THE LÆVULOSE TOLERANCE OF CONVALESCENT CHILDREN: WITH SPECIAL REFERENCE TO RHEUMATISM.

BY

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The investigations described in this paper were undertaken with the object of providing some answer to the question, 'Is there, in the child of rheumatic diathesis, some constitutional abnormality of hepatic function?'

A considerable amount of literature has been produced in connection with the testing of the function of the liver, and several methods have been devised, but almost all the work has been carried out on adults suffering from severe anatomical and pathological changes in the organ. References to disease in children are few, and confined to severe instances.

Of the tests of hepatic function that of the tolerance to laevulose appears to stand on the firmest footing, and in modified forms has now been in use for many years. In 1901, Strauss considered that the administration of laevulose and its detection in the urine was a test of liver function. But the renal threshold for laevulose is low, and many normal persons pass it in the urine after oral administration. Later observers have employed the more accurate method of estimating the blood sugar after oral ingestion of laevulose: Schirokauer, MacLean and de Wesselow, Spence and Brett, Tallerman, King and others. Rolleston has stated that laevulose is the only sugar which cannot be dealt with elsewhere in the body than in the liver. MacLean and de Wesselow have stated that laevulose is the only sugar which does not cause a rise in blood sugar when taken by healthy persons.

Certain observers have little faith in the test, but there is much concrete evidence that such views are untenable.

Present Investigations.

Nature of Material Investigated. Group I. In order to obtain figures for the effects of laevulose on non-rheumatic children, a number of tests have been made on convalescent or recovered cases of infantile paralysis, tuberculous peritonitis, tuberculous arthritis, bronchiectasis. The paralysis cases were of very long standing, and, except for their deformities could be regarded as healthy children. Certain of the other cases were of an active type, others could be considered quiescent.

Group II. For the rheumatic groups, children of several types have been employed. Classification as follows has been adopted as far as possible:—

(i) Rheumatism without residual heart lesion.
(ii) Rheumatism with residual heart lesion.
(iii) Chorea without residual heart lesion.
(iv) Chorea with residual heart lesion.
Practically all the rheumatic children tested have been of the recovering type, though in a few instances it has been possible to test cases clinically active. In several instances there was definite clinical evidence of relapse, and opportunity was taken of testing during these periods.

Throughout the investigations note has been taken of the clinical condition of the cases at the times of testing and during the intervening periods.

Many of the children have remained under supervision for long periods, some as long as six months, so that it has been possible to perform tests on more than one occasion in the same subject. This fact has elucidated findings which at first sight were confusing.

*The Dosage and Administration of Lævulose.* By preliminary trials it was found that doses of 20 to 30 grm. of lævulose dissolved in 100 c.c.m. of water were sufficient to cause a satisfactory rise in the value of the blood sugar. A drachm of fresh lemon juice was added to the fluid, and the resulting ‘lemonade’ was readily taken by the children. Standard doses of 20, 25, or 30 grm. were given according to the size of the child. Larger doses than 30 grm. were tried for the larger children over 13 years of age, but the results were no better than with the smaller standard dose.

*The Method of Estimating the Blood Sugar.* For blood-sugar estimation, the Hagedorn-Jensen method has been used. The technique is easy of performance, and the quantity of blood used, 0.1 c.c., is readily obtained from small children. (A full account of the method and reagents is given in Cole’s *Practical Biochemistry*, Cambridge University Press.)

*Arrangements for the Test Subjects.* A considerable amount of preparation has been found necessary in order to obtain satisfactory resting values for blood sugar in many of the children. Conditions of equanimity in mind and body are essential if concordant results are to be obtained. The following routine has been adapted:

1. Rest in bed for at least six hours before commencement of test. In bed during test.
2. Abstention from food of any kind for at least five hours before testing and during testing.
3. Enough water for drinking to quench thirst.
4. Books provided for reading, or small toys, etc., to keep child amused.
5. Two or more children undergoing test at the same time. In a small side ward for preference.

*Details of Blood Samples.* As a routine four to six samples of blood have been taken, one before the drinking of the lævulose solution, to give resting blood-sugar value, and the remainder at half-hourly intervals. Blood has been taken by stabbing the skin of the thumb, just above the nail on the dorsal surface, after engorgement by shaking and wrapping a piece of rubber tubing round the base of the thumb. A straight triangular skin needle, carried in the cork of a bottle containing ether for cleaning up the skin, has been found satisfactory. The drops of blood were received into a small porcelain crucible containing a trace of potassium oxalate ground fine to prevent clotting.
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RESULTS OF INVESTIGATIONS.

