HYPERTENSION IN NEPHRITIS IN CHILDHOOD, WITH A STUDY OF NINETY-THREE CASES *

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A recent and unusual case of high blood pressure in nephritis in a boy of 10 stimulated a review of the literature to ascertain the frequency with which, and to what degree, hypertension occurred in nephritis in children. Considering the attention blood pressure has received in the nephritis of adults, we were immediately struck by the scarcity of literature relating to blood pressure in nephritis occurring in the early years of life.

Shaw[1] reports three cases of acute nephritis in children with blood pressure readings, and concludes that "hypertension in acute nephritis, so constant in adults, is not so marked in children." Gordon[2] reports the blood pressure in nine cases, seven of which were acute nephritis and two chronic cases with acute symptoms superimposed. He found that the blood pressure in acute nephritis is elevated, and that the increase may be very great, one of his cases having a pressure of 180 mm. Hg. He also pointed out that the cases with the highest pressure show very little edema, but have large amounts of blood in the urine. The large amount of blood, he believes, is due to a rupture of renal capillaries by increased pressure. Barber[3] reports three cases of chronic interstitial nephritis in children. The blood pressure was below 100 mm. Hg on several occasions in the one case that he tested. Wessler[4] found a latent hypertrophy of the heart occurring in nephritis in children which he believes is secondary to arterial hypertension. Bugge[5] asserts that the blood pressure in both orthostatic and nephritic albuminuria is usually normal. Bass and Wessler,[6] after analyzing twenty-six cases of orthostatic albuminuria, conclude that the blood pressure differs but little from normal. Thus, while increased tension is expected, according to most authors, the evidence is not conclusive, and no figures have been reported giving the constancy or extreme limits of the increase.

In the records of the Massachusetts General Hospital and the medical service of the Children's Hospital, ninety-three cases of nephritis

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2. Gordon, Lennox: Arch. Pediat., 1911, **28,** 343.
3. Barber, Hugh: Brit. Med. Jour., Nov. 8, 1913, p. 1204.
4. Wessler, H.: Arch. Int. Med., 1914, **14,** 517.
5. Bugge, J.: Norsk Mag. f. Laegevidensk., 1913, **74,** 1601.
6. Bass and Wessler: Arch. Int. Med., 1914, **13,** 39.

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in children between the ages of 2 and 12 years were found in which blood pressures had been recorded. Sixty-five of these cases were diagnosed as acute nephritis and twenty-eight as some form of chronic nephritis. No attempt has been made to subdivide the cases of chronic nephritis into the different pathologic classes. These cases have been taken as the basis of this report. They cover a period of several years and represent the observations of numerous men. Deductions from these records are open to criticism on several points. In no case is the size of the cuff used mentioned, the importance of which has been pointed out by Judson and Nicholson[7] and P. Wolfensohn-Kriss.[8] The personal factor in blood pressure observations has been pointed out by Kilgore[9] and by Kilgore, Berkley, Rowe and Stabler.[10] The importance of the phase taken for the reading has been pointed out by numerous observers. We feel, however, that some value may be attached to these findings, and it is hoped that this report may lead to further investigation along the same line in which all of these factors have been properly controlled.

The blood pressure of normal children has been studied by several observers from different points of view. As early as 1900 Shaw[1] reported 400 observations on forty-five children, using Gartner's tonometer. P. Wolfensohn-Kriss[8] and M. Michael[11] report the relation of the blood pressure to the body weight and the height in normal children. Other investigators who should be mentioned are Cook,[12] Stowell and Gordon,[13] Gordon,[2] Nirrnheim,[14] Oppenheim and Bauchwitz,[15] Kaupe,[16] Mello Leitao,[17] Katsenberger[18] and Rolleston.[19] The most recent and most exhaustive work is that of Judson and Nicholson.[7] These authors give a complete summary of the work up to date and should be consulted by those interested in the subject. They also report a series of 2,300 observations of their own which they have tabulated, the pressures being those of normal children between the ages of 3 and 15 years. Their results are taken as a standard for comparison in this paper, though as stated above, we do not claim such accuracy as theirs.

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For the purpose of comparative study the cases here reported have been grouped as follows:

1. Nephritis in general (including all cases regardless of type).
2. Acute nephritis, sixty-six cases.
3. Chronic nephritis, twenty-seven cases.

Table 1 shows the distribution of these cases as to age, type of nephritis and the number of systolic and diastolic observations for each age.

Clinical notes in all cases but one have purposely been omitted. The following case, however, is given in detail because of certain unusual features.

