BLOOD PRESSURE ESTIMATION IN CHILDREN.

BY

G. SPENCER MELVIN, M.D.,

LECTURER ON EXPERIMENTAL PHYSIOLOGY,

AND

J. R. MURRAY, M.D.,

SENIOR ASSISTANT IN PHYSIOLOGY, IN THE UNIVERSITY OF ABERDEEN.

It is practically impossible at the present moment to meet with any class of patient or any clinical condition of which no record of blood pressure exists. Till recently it seemed almost impossible to break fresh ground or to supply data that were original and not merely confirmatory or contradictory. But from the present standpoint of sphygmomanometry these existing records must be regarded as vitally incomplete. Blood pressure, clinically interpreted, consists of a more or less constant pressure—the diastolic pressure—on which there is periodically superimposed an additional pressure—the systolic pressure. So long as there was no method of determining the extent of the constant strain on the blood vessels due to the diastolic pressure, “blood pressure readings” was a term synonymous with “systolic pressure readings.” There has certainly for some time existed a class of apparatus designed to make good this serious deficiency. While some of these instruments were cumbersome in structure or complicated in the method of working, all suffered from a lack of definition in the indication (maximum oscillation, etc.) they were designed to give. Moreover, the theory on which they were based is one which must now be regarded as interesting but inaccurate.

Application of the Auditory Method in Children.

This method is simple and determinate. By experiment and investigation it has been established as accurate. A doubt in our own minds as to the applicability of the method in the case of the small arteries of children led to our carrying out a series of determinations. We were early satisfied that the phenomena were not only very definite, but were in many cases as definite as those in adults; in fact, the clearest impression of the sounds we have yet obtained was in the case of a child.

The apparatus required for the application of the method in children are:

1. A mercury manometer (preferably an ordinary one). The slight advantage in portability of the compressed-air type of manometer is depreciated by the necessity in its use for frequent calibration to ensure accuracy.
2. An armlet of suitable size, much narrower than the ordinary one for adults; an armlet of 8 cm. broad does very well—for example, that supplied with the Pachon oscillometer.*
3. Some form of filler, either of the “ball” type or of the “screw compressor” type. The latter, greatly superior for finer adjustments of pressure, suffers in having a fixed capacity. This difficulty can, however, be easily overcome.
4. An Oliver tambour with strap attachment, which secures it in a fixed position on the arm. Such an arrangement leaves the observer with both hands free—an important point.
5. Rubber tubing and connexions.

With such an apparatus, extremely simple and portable, it is possible to do a complete blood pressure estimation. In making a determination, the armlet is fitted snugly but not tightly to the upper arm, and the tambour (phonendoscope) is strapped lightly over the site of the brachial artery of the same arm at the bend of the elbow. The strap of the tambour should not constrict the arm, but should be sufficiently tight only to prevent movement of the tambour, which then lies practically without pressure on the skin. With the ear pieces fitting properly in the ears of the observer, both his hands are free. One hand should be utilized to palpate the radial pulse of the arm under investigation, the other to manipulate the compressor. The armlet should now be inflated till the external pressure thus established is considerably higher than that at which the radial pulse was felt to disappear.

It is perhaps desirable in the meantime to proceed with the next step, before directing attention to the significance of the phenomena appreciated. The next step consists in the gradual lowering of the external obliterating pressure. At a certain point, most probably while yet no pulse is appreciable by tactile examination at the wrist, a

distinct sound is heard. Careful attention directed to the quality and intensity of this sound will enable the observer to note the following alterations, first proposed by Ettinger, and now pretty generally accepted by workers at the method: The sound at first clear cut, the *first phase* as it is called, develops a murmurish quality—the *second phase*. This, later, is replaced by a clear sound—the *third phase*. The onset of the *fourth phase* is marked by the transformation of this loud, clear sound into a dull sound of less intensity. The complete abolition of the sound is referred to as the *fifth phase*.

Significance of the Phases.

Experiment has shown that attention must be directed to two of these phases:

Phase 1.—The onset of the sharp, clear sound. The external pressure indicated by the manometer at the point at which phase 1—that is, the beginning of sound—represents systolic pressure.

Phase 4.—The commencement of the fourth phase—that is, the point at which the sound, from being loud and clear, becomes dull and diminished in intensity—is an indication of diastolic pressure. By some observers the fifth phase—that is, the point at which the sounds disappear—was regarded as indicating diastolic pressure; but it must be admitted that such a view is untenable.

For the actual determination of these pressures all that is required is that the observer gradually lower the external obliterating pressure, and note the external pressure corresponding to (a) the onset of the sound; (b) the onset of the fourth phase. He will then be in possession of the values of the systolic and diastolic pressures.

