

### SERUM PROTEINS IN KWASHIORKOR

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Although it is now generally accepted that kwashiorkor is a protein-deficiency disease, certain aspects of the condition which have so far not been studied appeared worthy of investigation. Among these aspects are:

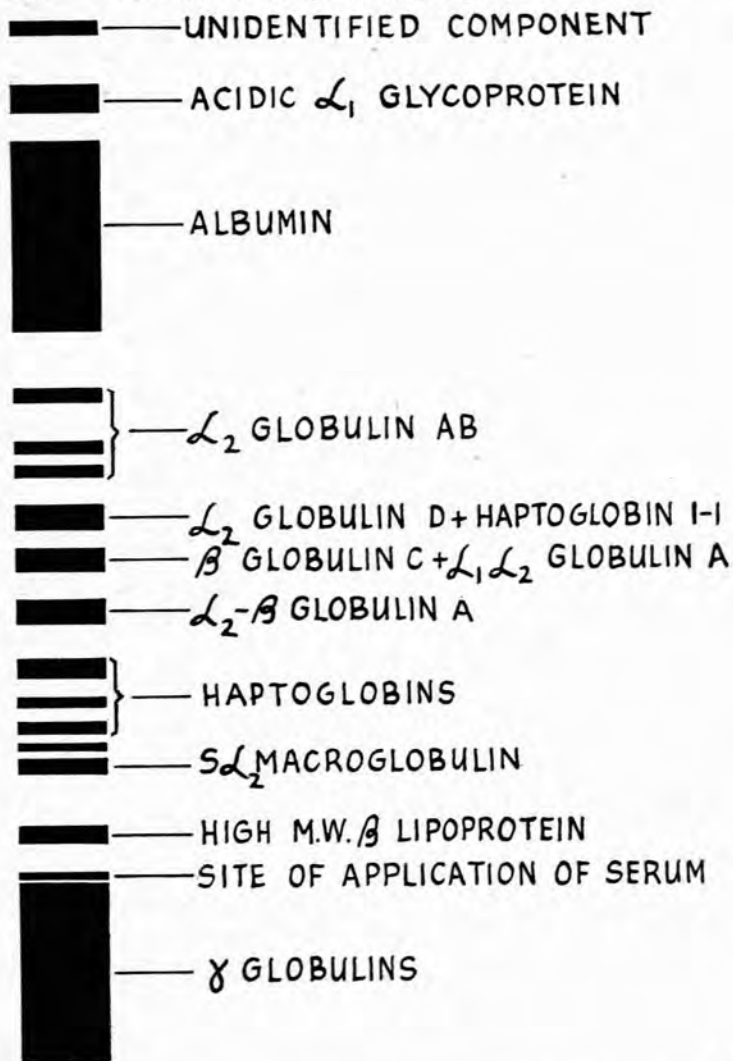
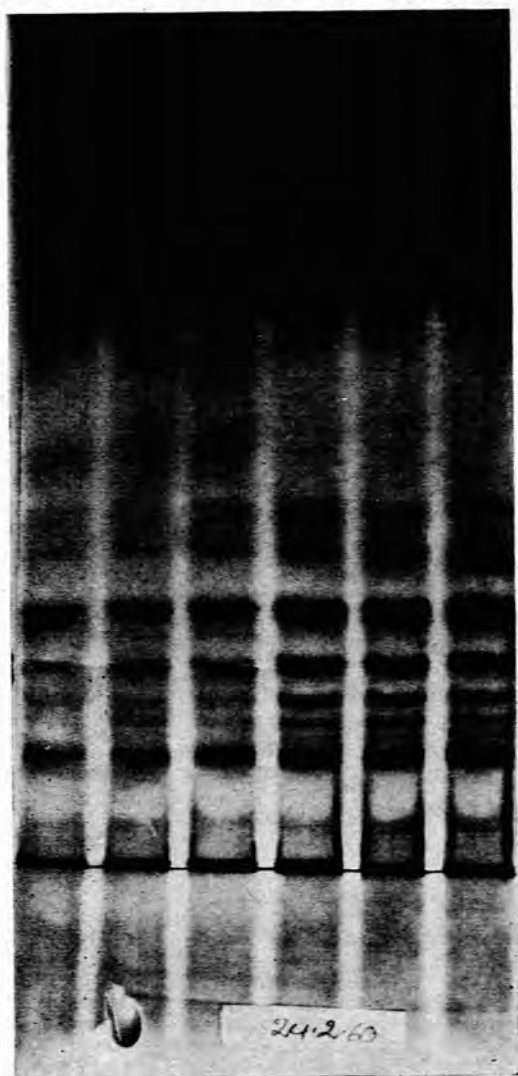
1. The detailed pattern of the serum proteins in kwashiorkor as portrayed by starch-gel electrophoresis.