Brief clinical notes of the thirty-five cases tested are given, the cases being classified into the groups already described. The blood-sugar readings are given in the tables (Tables I—V). In these the dates of the tests have not been given, but where repeated tests were made, the intervals between them have been indicated. The various tests have been carried out in the last two years, as the supply of material availed.

GROUP I. NON-RHEUMATIC CHILDREN (see Table I.)


CASE 8. Eddie P. 9. Recent tuberculous peritonitis. 9 months’ history, moderately severe. Boy looks unwell, very pale. No diarrhoea, good appetite, weight increasing. Abdomen a little resistant and doughy.

One month later, improved. Abdomen quite soft.


GROUP II. RHEUMATIC CASES (see Tables II—V.)

(i) CONVALESCENT ACUTE RHEUMATISM WITHOUT DETECTABLE HEART LESION AT TIME OF TESTING. (See Table II.)


(ii) CONVALESCENT RHEUMATIC CHILDREN, WITH CARDIA: ABNORMALITIES AT THE TIME OF TESTING. (See Table III.)


One month later. Feels well. Rapidly putting on weight. Commencing light physical exercises. The heart sounds are now natural, there is no mitral systolic murmur, and the enlargement has gone.

Three months later. Temperature irregular, after being subnormal since admission. Throat reddened, but not sore, no pains, no joint swellings. Heart impulse forcible, pulse rate increased. Return of mitral systolic murmur.
Two months later. Temperature now regular and subnormal. Cardiac impulse slight and localised. No murmur.


One month later. Clinically improving. A definite mitral presystolic murmur was heard at time of testing, and confirmed at later dates. Temperature irregular.


**Case 15.** Bertha R. 13. Sub-acute rheumatism with endocarditis. First attack of rheumatism at the age of six. Since then has suffered from repeated attacks of growing pains, and joint swellings. Never choreic. On examination:—Tall, pale girl, lips and ears bluish. No respiratory distress. No joint pains at present, but had some a week ago. Tonsils much enlarged. Heart: short, sharp cardiac impulse, localized, slight presystolic thrill. Heart not enlarged. Mitral first sound short, loud, mitral systolic and presystolic murmurs, pulmonary second sound accentuated no murmur, aortic second natural. Liver not enlarged.


Two glucose tolerance tests were carried out on this case one week after each of the laevulose tests respectively. They showed no departure from the type of curve given by a healthy person.

**Case 16.** Annie G. 9+. Endocarditis following measles. 14 months ago, attack of measles. 1 month ago, marked roughening of the first sound in the mitral area. No signs to explain same. No enlargement of the heart. Just before testing, a definite diagnosis of mitral stenosis, with enlargement of the right side of the heart was made. There were no growing pains or other rheumatic phenomena. No enlargement of the liver.

One fortnight later. No apparent change in the clinical condition. After 2½ hours blood sugar reached 0.092%.

Three months later. There has been a definite improvement in the general condition of the child. Gain in weight, no rheumatic manifestations. Heart condition one of established mitral stenosis.

**Case 17.** Alfred W. 12. Severe rheumatism with cardiac lesions. Rheumatism commenced six months ago. Sore throat, pain and swelling of joints. Treated by private doctor who stated that at the time there was no severe heart lesion. When seen at the Out-patients rheumatic clinic, was very pale, with inflamed throat, enlarged tonsils. Back of right hand puffy, no swollen joints. Heart dilated, sounds hurried and loud, double mitral valve lesion, a loud pulmonary systolic murmur, nil abnormal in the aortic sound. He was kept under treatment for just over a month in bed. When examined before testing, the heart was less dilated, double murmurs could be heard over the mitral and aortic regions. The temperature had settled down, but the pulse remained rapid. No pains recently.

One month later. Considerable improvement in the clinical condition. The boy has put on weight, the pulse rate is lower, temperature regular. No pain.