We make it a point to determine that the auditory systolic index exceeds the tactile systolic index—that is, that the first sound is heard at a higher level of external pressure than that at which the pulse is felt to return at the wrist. This is almost invariably the case, and is to be insisted on. Otherwise—that is, if the pulse be felt before the sound is heard—we do not proceed with the estimation, unless, as generally happens, it be possible, by adjustment of the tambour, or other alteration, to establish the proper relation of auditory systolic index at least as high as tactile systolic index.

The extent of pressure to which the sound persists after the diastolic index—that is, the duration of the fourth phase—is very variable in young adults. It seems to depend in part, but by no means wholly, on the degree of quiet prevailing in the surroundings in which the examination is made. In children a fourth phase of any considerable duration is very rarely found.†

The method, as will thus be seen, is exceedingly simple, and to a very large extent removes the personal equation which with other methods often results in appreciably different estimations. From personal experience we gladly welcome a method which, especially in the case of children, substitutes the delicate sense of hearing for the coarser and more variable sense of touch. Its simplicity and ease of application, together with the portability of the apparatus employed, makes its employment possible in almost every conceivable situation.‡ Above all, it is accurate both as regards systolic and diastolic pressure values, without which properties no method of blood-pressure estimation has at the present day any legitimate right to the title.

The tabular statement (p. 670) shows some of the results we have obtained from investigations made on forty children. These children, of ages between 4 and 14 years, had an average age of 9.5 years. So far as we could make out, they were, as far as the circulatory system was concerned, healthy, so that our results are to be taken as applying to normal children. No such data have hitherto been supplied; they are obviously essential as a basis for the study of blood pressure in disease.

Estimated by the auditory method, the average systolic pressure is seen to be 108.1, the average diastolic pressure to be 72.4, and the average pulse pressure 35.7 mm. Hg.

The cardiac output is, of course, very small in children, and in association with this the capillary system to be filled is very limited as compared with the adult. Yet, from our results, it is to be noted that the systolic pressure

† The fourth phase rarely amounts to more than 2 to 3 mm. in children—in only one case of the present series was a prolonged phase got (Case No. 8, Table).

‡ An obvious exception is in noisy surroundings.

* Supplied by Hawksley.

Table of Results Obtained from Healthy Children.

No.	Age.	Pulse-Rate.	Auditory Systolic.	Auditory Diastolic.	Pulse Pressure.	No.	Age.	Pulse-Rate.	Auditory Systolic.	Auditory Diastolic.	Pulse Pressure.
1	10	100	108	80	28	21	7	128	110	60	50
2	12	102	105	78	27	22	12	128	100	80	20
3	10	60	90	55	35	23	7	100	106	85	21
4	12½	50	108	65	43	24	5	95	114	90	24
5	14	84	108	78	30	25	4	90	102	58	44
6	12	84	115	80	35	26	10	80	106	55	51
7	12	84	113	77	36	27	5	70	95	55	40
8	10	92	110	86	24	28	10	90	110	78	32
9	12	100	110	70	40	29	6	120	120	80	40
10	13	106	100	70	30	30	11	106	108	62	46
11	8	104	112	75	37	31	13	60	90	70	20
12	14	88	106	68	38	32	11	90	120	90	30
13	9	80	108	75	33	33	4	80	90	60	30
14	8	90	120	70	50	34	9	93	120	80	40
15	11	100	120	90	30	35	8	104	115	75	40
16	7	120	110	60	50	36	6	92	106	78	28
17	11	65	120	65	55	37	8	96	100	70	30
18	9	96	90	62	28	38	11	82	120	85	35
19	12	96	120	80	40	39	11	126	130	80	50
20	5	132	90	50	40	40	4½	84	100	70	30

Averages: Age, 9.5; pulse-rate, 93.6; auditory systolic, 108.1; auditory diastolic, 72.4; pulse pressure, 35.7.

is only very slightly lower in children than in adults. Various observers, using the much less accurate tactile method, have estimated the average systolic pressure in children at decidedly lower values, for example, 90 mm. mercury. But the fallacies of the tactile index are much more serious in young children than in adults, and the results by the auditory method are so sharp and precise as to admit of no doubt.

The average diastolic level, on the other hand, is decidedly higher in children than in adults; this is the main cause of the considerably smaller pulse pressure in children—35.7 mm.—as compared with 46 mm. in adults.

Comparison of Children and Young Adults.

The relation between the values obtained in a series of fifty-nine healthy young adults and in the present series of children is as follows:

	Adults.	Children.
Systolic pressure ...	111.8	108.1
Diastolic pressure ...	65.7	72.4
Pulse pressure ...	46.0	35.7

The average pulse-rate in children was 93.6 (range 132-50), and it is noteworthy that, while a slow pulse naturally tends to give a lower diastolic pressure (by allowing longer time for the blood to escape from the arterial system into the capillaries between the beats), the adjustment of the vascular system may be such as to give a diastolic pressure quite up to the normal, in presence even of a markedly slow heart-rate—for example, Cases Nos. 4 and 31 in table.