TABLE 1.—AUTHOR'S CASES SHOWING TYPE OF NEPHRITIS AND NUMBER OF BLOOD PRESSURE OBSERVATIONS

Age	Total Number Cases	Number of Acute Cases	Number of Chronic Cases	Number of Systolic Observations	Number of Diastolic Observations	Total Observations
2	3	2	1	3	3	6
3	4	3	1	6	5	11
4	11	10	1	24	15	39
5	9	9	0	16	16	32
6	9	7	2	13	11	24
7	11	7	4	17	8	25
8	10	6	4	34	16	50
9	14	12	2	32	12	44
10	8	1	7	20	6	26
11	10	7	3	25	20	45
12	4	2	2	26	1	27
	93	66	27	216	113	329

REPORT OF CASE

History.—M. F., boy, aged 10 years, entered the Massachusetts General Hospital for diagnosis. The family history was negative, and there was no evidence of specific disease.

Past History.—Full term, normal delivery, normal at birth, and weighed 8 pounds. No coma or convulsions. Breast fed for three weeks and then discontinued because the child had three convulsions (general rigidity with clonic contractions). He was subsequently fed on modified cow's milk and did poorly. He had measles at 6 years, whooping cough at 6½ years, mumps when 7 and chickenpox when 7½ years of age. He had not had scarlet fever, diphtheria, rheumatism, chorea or tonsillitis.

Present Illness.—Complaint, headache and failing vision. The patient was apparently perfectly well up to two months before entry to the hospital, when his mother noticed that he held papers close to his eyes when reading. Six weeks previous to admission to the hospital his teacher reported that his vision

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was imperfect, but he continued in school three weeks after this and then had glasses fitted by an optician, with no improvement. An oculist consulted shortly after this offered no satisfactory explanation. Since onset of present illness he had had occasional attacks of headache and vomiting. The headaches were always frontal, sometimes radiating to the occiput. They came at no definite time, being present at times when he awoke in the morning and sometimes coming on during the day. Occasionally he had headache after reading. During the week previous to entering the hospital the headaches were unusually severe and were accompanied by vomiting. For two days he had had no pain. The vomiting bore no relation to meals and was definitely propulsive. There was no marked change in disposition, though the mother thought the boy had been more "cranky" recently. He had no staggering, twitchings, convulsions, diplopia, blurring of vision, dyspnea, cyanosis or edema. No nocturia, frequency, bloody or smoky urine had been noted. The mother believed his eyes had been puffy at times, but was not sure.

Physical Examination.—A fairly well developed, thin, sallow, white boy of about 10 years. Pupils equal, regular; react to light and distance. There was a lateral nystagmus and a marked albuminuric retinitis. Tonsils moderately enlarged. Multiple shotty glands palpable in cervical, axillary and inguinal region; epitrochlears palpable. Left border cardiac dulness 9 cm. to left of midsternal line; right border 3.5 cm. to right of midsternal line. Apex impulse diffuse and forcible. Sounds regular, slow and of good quality; no murmurs. Aortic second sound was greater than pulmonic second sound, and loudly accentuated. At aortic area there was a gallop rhythm. Palpable and visible impulse in second interspace, 3.5 cm. to right of midsternal line. Palpable pulsation in suprasternal notch. Pulses equal, synchronous and of high tension. Arterial wall distinctly palpable after pulse had been shut off by compression. Lungs normal. Abdomen normal, liver and spleen not palpable. Extremities normal, no edema. Knee jerks equal and exaggerated. Achilles reflexes active, with suggestion of clonus on the right. Physical examination otherwise normal. The blood pressures in this case on entry were, systolic 250 mm. Hg, and diastolic 210 mm. Subsequent readings were

Systolic	250	218	210	210
Diastolic	190	190	180	180

Clinical Notes.—On a dry diet (360 c.c. fluid intake) 1,560 c.c. of urine were excreted with a specific gravity of 1.005, which indicated an inability of the kidneys to excrete salts in a concentrated form.

The carbon dioxid tension of the alveolar air was 42.8. The urine became neutral in reaction after the administration of 1 gm. of sodium bicarbonate by mouth. Both of these tests showed the absence of acidosis.

After the administration of 10 gm. of urea by mouth the urine for the following twenty-four hours contained but 5.3 gm. (urease method), indicating a marked decrease in the ability of the kidneys to excrete nitrogen.

Nonprotein blood nitrogen, 40 mg. per 100 c.c. of blood.

Urine: Sp. Gr. 1.005; albumin, heavy trace; sugar, 0; acetone, 0; sediment showed many hyaline and granular casts; no blood cells.

M. F. was discharged unrelieved with a diagnosis of chronic nephritis and an unfavorable prognosis given to the parents. Death occurred at home three weeks after leaving the Massachusetts General Hospital. Unfortunately no postmortem examination was made.

This case shows that the blood pressure in nephritis in childhood may be tremendously increased, even reaching a point usually seen only in well marked adult cases. Hypertension of this degree is unusual in children, and in our series only seven cases show a pressure of 150 mm.