The boy continued to attend Out-patients for a few months after discharge from hospital, and did well, but nine months after these tests were carried out, there was a severe relapse, and the boy died.
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CASE 18. Dorothy E. S. Severe cardiac rheumatism with relapse. A severely ill child, with joint swellings and pains, nodules on the hands and knees, rapid pulse, raised temperature. Heart dilated, pericardial friction, severe lesions of the mitral and aortic valves. Compression of the left base of the lungs, with many moist bronchial sounds. Liver slightly enlarged, palpable 1/2 inch below the costal margin. The child had suffered from recurrent rheumatism for the last two years, and had spent most of her time in bed.

Four blood sugar values were obtained, when it was decided to discontinue testing, as the child's condition was bad.


CASE 20. Stella B. 11. Rheumatic endocarditis. Three months ago, started to have pain in the left side and head, with loss of weight and energy. No joint swellings, but transient pains in the limbs. When first seen at this time, the heart was dilated and there was a loud, rough mitral systolic murmur. On examination:—three months after first seen. Dark, well made girl. No pain or joint lesions. Heart enlarged, with mitral systolic and diastolic murmurs, and loud pulmonary systolic murmur.

Two months later. Great clinical improvement. No signs of active disease. Heart much smaller. Still double mitral murmur. Temperature now steady.

This girl has been watched in Out-patients for the last year. There has been no relapse, and the general condition has been excellent. The heart murmurs have disappeared.


One month later. Child has had an attack of acute tonsillitis. No pains or joint lesions, but the heart dilated and developed a double mitral murmur. Levulose testing was carried out one month after the previous test, and one week after the sore throat had developed.

Three months later. Tonsillectomy one month previous to test. At the time of the test, the heart was not dilated, there was an established double mitral lesion. The electrocardiogram was normal, and the child's clinical condition much improved.

CASE 22. Kathleen K. 11. Rheumatic endocarditis. History scanty. Child had had acute rheumatism about two years ago, was treated at home. On examination:—Well covered girl, no cyanosis, tonsils large, teeth carious. Heart not enlarged, no thrill, a loud mitral systolic murmur, conducted to posterior border of the left axilla.

One month later. Child improving.


CASE 24. John H. 9. Chronic rheumatism with endocarditis. History of growing pains over the last three years. Has been absent from school on many occasions. Easily tired and gets badly out of breath on exertion. On examination:—A well-built boy, who has lost weight. Face and ears cyanosed. Tonsils large and inflamed. Heart not enlarged, sharp impulse, localized. Double mitral murmur, presystolic element well marked. At present is having pains in the legs, with slight swelling of the ankles.

One month later. Still has occasional growing pains in the legs, especially when the weather is damp. The boy is being kept in bed. At 2 hr. 20 min., blood sugar reached 102%.

Boy's term of stay finished and there was no opportunity of retesting at a later date.

enlarged, with loud blowing mitral systolic murmur, conducted into the axilla. Second sound reduplicated.

One month later. The heart is less dilated, the mitral systolic murmur is louder, and the pulmonary second sound is much accentuated.

Three weeks later. The boy had pain and swelling in the right wrist for a week previous to this test. The heart dilated again, and a presystolic murmur appeared. The pulse and temperature were irregular. After 2\frac{1}{2} hrs. the blood sugar was 0.03.

One month later. No further signs of active rheumatism. The presystolic murmur has persisted.

(iii) Cases of Chorea without Heart Lesion (See Table IV).

This is again a small group, and the cases show rather unexpected results. Their behaviour is more like that of the non-rheumatic children, as opposed to the intolerance of the rheumatic and choreic cardiac groups.

Case 25. Edith B. 7\frac{1}{2}. Recent chorea. Eleven years ago commenced with chorea of moderate intensity, affecting the limbs and face. Previously had been quite healthy. On examination:—Small girl, well covered. Slight choreiform movements of the tongue and face still present. No clinical heart lesion.

Case 26. Nellie H. 9. Recent chorea. 12 weeks ago began to have twitchings of left hand, leg and the face. Has been quite healthy. On examination:—Small girl, well covered. Slight choreiform movements of the tongue and face still present. No clinical heart lesion.

Case 27. Ada K. 13. Persistent chorea. The child has suffered from chorea almost persistently for the last twelve months. Movements of the hands and face, to a lesser degree of the legs. There have been occasional growing pains in the legs and feet at various times, but no swelling of the joints. On examination:—A tall, rather thin girl. Movements of hands and face. No pain. Heart not clinically implicated.

