ON BLOOD PRESSURE

By F. CROXON DELLER, M.D.(Liv.), M.R.C.P. (London)
(*Temp. Hon. Asst. Phys., Croydon General Hospital, Acton Hospital, etc.*)

This is no learned treatise, but an attempt to discuss the simple methods by which comparatively accurate blood pressure readings may be estimated. Such estimations are not only of great importance in life assurance work, but in the general workaday life of practice: and it is surprising how often this simple procedure is either omitted or performed perfunctorily with consequent unprofitable results.

For the purpose of this discussion we will divide the subject into the following sub-sections:—

1. the apparatus
2. the patient
3. the method
4. the interpretation
5. the theory
6. the pitfalls
7. the abnormal

in order that a comprehensive survey may be possible. Reference will be made to some of the important literature on the subject, and some personal notes will be added. But, in essence, the practical viewpoint will be described only.

The Apparatus.

In the Joint Report of the Blood Pressure Committees of the Cardiac Society of Great Britain and Ireland and the American Heart Association, published in the *British Heart Journal* (1939) it was noted that the British Committee expressed a decided preference for the mercurial manometer, whereas the American committee felt that either the mercurial or aneroid types could be used with equal choice.

In this country, generally, the mercurial manometer holds sway, and is deserving of its popularity because of its dependability. But it is essential to see that the machine is in proper working order. Thus, when the apparatus is placed upon a flat even surface, the meniscus of the column of mercury should be actually at the zero mark. If mercury has been lost this will not be so, and more must be added to make it up to the level. Next, the tube itself must be neither broken, cracked, nor dirty. If it is dirty, then the mercury will cling to the sides after deflation, and often bubbles of air appear in the column, and inaccuracies due to altered surface tension and mercury weight will be inevitable. Most makers of mercurial manometers give a special cleaner with the instrument for use on such an occasion: if missing, a little cotton wool or gauze attached firmly to a long thin metal rod can always be used for the purpose. At the top of the glass tube there is a cap with an air vent in it: if this is blocked inaccurate results will be obtained owing to compression of the air in the tube.

Once these points have been checked, next test the action of the mercury column by closing the air outlet on the pressure bulb and gripping the folded cuff in the hand. The response of the column to pressure from the bulb should be immediate, and its ascent should cease immediately that pressure be arrested, but be maintained at constant height for constant pressure for any length of time.

The aneroid type of apparatus should be calibrated occasionally against a mercurial manometer. The needle must stand at zero when deflated, and there should be no stop pin at the zero mark.

The special types of apparatus, such as the oscillometer, the recording sphygmomanometer etc., will not be discussed here since their use is not so generalised, and indeed may lead to some confusion when employed by the uninitiated.

The Patient.

The taking of the blood pressure is sometimes an uncomfortable procedure even to those fully cognisant with its nature and physical effects. But to a tired, nervous patient that first experience may be most unpleasant and cause psychological reaction with its attendant vasoconstriction and reflex rise of blood pressure. It behoves us therefore to tell the patient quietly of the coming procedure. So much may depend upon that pressure reading, even in general practice. The thought of blood pressure conjures up many lurid and unpleasant thoughts in the minds of the ignorant layman. Personally, I like to have the patient lying down and to complete my routine examination before taking the blood pressure. The patient has then had time to settle down, and relaxation is the more easily attainable. A recent large meal, recent severe or violent exercise, or an aggressive examiner will all tend to increase considerably the systolic and, to a lesser extent, the diastolic pressures.

The reading can be taken with the patient sitting in a comfortable chair in a relaxed position with the arm adequately exposed, lying on a small cushion placed on the arm or table. But since adequate exposure of the arm necessitates removal of the coat, and sometimes the shirt or dress, it is surely not such a distant cry to ask the patient to lie down on the examining couch with its head rest elevated up to about 45°. By this means comfort and relaxation may be obtained more easily.

The Method.