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Hg or above, four of these being acute and three chronic nephritis. Only five additional cases had pressures as high as 140 mm. Hg, three acute and two chronic cases.

Headache, so prominent a feature in this case, is an uncommon symptom. It is mentioned in but one other case in the entire series, a child, aged 10 years, with chronic nephritis, uremia, temporary blindness, and having a blood pressure of 170 mm. Hg.

Changes in the fundus secondary to nephritis apparently are very uncommon in childhood. We have found no mention of such changes in the literature, and such changes were found in but one other case in the series, a boy, aged 10 years, with a systolic pressure of 210 mm. Hg, who died two weeks after leaving the hospital. These two cases are the only ones in the entire series of ninety-three cases having systolic pressures of over 200 mm. Hg. In the case recorded there was a well marked albuminuric retinitis, with large patches of exudate and numerous small hemorrhages in each eye. Whether these changes are frequently present and are not looked for, or are extremely rare, it is of course impossible to say. It seems probable, however, that the condition but rarely occurs. This condition in adults is generally considered a prognostic sign of some importance, and the rapid, fatal outcome in both of these cases suggests that it may carry with it a similar prognosis in children.

It is of interest to note that in this case, with a tremendously increased blood pressure, there were no blood elements found in the urine.

As is not infrequently the case in nephritis in children, no etiology for the nephritis could be found in this case.

COMPARISON OF THE BLOOD PRESSURES OF NEPHRITIC AND NORMAL CHILDREN

Believing that the blood pressure is raised in the nephritis of children, it becomes of interest to know the constancy and extent of this rise. In Figure 1 we have shown the averages of all the blood pressures in the ninety-three cases of nephritis compared graphically with the normal figures of Judson and Nicholson. This figure shows that although there are slight variations, there is a definite increase in both systolic and diastolic blood pressures in nephritis when compared with the normal blood pressure for the corresponding age. In our series this increase averages about 20 mm. Hg for systolic and about 10 mm. for diastolic readings.

The diastolic pressures showing a less marked increase over the normal, indicate that in nephritis in childhood there is an increase in the pulse pressure. The extent of this increase is shown in Table 2, the normal figures being those of Judson and Nicholson. It is readily

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seen that this increase is not a constant factor and varies between the wide limits of 0.1 and 21. The normal pulse pressure as given by other observers also show wide variations from those given by Judson and Nicholson, and for this reason we feel that further studies are necessary definitely to decide the effects concerning the pulse pressure in nephritis in childhood.

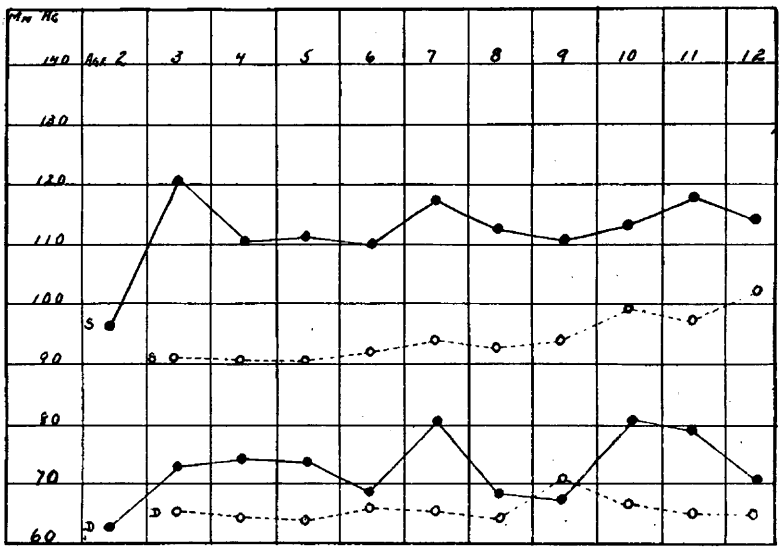

Fig. 1.—Curves showing averages of the blood pressures in ninety-three cases of nephritis compared with the normal figures of Judson and Nicholson. S = systolic; D = diastolic; O—O = normal; ●—● = nephritis.

TABLE 2.—Normal Pulse Pressures Compared to Those of Nephritis

Observers	Age, Years										
	2	3	4	5	6	7	8	9	10	11	12
Normal pulse pressure, Judson and Nicholson...	—	26.2	26.7	26.9	25.3	26.9	28.9	23.3	32.1	31.5	37.1
Nephritic pulse pressure, Berkley and Lee.....	34	47.2	35.1	37.0	30.5	36.5	44.0	44.3	32.2	38.4	42.6
Increase over normal.....	—	21.0	8.4	10.1	5.2	9.6	15.1	21.0	0.1	6.9	5.5

COMPARISON OF THE BLOOD PRESSURES OF CHRONIC AND ACUTE NEPHRITIS

In order to ascertain whether in children chronic nephritis showed higher blood pressures than acute nephritis, we have in Figure 2 compared the average blood pressures of our patients in these two groups. The differences are not sufficient and are too irregular to warrant

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drawing definite conclusions. It would seem that there is no increase in the blood pressure of chronic nephritis over that of acute nephritis in childhood. It is possible, however, that in a larger series some difference might be shown. It was found impossible to study the effect of such factors as severity, type of involvement, or duration of the disease in our cases. The highest systolic pressure among our acute cases was 190 mm. Hg (in a child of 4) and among the chronic cases, 250 mm., the case above reported.