Case 28. Eva C. 12. Persistent chorea. The child has suffered from chorea almost persistently for the last six months. Movements of the hands and face, and to a lesser degree of the legs. No clinical heart lesion.

Case 29. Ada K. 13. Persistent chorea. The child has suffered from chorea almost persistently for the last twelve months. Movements of the hands and face, and to a lesser degree of the legs. No clinical heart lesion.

(iv) Cases of Chorea with residual Heart Lesion (see Table V.)

This is a much more extensive group than the foregoing. It has been possible to keep the cases under observation for longer periods. The intolerance to lavelulose is found to agree closely with that of the frank rheumatic group.

Case 30. Ruby W. 7\frac{1}{2}. Chorea with transient heart lesion. Nine months’ history. Recurrent sore throats, with pain and swelling of right knee. In bed for a few days at first, and was kept away from school. Developed choreiform movements a few weeks before admission to institution. On examination:—A well looking, well covered girl. Slight, generalized choreiform movements. Tonsils enlarged and ragged. Heart not enlarged, sounds high-pitched, with a short, soft mitral systolic murmur. Liver not enlarged.

Two months later. The girl has improved greatly. There are no choreiform movements now, and the systolic murmur has disappeared.

Five months later. The condition of the girl continues good. No return of the chorea.

No change in the heart. No light physical exercises.

Case 31. Edith J. 13. Chorea following scarlet fever. 2\frac{1}{2} years ago, scarlet fever. 2 years ago, first attack of chorea, lasting two months. 3 months ago, second attack of chorea of severe intensity. On examination:—Pale, tall, thin girl. Slight choreiform movements of face and upper limbs. Tonsils large and ragged. Heart, impulse forcible and diffuse, sounds loud and booming, with a mitral systolic murmur, and accentuated pulmonary second sound. Liver not enlarged.

A fortnight later. Girl has improved considerably with continuous bed treatment. Very little chorea now. No murmur in the heart, which is much less forcible.

Case 32. Nellie H. Recurrent chorea and mitral disease. Onset of moderately severe chorea one year ago, which has recurred at times since. On examination:—Very slight choreiform movements noticed. Heart not enlarged, but there is a loud mitral systolic murmur, conducted to the axilla.
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This girl has been watched for a year in the Out-patient department, and has had relapses of the chorea, with attacks of growing pains. The heart condition appears to be one of developing mitral stenosis.


One month later. Quite steady, no movements of the arms or face. No pains in the lower limbs. The heart murmur has disappeared, the tone has improved.


One month later. Chorea much less marked. Heart condition unchanged.

DISCUSSION.

Lævulose tolerance tests have been performed on 35 children, 9 cases being controls, 4 cases of simple chorea, 22 of rheumatism or chorea with signs of heart involvement. In addition to the children described in this paper similar tests have been performed on some 30 other children suffering from rheumatism, whose blood-sugar curves show the same results and have been omitted for sake of brevity.

Group I. Considering first the non-rheumatic control children, cases of old-standing infantile paralysis were chosen as controls since they showed no signs of disease except their residual deformities. In two of the cases there was no rise in the blood sugar; in one, a child of unstable blood sugar, there was a rise of 0-019 grm. per cent.

One case of tuberculosis of the knee, apparently quiescent, showed a rise of 0-005 grm. per cent. One case of quiescent abdominal tuberculosis showed a rise of 0-003 grm. per cent. A similar case, but showing signs of active disease, showed a rise of 0-022 grm. per cent.; one month later when the condition had much improved there was a rise of only 0-001 grm. per cent. One case of tuberculosis of the wrist, healed at time of examination showed a rise of 0-036 grm.

One case of active bronchiectasis showed a rise of only 0-005 grm., and a quiescent case showed no rise, but a drop, in the value.

In testing the cases with bronchiectasis and tuberculosis it was thought that a long continued infective process might have shown itself in some failure of liver function, but the only case to show any such evidence was one in which the tuberculous process could be taken as active.

It was also thought probable in the bronchiectasis cases that the venous stasis which was very marked in the hands and toes might be demonstrable in the liver, but there are no evidences of ill-effects on sugar function.

Group II. Considering secondly the cases of chorea and rheumatism, there is a sharp line of demarcation into two groups, those of simple chorea, and those of rheumatism with or without heart involvement and of chorea with heart involvement.
Simple chorea. Two of the cases with a recent history and active at the time of examination showed only 0·004 and 0·003 grm. per cent. rise in sugar value. Two very persistent cases showed rises of 0·009 and 0·021 grm. respectively. The latter case has been watched in out-patients for nearly two years and still suffers from twitching of a marked degree.