The apparatus checked, the patient relaxed and receptive of one's explanation, next comes the actual recording. The standard sized inflatable cuff (at least 12 cms. wide) quite deflated is placed around the middle of the arm with the middle of the cuff over the inner side of the arm, the lower edge being situated about an inch above the bend of the elbow. The long tapering cuff end must then be wrapped firmly yet evenly about the arm, or its end pushed under the penultimate fold. The cuff is then connected firmly with the apparatus.

The brachial artery should next be palpated. Failure to do this often leads to trouble, since congenital abnormalities or displacements are far from rare.

There are now two methods of procedure. Either the mercury column may be pushed up rapidly to the 200 mm. mark and the stethoscope immediately placed over the brachial artery, or the fingers are placed upon the radial pulse and inflation proceeded with slowly until the pulse wave is obliterated. Further inflation for about another 10 mm. is made before the stethoscope is applied. Personally, I prefer the latter method, because in an apprehensive patient the rapid raising of the pressure to the 200 mm. mark may prove an unpalatable discomforture.

The Interpretation.

One listens over the brachial artery and, using the outlet valve, slowly deflates the bag. As the actual systolic pressure is reached a sound assails the ear. This sound is all-important. Korotkow (1905) described it as having four phases, some of which, however, are not always easy of distinction. The first sounds heard as decompression occurs are dull thuds—"first phase Korotkow sounds," and the first sound is taken as the systolic reading (*vide infra*). The sounds next become blurred and muffled with a murmur-like quality, and are known as the "second phase Korotkow sounds." Following the second phase sounds, the character changes yet again to clear loud sounds which progressively increase in intensity—the "third phase sounds." Suddenly, and often abruptly, the sounds become dull and muffled, differing from the second phase both in quality and intensity. As already stated above, with a normal sinus rhythm, the first sound of the first phase gives the systolic reading. But in the interpretation of the diastolic end point there is considerable cleavage of opinion. The British Committee (*loc. cit.*) recommend the point at which the clear loud sounds change—the third phase change to the dull muffled sounds of the fourth phase. But the American Committee recommend "that if there is any difference between this point and the level at which the sounds disappear completely, the latter reading should be regarded also as a measure of the diastolic pressure.

This should then be recorded in the following form—

Rt. (or Lt.) 140/80–70 or 140/40–0, or, if their levels are identical, 140/70–70."

With due deference to this eminent body of opinion, I personally regard the change from "third to fourth phase Korotkow sounds" as the diastolic end point. I have often remarked that in cases of medial atherosclerosis the fourth phase sounds may be continued practically down to the zero mark. In these cases, if the stethoscope is applied over the brachial artery after deflation, and the pressure is gradually increased, the change from fourth to third phase sounds will be noted and gives, in my opinion, a fair estimate of the diastolic reading.

One of the classical clinical signs in aortic incompetence is Duroziez's pistol-shot murmur heard on applying the stethoscope over the brachial or femoral arteries. In character it is like the "third phase Korotkow" sound. In this condition no diastolic end point can be accurately discovered. The lower the diastolic pressure, however, the greater the physiological tachycardia present in these cases. As a working rule, then, I always try, therefore, to prognosticate in this condition, not on the blood pressure so much, but upon the resting cardiac rate. The increased heart rate must be due in large measure to a very low diastolic pressure stimulating the sinoaortic nerve plexus.

Another important point is to measure the blood pressure in both arms, and if there is any difference—as there so often is—to record both. I recently saw a patient whose blood pressure had apparently varied as much as 250/150 to 200/130. By taking the blood pressure in both arms it was strikingly obvious that the apparent changes in his blood pressure were not due to varying states of his myocardium or peripheral resistance, but were dependent upon which arm had been used at each examination. Radiological investigation showed that he had a cervical rib on the side showing the lower reading. Prognosis was based upon the arm with no cervical rib, and this proved correct in the passage of time. Especially therefore in life assurance work each arm should be used for recording the blood pressure.

Too accurate reading of the blood pressure is not yet possible with present-day clinical methods, because there is a considerable margin of experimental error, and it is well as a general rule to record the readings to the nearest multiple of five. Thus, if the readings come to 133 systolic and 87 diastolic the record should read 135/85, giving a pulse pressure of 50.

The Theory of Blood Pressure Estimation.

