stress**

Several studies have looked at classical stress and blood pressure.

A temporary rise in blood pressure was shown amongst survivors of the Texas City disaster. A ship loaded with explosives blew up causing a further explosion in an adjoining chemical works. A number of the victims were attending the local hospital before the explosion and for these a pre-existing blood pressure reading was available. Using other hospital patients as controls a clear rise in blood pressure was shown for the victims. This rise took place about 8 hours after the explosion and blood pressure had returned to normal within 10 – 14 days.

39. Therapeutic trials of behavioural interventions such as transcendental meditation, yoga and biofeedback have in some instances reported short-term blood pressure reductions. Long term effects have however not been observed.
40. American studies of former German, Japanese and Korean prisoners of war identify a significant increase in the incidence of psychiatric disorders in this group, but no increased incidence of cardiovascular disease. Keehn reported that the frequency of hypertension recorded on death certificates of World War II and Korean War prisoners did not differ from controls. No specific temporal end-point was chosen for these studies but the cases were all studied for several years post captivity. These men would clearly have been exposed to both classical and psychosocial stress.
41. A well-designed and conducted study of 1428 San Francisco bus drivers found a highly significant **inverse** association between blood pressure and perceived psychosocial stress; the higher the stress, the lower the blood pressure. This negative association remained significant after adjustment for 12 potentially confounding variables, although associations in the expected direction were confirmed for other gastro-intestinal, respiratory and musculoskeletal problems.

#### 42. **Case-control studies of personality and hypertension**

Two main types of hospital and community studies have been undertaken which have shown no consistent trends. Personality evaluations have been carried out in persons with hypertension. Prospective studies have been undertaken where developing hypertension is recorded in people of known personality type. No association has been shown between personality type and hypertension. In particular, in population samples, the aggressive type A personality of Rosenmann and Friedman shows no association with blood pressure.

#### 43. **Case control studies of known psychiatric illness and hypertension**

Many international studies have looked for a possible relation between psychiatric illness and hypertension. These have not shown that either psychotic or neurotic illness causes or affects the course of hypertension. A number of hospital studies of psychotic patients have shown that they have a lower than average blood pressure.

#### 44. **Recent work on psychological stress and blood pressure**

In March 1995 further light was shed on the relation between stress and sustained hypertension with the publication of the Whitehall II study. This rigorously designed and analysed study involved 10,000 civil servants aged between 35 and 55 years. First the casual blood pressure was measured. After an interval, the basal resting blood pressure was noted and every fourth male was randomly selected to undergo mental stress testing. The stress stimulus took the form of computerised performance tests, during which the blood pressure was recorded. Finally the follow-up blood pressure was measured about five years later.

45. The results showed that:-

45.1. the basal resting blood pressure was no better at predicting the blood pressure five years later than the initial casual reading of the blood pressure

45.2. acute psychological stress produced an acute rise in blood pressure but –

45.3. the reaction of the blood pressure to psychological stress was less predictive of the future blood pressure than either the casual or the basal resting blood pressure.

46. Present evidence regarding the relation between stress and hypertension can be summarised as follows.

46.1. Classical stress, whether pain, fright or acute mental stress, causes an acute transient rise in blood pressure. Although investigated in many ways, subsequent development of sustained hypertension has not been demonstrated. Prolonged psychological stress is not associated with an increased incidence of essential hypertension.

#### **CONCLUSION**

47. Hypertension is a quantitative condition which may be secondary to other medical conditions. In most cases it is a primary condition which is known as essential hypertension. Essential hypertension is a constitutional condition where heredity is of major importance. It arises from the interaction of inherent biological traits, behaviour and environmental factors in a genetically susceptible individual.

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