Rheumatism with and without heart involvement and chorea with heart involvement. This group, which comprises the largest in the series, differs from the earlier classification into four groups, owing to the similar results found in rheumatism, simple and complicated, and chorea with heart disease. In many of the children tested there was found a definite intolerance to laevulose. Certain of the cases have been followed for several months, and there was found a diminishing of the intolerance as clinical improvement took place. The intolerance did not follow the severity of the heart affection in respect of the valvular lesion, but seemed to bear a relationship to the dilatation and state of tone of the muscle. Thus a heart which was toxic and recovering from a recent bout of disease was associated with a much more marked intolerance to laevulose, and the same statement applied to a child recovering from recent rheumatism without clinical evidence of heart affection. Similarly, a child recovering from chorea with a residual heart lesion showed a more marked intolerance than one who could be regarded as quiescent.

There were in the cases tested no instances of jaundice, and in two cases only was there clinical evidence of enlargement of the liver, namely, Cases 18 and 25, both children showing intolerance. Three cases were examined during a relapse of rheumatism, namely, Cases 12, 24 and 25, and curves showing a return to a state of improved tolerance obtained. Case 18 was examined during a very severe relapse, and died three weeks after the test.

Two cases of rheumatism without detectable cardiac lesion were tested. In both there was a considerable rise in the sugar value, 0·036 and 0·085 grm. per cent.; here the rheumatic attack had been recent.

Turning to the cases of rheumatism with cardiac lesion, it is found that there is considerable variation in the rise of the blood sugar. In the more recent cases a rise of as much as 0·096 grm. per cent. (Case 19) was recorded though figures below 0·06 grm. per cent. were more usual. In cases watched over a period of several months it was found that there is a progressive fall in the intolerance, e.g., Case 12, who showed an increased intolerance during a slight relapse and a return to a flat curve later (Cases 15 and 20), as the clinical condition improved.

When there was clinical evidence of quiescence of the rheumatic process the children showed very little or no rise in blood sugar value after a dose of laevulose which previously caused an appreciable rise in that value, e.g., Cases 12, 16, 20 and 21. It will also be noted that the curve tended to be higher in those cases who had previously shown a number of relapses.

Cases of chorea with heart signs were closely comparable with those of rheumatism with similar heart condition, though the rise in the blood sugar was generally not so marked, rarely exceeding 0·03 grm. per cent. The same tendency to a return of a flat type curve was shown.
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The time of the maximum value of the blood sugar was shown to vary in the different cases and in the same case. The most common time for the maximum to occur was at the end of the first hour, but a proportion of the cases were later, at the hour and a half. In some of the more severe cases there was a prolongation of the curve beyond two hours before return to the normal value. A possible explanation of this delay may perhaps lie in an inability of the intestine to absorb levulose at the usual rate, or perhaps to a state of increasing saturation of a liver unable to deal with levulose in quantity.

Very different figures have been given for rise of blood-sugar values which may be taken as showing hepatic intolerance to levulose. Certain observers state that there should be no rise in value in the normal person, Maclean and de Wesselow. Tallerman gives a value of 30 mgrm. in his paper. Brown in her recent paper gives a value of 30 mgrm. It is interesting to note that she quotes three cases of acute convalescent rheumatism in this paper with rises of 0-012, 0-022, and 0-027 grm. per cent. None of these cases had a heart lesion. Taking into consideration the figures for normal children and quiescent rheumatism given for the cases described in this paper, a value of 20 mgrm. rise more than covers the range.

In fact, with the exception of the cases of simple chorea given above, there would appear to be no intolerance to levulose in those children who could be classed as well. When, however, the rheumatic process is active from a clinical standpoint, or when the child is recovering from a phase of rheumatic activity, there is intolerance to a greater or lesser degree.

Why the tolerance to levulose should be upset in the rheumatic child, and should return to normal when the disease process is quiescent, are questions difficult to answer. The effects do not appear to be due to alimentary disturbance, as all the children were on a good diet, and there was no evidence of alimentary derangement. The question of tonsillar sepsis and enlargement appears to have some bearing on the subject, as most of the cases have had large and inflamed tonsils, though intolerance has been found in some cases whose tonsils have been removed. The suggestion is put forward for what it is worth, that the levulose intolerance is due to toxic absorption from the tonsils, the heart, or other nidus of rheumatic infection.