Accurate discussion of the causation of the various sounds already described leads us into dangerous ground. Bramwell (1943) discusses the theories of causation, and reference should be made to that work and to his bibliography for fuller details.

Sound is produced by waves or vibrations. The pulse wave is propagated by the elastic recoil of the arteries distended in systole, and is independent of, and much slower than, the rate of blood flow. Furthermore, the rate of flow of any liquid in a pipe is not uniform. The liquid nearest the periphery moves more slowly than that in the centre, owing to friction with the walls of the pipe. Thus, owing to these differences in flow, a certain intrinsic turbulence must be produced within the liquid stream. Similarly, an ocean wave moves over the surface of the sea regularly until it meets the shelving shore. The undermost portion becomes slowed by friction with shingle, while the topmost portion, unhindered, moves forward faster than its base until it topples over with great roar and turbulence.

When the sphygomanometer cuff is placed around the brachial artery and the pressure within is raised above the systolic reading, all blood flow stops and the pulse wave is also interrupted. With slow deflation a point is reached at which the pressure within the artery is equal to that outside in the cuff. Slightly lower, however, both blood flow and pulse wave can pass the external pressure. Vibrations are then set up in the lumen of the artery, not only from the pulse wave but also from the turbulence of the blood flow, and these vibrations must produce the sounds. With further gradual lowering of the external pressure in the cuff more blood flows and more of the pulse wave passes the obstruction. With changing conditions the frequency of these vibrations must alter, and so produce the varying sounds described by Korotkow. Further into the depths of theory I will not venture. That normally the sounds, synchronous with the pulse wave, are only heard between the systolic and diastolic reading shows that besides alterations in the actual blood flow within the artery, the variations in the state of the arterial wall produced by the pulse waves plays a major part in causation.

The Pitfalls.

Already certain pitfalls in the estimation of the blood pressure have been discussed.

1. *The nervous patient*.—It is surprising how much elevation of both systolic and diastolic pressure may occur with fear or fright, especially in children or young adult females. If in

doubt keep the patient lying down relaxed for upwards of half an hour. In children, I always try to focus their attention not upon the bag or pressure around the arm, but upon the column of mercury, talking to them and asking them to watch and record the figures. This method works surprisingly well, and only rarely will an apprehensive child not co-operate.

2. *Medial atherosclerosis*.—The simple method of trying to overcome the difficulties of differentiation in these cases has already been described. It must be admitted, however, that in some cases measurement of the diastolic pressure is impossible: notation of such a fact must always be made.

3. *Aortic incompetence*.—Again, discernment of the diastolic pressure, *per se*, may be very difficult, if not impossible. To quote Bramwell again: ". . . the fourth phase sounds may be very loud. Then it is the change in quality, rather than any falling off of intensity, of the sounds which marks the transition from third to fourth phase. The novice frequently fails to appreciate this transition, and consequently has difficulty in recognising the diastolic end point."

But from a prognostic point of view the resting cardiac rate may supply much of the information of the effectiveness of the diastolic pressure.

4. *Aortic stenosis*.—In a case of pure stenosis the measurement of the diastolic pressure may be extremely difficult owing to the slow rise and fall of the pulse wave—the anachrotic pulse. Careful palpation of the radial pulse will give more accurate results than auscultation as far as the systolic pressure is concerned. The diastolic end point can rarely be obtained, or if it is, it is markedly inaccurate.

5. *Cardiac arrhythmias*.—Further difficulties may be experienced in these conditions. The Blood Pressure Committees (*loc. cit.*) made the following recommendations:

a. Where there are extrasystoles the higher pressure of the beat that follows should be ignored.

b. In auricular fibrillation only approximate blood pressure readings can be obtained; the systolic value should be taken at the point where the majority of beats appear, and the diastolic (if at all) at the point where they become dull and muffled. The American Committee suggest that the average of a series of such readings should be noted as the systolic and diastolic pressures.

c. Alteration in the strength of the beats (pulsus alternans) must be looked for carefully. It must be distinguished from the alternating values produced by regular alternating extrasystoles (pulsus bigeminus).