2. The day-to-day changes in pattern observed during relapse and recovery.

3. The proteins of the interstitial oedema fluid.

4. The relationships, if discernible, between these biochemical observations and the clinical picture.

An account is given of the results of investigations along these lines in this preliminary report.



1 2 3 4 5 6 (DAYS FOLLOWING ADMISSION) 1

Fig. 1. Serum proteins in the first 6 days of treatment illustrating, in this case, a rapid increase in the concentration of the haptoglobin fractions.

## METHODS

Eleven children suffering from kwashiorkor were studied. Treatment was as follows: Each child was given half-strength Darrow's solution and 2.5% glucose by mouth for 24 hours, followed by  $\frac{1}{2}$ -cream skimmed milk for 2 days and full cream for another 2 days; 2.5 oz. of each of these foods being given daily per lb. of body weight. A mixed diet was given from the 10th day. Vitamins and potassium supplements were added and broad-spectrum antibiotics administered to control infection. Cortisone was given to 2 children to counteract a state of collapse.

Blood was collected from the 11 subjects in tubes either from finger or heel pricks. The serum was separated immediately and stored at 4°C until it could be studied. Sera were examined spectroscopically for evidence of haemolysis. Grossly haemolysed sera were discarded; those containing traces only of haemoglobin were examined, the extent of haemolysis being recorded.

In 2 cases oedema fluid was collected from the foot for investigation. Sera were collected daily, or sometimes specimens were obtained on alternate days. Total serum proteins were measured by the standard biuret procedure, and the detailed fractional distribution of the proteins was examined by vertical starch-gel electrophoresis.<sup>1</sup>

## RESULTS

*Serum Proteins*

The concentration of total proteins on admission ranged between 2.76 and 4.15 g. with a mean value of 3.58 g. per 100 ml. The albumin varied between 1.0 and 1.98 g. with a mean value of 1.57 g. per 100 ml.

The electrophoretic pattern on admission showed that some fractions were little depleted even at the gravest stage of the illness. These were the  $\gamma$  globulins,  $\alpha_1$  acidic glycoprotein,  $\alpha_2$  globulin AB, and the S  $\alpha_2$  macromolecular globulin.

Recovery changes were evident in the appearance of bands not initially present or by an increase in intensity of a band. Alterations of this nature appeared as early as the 3rd day after admission, more usually from the 5th to the 7th day, but in one child they were delayed until the 10th day.

The sequence of changes in the serum-protein pattern was variable:

1. In 2 cases the earliest increase was apparent in serum albumin closely followed by  $\beta$  globulin C.

2. In some haptoglobins appeared first followed by  $\beta$  globulin C and serum albumin (Fig. 1).

3. In others,  $\beta$  globulin C was the first to appear.

4. In 1 case the haptoglobins were still not normal 8 weeks after admission.

5. Bands appeared suddenly in some cases whilst in others a transient appearance of a band might precede by some days the return to an established normal pattern.

It is clear that there is no consistent sequence by which the various serum proteins reappear.

*Proteins of Oedema Fluid*

Oedema fluid collected from 2 cases on 3 separate occasions was found to have a total protein varying between 0.46 and 0.5 g. per 100 ml. Electrophoretic separation showed that most of the protein was albumin. Loss of weight associated with disappearance of oedema in 1 child indicated that the oedema fluid present weighed 5 lb.; the total protein contained in the oedema fluid must therefore have been approximately 12 g. The return of even part of this protein into the circulating blood could have an appreciable effect on the recovery pattern of the serum proteins, a factor until now apparently not recognized.

## CORRELATION OF BIOCHEMICAL WITH CLINICAL OBSERVATIONS

1. Clinical signs of recovery were invariably accompanied by improvement in the electrophoretic pattern detailed above. However, in some cases, despite a trend towards normal in the pattern, death ensued.

2. Children assessed as being mildly affected, because they could stand or walk, recovered more rapidly both clinically and also biochemically (as judged by the concentrations of various proteins present in the serum) than those children with severe muscular wasting and weakness.

3. Some infections were associated with a delayed recovery of the serum-protein pattern, but in 1 child the pattern continued to improve during a fever and a herpes simplex infection.

4. No particular pattern was associated with pellagroid skin changes.

5. The clinical outcome could not be foretold from a knowledge of the initial degree of depletion of serum albumin. The child in this series with the lowest serum albumin (1.0 g. per 100 ml.) recovered, whilst 3 others, in whom the initial serum-albumin concentration was higher, died.

## REFERENCE

1. Smithies, O. (1959): *Biochem. J.*, **71**, 585.