Summary.

1. Details are given of levulose tolerance tests carried out on healthy control children, and on cases of active disease, especially rheumatism.
2. Figures are given to show that in the healthy child, the child suffering from simple chorea and the child who has recovered from rheumatism, administration of levulose has little or no effect on the blood sugar.
3. In the child with active rheumatism, with or without heart affection, and in the child with chorea and heart affection, there is an appreciable intolerance to levulose.
4. The suggestion is made that intolerance to levulose is due to toxic absorption from some focus of rheumatic infection.
The thanks of the writer are due to Dr. A. Dingwall Fordyce for his interest in this work, to the Committees of the Childrens' Convalescent Home, West Kirby, and of the Royal Liverpool Childrens' Hospital, Heswall, for their grants of apparatus and materials, and to the Merseyside Committee for Rheumatism for a financial grant.

REFERENCES.

TABLE I. LEVULOSE TEST: CONVALESCENT NON-RHEUMATIC CHILDREN.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Clinical Notes.</th>
<th>Levulose.</th>
<th>Percentage of Sugar in the Blood.</th>
<th>Levulose.</th>
<th>%</th>
<th>1/2</th>
<th>1</th>
<th>1 1/2</th>
<th>2</th>
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<td>1</td>
<td>Inf. Paralysis (old)</td>
<td>25 Grm.</td>
<td>106</td>
<td>-079</td>
<td>-088</td>
<td>-088</td>
<td>-088</td>
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<td>25 Grm.</td>
<td>088</td>
<td>-079</td>
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<td>-088</td>
<td>-079</td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>Tub. arthritis (quiescent)</td>
<td>30 Grm.</td>
<td>135</td>
<td>-121</td>
<td>-135</td>
<td>-119</td>
<td>-116</td>
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<td>4</td>
<td>Bronchiectasis &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot; &quot;</td>
<td>30 Grm.</td>
<td>095</td>
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<td>-083</td>
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<td>5</td>
<td>Tub. peritonitis (healed)</td>
<td>25 Grm.</td>
<td>097</td>
<td>-102</td>
<td>-093</td>
<td>-097</td>
<td>-093</td>
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<tr>
<td>6</td>
<td>&quot; &quot; 1 month later (improved)</td>
<td>25 Grm.</td>
<td>106</td>
<td>-106</td>
<td>-107</td>
<td>-102</td>
<td>-097</td>
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TABLE II. LEVULOSE TEST: CONVALESCENT RHEUMATIC CHILDREN, WITHOUT HEART LESION.

<table>
<thead>
<tr>
<th>Case No.</th>
<th>Clinical Notes.</th>
<th>Levulose.</th>
<th>Percentage of Sugar in the Blood.</th>
<th>Levulose.</th>
<th>%</th>
<th>1/2</th>
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<th>1 1/2</th>
<th>2</th>
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<tr>
<td>10</td>
<td>Ac. rheumatism (convalescent)</td>
<td>25 Grm.</td>
<td>115</td>
<td>146</td>
<td>146</td>
<td>141</td>
<td>123</td>
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<td>25 Grm.</td>
<td>115</td>
<td>200</td>
<td>196</td>
<td>164</td>
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TABLE III. LEVULOSE TEST: CONVALESCENT RHEUMATIC CHILDREN, WITH HEART AFFECTION.