At best in these conditions only an approximation of the mean blood pressure values is possible.

The Abnormal Blood Pressure.

The significance of the normality or otherwise of the blood pressure assessed by the methods described leads us on to stony ground. Statistics compiled by certain insurance companies, and quoted by Bramwell (*loc. cit.*), show that the systolic pressure varies from 123–125 mm. Hg. at 20 years of age to 131–135 mm. Hg. at the age of 50. Bramwell (1942) himself is much more forthright: he says that only systolic blood pressures over 150 mm. Hg. are pathological. Treadgold (1923) gave a detailed analysis of the blood pressure readings in 2,497 fit pilots in the R.A.F., and found that there was little change in the systolic pressures between the ages of 18 and 40 years, and that the average readings were 124 mm. Hg. systolic–77 mm. Hg. diastolic; and he also showed that the blood pressure varied directly with the weight, when that weight was disproportionate to height. Thus the lightest group had an average blood pressure of 118/75 and the heaviest 132/82.

To sum up: in everyday practice a systolic pressure of 150 mm. Hg. or more should be regarded as pathological until proved otherwise; and, even more important, a diastolic pressure of 85 mm. Hg. should make one begin to suspect, or a diastolic of 90 mm. Hg. or more take great regard of the insidious pathology underlying that discovery.

Summary

1. An attempt has been made to give brief practical details concerning the estimation of the blood pressure both in adults and in children.
2. The interpretation of the results have been given.
3. The difficulties in the estimation have been tabulated and discussed.
4. Reference to some of the important literature has been freely used.

REFERENCES

1. Joint Report, *British Heart Journal*, 1939, **1**, 263.
2. KOROTKOW, N. (1905), *Mitt. Kaiserl. milit-mediz. Akad, St. Petersburg*, **11**.
3. BRAMWELL, C., and KING, J. T. (1942), *The Principles and Practice of Cardiology*.
4. TREADGOLD, H. A. (1933), *Lancet*, **1**, 733.

DEVELOPMENTAL ABNORMALITIES OF CERVICAL VERTEBRAE IN A CASE OF GENERALISED NEUROFIBROMATOSIS

By ALBERT PEACOCK, M.B., B.S.(Lond.), M.R.C.S., L.R.C.P.
(*Demonstrator in Anatomy, London Hospital Medical College.*)

The skeletal abnormalities described below were present in a patient suffering from generalised neurofibromatosis, who was admitted to the London Hospital in October 1943. The salient clinical features were as follows:—

History

The patient was a male of 49 years, a labourer by occupation. He had long standing cutaneous lesions on face, neck, trunk and limbs and complained of loss of weight over the previous 6 months. Seven days prior to admission to hospital, he complained of difficulty in speaking, swallowing and breathing and of the simultaneous and rather sudden appearance of a swelling in the left side of the neck. The character of the voice changed, swallowing became progressively difficult and the patient was admitted on account of difficulty in breathing.

The previous history was of minor illness only and nothing relevant to his present condition. In the family history, there was no mention of generalised neurofibromatosis.

Physical Examination

The patient was rather emaciated. Characteristic cutaneous lesions of generalised neurofibromatosis, both sessile and pedunculated, were present practically over the whole body. On the left side of the neck, a large firm mass was present projecting from beneath the angle of the jaw and deep to the sternomastoid. On examination from the mouth, the mass was seen to bulge into the left side of the pharynx almost halfway across that cavity, measuring about 2 in. in the longitudinal and 1½ in. in the transverse axis respectively. The trachea was displaced to the right. No enlarged lymphatic glands were discovered and the thyroid appeared to be normal. On examination of the chest, slight emphysema was found to be present. No cardiac signs were found. The blood pressure was 120/70. Nothing abnormal was found in the abdomen. The patient exhibited a left lateral rectus ocular palsy. The arms showed wasting, but muscular tone was normal and the tendon jerks were diminished but equal on the two sides. No abnormality was seen in the legs and the tendon jerks were present and normal.

The patient complained of some coldness of the hands but there were no other symptoms present. No sensory disturbance was detected.