Some other points of comparison between children and adults may be stated. By the tactile method the average systolic pressure was 105.7 in children as compared with 108.7 in adults, while the range was 125-84 in the former and 132-92 in the latter.

By the auditory method the range of systolic pressure was 130-90 in children and 135-92 in adults, while the range of diastolic pressure was 90-50 in the former as compared with 82-50 in the latter.

In children the relation of pulse pressure to systolic pressure was 1:3 and to diastolic pressure 1:2, while in adults this relation was 1:2.7 and 1:1.6 respectively.

The normal readings of systolic and diastolic pressures, and of pulse pressures in children, as described above, are

so definite and reliable as to constitute a sound basis for the study of pathological variations and their significance.

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ON IDIOGLOSSIA: WITH AN ACCOUNT OF A CASE.

By W. B. DRUMMOND, M.B., C.M., F.R.C.P. EDIN.,

ACTING PHYSICIAN TO OUT-PATIENTS, ROYAL HOSPITAL FOR SICK CHILDREN, EDINBURGH.

IDIOGLOSSIA is a defective condition of speech of such a nature that the affected person is unintelligible, except, perhaps, to his own relations; yet what he speaks is really English, very grossly mispronounced. In the following marked case rapid improvement took place under treatment.

A boy, 13 years and 9 months old, was brought to the Sick Children's Hospital, Edinburgh, on February 18th, 1914, on account of his defective speech. Dr. John Thomson reported that he was strong and healthy, though small for his age. His intelligence was quite up to the average. His birth was premature by two weeks, his mother having had a fright. There was no family history of any disability of speech. Though his teachers (in a country school) apparently left him much to himself, he was advanced in his classes along with his companions.

When he was first examined he mispronounced twelve letters in the alphabet. These were as follows: C—he, F—ech, H—aick, I—oi, L—ai, Q—kay, S—ech, V—oo, W—do'er, X—ech, Y—oi, Z—he'ed. Yet, as in other cases, many of these letters were pronounced quite differently when he spoke. Moreover, consonantal sounds were often slurred over, or missed out altogether. When asked to say "the school" he said "ud kool." Instead of "pleasure" he said "penur." His speech generally was quite unintelligible. As in other cases the consonants D, T, B, P, and H were, as a rule, correctly rendered, especially as initials. They were also liable to be substituted for other sounds. His voice was disagreeable and very monotonous.

Miss Margaret Drummond, lecturer on psychology, and myself undertook the treatment of the boy, who was keenly anxious to be cured of his defective speech. As the patient had failed to learn correct articulation by the ear, he was taught by eye. The various sounds were taken up seriatim, more or less in accordance with their arrangement in Professor Wyllie's physiological alphabet, and the boy was shown how to reproduce them as is done in teaching deaf-mutes to speak. An exercise book was also gradually filled with lists of words containing the different sounds in various positions, and sentences were constructed so as to secure a frequent repetition of the required sounds. He spent half an hour every evening reading his exercises aloud to his mother, and repeated to himself at intervals during the day as many of the sentences as he could remember. These instructions were faithfully carried out, and just two months after treatment was begun Dr. Thomson saw the boy again and reported that he now pronounced all letters properly except L, W, and Y, and even those three he could articulate if made to repeat them. The boy could now speak quite intelligibly to anyone, though the letter L, which was the last to be learnt, still gave him a good deal of difficulty, especially at the beginning of a word. Unfamiliar words were still something of a stumbling-block, but if he were asked to repeat a sentence containing such words, he did not become embarrassed, but broke up the words into syllables—tackled separately as he had been taught to do. He had none of the lack of confidence of the stammerer who will write down a message he is asked to deliver, in case he may be unable to deliver it verbally. This boy was a very good visualizer, and he could "see" before him, as if in printed characters, any word which still gave him difficulty. At this time the boy could speak intelligibly and with fair fluency. His voice was still, however, very monotonous, after the fashion of an unpractised reader.

Thus the visual memory in this case, and the power to concentrate the attention, were good. Dr. Leonard Guthrie, in discussing the nature of idioglossia, says, "The subjects of idioglossia have some inherent inability to make prolonged use of the faculties of attention and observation which are necessary for the acquisition of correct speech." This boy, however, had very good observing powers, and his attention did not readily wander, even towards the end of a prolonged lesson. He had a fair vocabulary, which he could use well, and if told to describe something he had seen, he would do so in detail without prompting. On the other hand, his auditory memory was poor, and he had little or no ear for music. He could not hum or whistle music, and he declared that there was no tune he could recognize, not even the air of the psalms frequently sung at the opening of school, which he could only distinguish by the words. At present his condition continues as above described.

The symptoms in this case support the view that in idioglossia the peculiar speech is neither a persistence of