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<tr>
<th>Case No.</th>
<th>Clinical Notes.</th>
<th>Levulose.</th>
<th>Percentage of Sugar in the Blood.</th>
<th>Levulose.</th>
<th>%</th>
<th>1/2</th>
<th>1</th>
<th>1 1/2</th>
<th>2</th>
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<td>12</td>
<td>Rheumatism with transient ht. dis.</td>
<td>30 Grm.</td>
<td>120</td>
<td>123</td>
<td>153</td>
<td>102</td>
<td>107</td>
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<tr>
<td>13</td>
<td>Rheumatism with persistent ht. dis.</td>
<td>30 Grm.</td>
<td>088</td>
<td>084</td>
<td>092</td>
<td>090</td>
<td>093</td>
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<td>Sub-ac. rheum. with endocarditis</td>
<td>30 Grm.</td>
<td>123</td>
<td>097</td>
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<td>15</td>
<td>Endocarditis following measles</td>
<td>25 Grm.</td>
<td>093</td>
<td>099</td>
<td>099</td>
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<tr>
<td>16</td>
<td>Ac. rheum. with transient ht. dis.</td>
<td>25 Grm.</td>
<td>102</td>
<td>113</td>
<td>115</td>
<td>106</td>
<td>106</td>
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<tr>
<td>17</td>
<td>Severe rheum. with heart dis.</td>
<td>30 Grm.</td>
<td>088</td>
<td>100</td>
<td>120</td>
<td>102</td>
<td>093</td>
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<td></td>
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<tr>
<td>18</td>
<td>Severe cardiac rheumatism</td>
<td>25 Grm.</td>
<td>106</td>
<td>111</td>
<td>115</td>
<td>106</td>
<td>106</td>
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<tr>
<td>19</td>
<td>Recurrent rheum. with heart lesion</td>
<td>30 Grm.</td>
<td>099</td>
<td>138</td>
<td>145</td>
<td>169</td>
<td>157</td>
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<tr>
<td>20</td>
<td>Rheumatic endocarditis</td>
<td>30 Grm.</td>
<td>115</td>
<td>115</td>
<td>127</td>
<td>128</td>
<td>159</td>
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<tr>
<td>21</td>
<td>Ac. rheum. with endocarditis</td>
<td>25 Grm.</td>
<td>099</td>
<td>113</td>
<td>127</td>
<td>092</td>
<td>088</td>
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<td></td>
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<tr>
<td>22</td>
<td>Rheumatic endocarditis</td>
<td>25 Grm.</td>
<td>097</td>
<td>100</td>
<td>109</td>
<td>097</td>
<td>088</td>
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<tr>
<td>23</td>
<td>Rheumatic endocarditis</td>
<td>25 Grm.</td>
<td>107</td>
<td>118</td>
<td>127</td>
<td>127</td>
<td>095</td>
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<td></td>
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<tr>
<td>24</td>
<td>Chr. rheum. with endocarditis</td>
<td>25 Grm.</td>
<td>115</td>
<td>118</td>
<td>120</td>
<td>105</td>
<td>099</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>Chr. rheum. with endocarditis</td>
<td>25 Grm.</td>
<td>106</td>
<td>113</td>
<td>120</td>
<td>103</td>
<td>109</td>
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</table>
TABLE IV. LEVULOSE TEST: CHOREIC CHILDREN, WITHOUT HEART LESION.

<table>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Grm.</td>
<td>Fast-ing.</td>
</tr>
<tr>
<td>26</td>
<td>Recent chorea</td>
<td>20</td>
<td>0.086</td>
</tr>
<tr>
<td>27</td>
<td></td>
<td>25</td>
<td>0.084</td>
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<tr>
<td>28</td>
<td>Persistent chorea</td>
<td>30</td>
<td>0.094</td>
</tr>
<tr>
<td>29</td>
<td></td>
<td>30</td>
<td>0.088</td>
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</tbody>
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TABLE V. LEVULOSE TEST: CHOREIC CHILDREN, WITH HEART AFFECTION.

<table>
<thead>
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<tbody>
<tr>
<td></td>
<td></td>
<td>Grm.</td>
<td>Fast-ing.</td>
</tr>
<tr>
<td>30</td>
<td>Chorea with transient ht. dis.</td>
<td>30</td>
<td>0.109</td>
</tr>
<tr>
<td>31</td>
<td>Chorea following sc. fever</td>
<td>30</td>
<td>0.088</td>
</tr>
<tr>
<td>32</td>
<td>Recurrent chorea with endocarditis</td>
<td>30</td>
<td>0.097</td>
</tr>
<tr>
<td>33</td>
<td>Chorea with rheum. pains</td>
<td>30</td>
<td>0.106</td>
</tr>
<tr>
<td>34</td>
<td>Ac. chorea with rheumatism</td>
<td>25</td>
<td>0.093</td>
</tr>
<tr>
<td>35</td>
<td>Chorea and endocarditis</td>
<td>30</td>
<td>0.145</td>
</tr>
<tr>
<td></td>
<td>1 month later (improved)</td>
<td>30</td>
<td>0.099</td>
</tr>
</tbody>
</table>