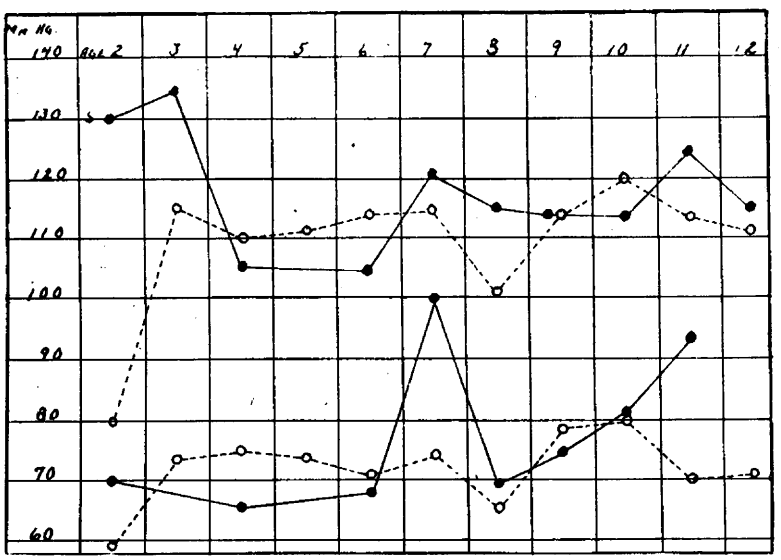

Fig. 2.—Curves comparing the blood pressures of acute nephritis with those of chronic nephritis. S = systolic; D = diastolic; o—o = acute nephritis; ●—● = chronic nephritis.

EDEMA AND BLOOD IN THE URINE WITH RESPECT TO BLOOD PRESSURE

Since Gordon has stated that patients showing the highest blood pressures had comparatively little edema and a large amount of blood in the urine, we reviewed the forty-one cases from records of the Massachusetts General Hospital with these points in view. Thirty-three patients showed a more or less marked edema, while eight showed very little or none. The average blood pressure in those patients having edema was 123.8 mm. Hg. The average systolic blood pressure of those with little or no edema was 112 mm. Hg. Twenty patients with large amounts of blood in the urine had an average systolic blood pressure of 112 mm. Hg, while twenty-one having little or no blood had an average of 126 mm. Hg. In each instance in which the systolic blood pressure has averaged above 150 mm. Hg the urine has been

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found to show but little blood. The degree of edema in our patients having a systolic pressure of 150 mm. or over has been found to vary from "very slight" to "well marked." These results show that there is probably no definite relation between the increase in the blood pressure and the amount of edema present or the amount of blood in the urine, as suggested by Gordon. The amount of blood we believe is relative to the severity of the pathologic process present rather than to an increase in blood pressure. The amount of edema probably varies with the ability of the kidneys to excrete salts.

URINARY FINDINGS COMPARED WITH BLOOD PRESSURE

We have reviewed the urine charts in these same cases to find, if possible, any relation between the increase in blood pressure and the amount of albumin or number of casts in the urine. Blood pressures were also compared with the specific gravity of the urine. So far as we were able to determine, no relation exists between the blood pressure and any of these factors. That the urinary findings bear no relation to the pathology of kidney lesions has been shown by Stark.[20]

SUMMARY

From a study of blood pressure observations in ninety-three cases of nephritis in children between the ages of 2 and 12 years, we may say that

1. The blood pressure is elevated in the nephritis of childhood, and occasionally to a marked degree. This applies to both acute nephritis and chronic nephritis.

2. Systolic and diastolic pressures are not increased to the same degree, the former averaging about 20 mm. Hg, and the latter about 10 mm. above normal.

3. The pulse pressure is increased, but the factor is not constant.

4. The blood pressure in chronic nephritis shows no constant elevation above that of acute nephritis.

5. The blood pressure may, in rare instances, be of prognostic value.

6. No relation has been found to exist between the blood pressure and the urinary findings.

7. Patients having marked edema showed a slightly higher average blood pressure than those with little or none. This difference is not great enough to warrant definite conclusions.

8. Albuminuric retinitis is probably not common even in cases showing a marked increase in blood pressure.

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20. Stark, J. R.: Jour. Lab. and Clin. Med., November, 1916, p. 134.

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