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# Pulmonary Changes in Acute Glomerulonephritis of Children

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Association of chronic nephritis with pulmonary oedema in uraemic adults has long been known and is termed in literature fluid lung, uraemic lung or uraemic pneumonia [1]. Acute glomerulonephritis of children may likewise be accompanied by pulmonary manifestations, e.g. atelectasis, infiltration, interlobar and parietal fluid effusions. Such changes are usually of small extent, and occur mostly around the hilum or in the area of the lower and middle lobe.

Pulmonary changes of this kind have been observed in this department for a number of years with a view to collecting data that would throw light on their pathogenesis.

A total of 92 children suffering from acute glomerulonephritis with ages between 2 and 15 years have been treated in the four years of this study. Table I shows the distribution of the material according to age and to radiologically positive and negative cases.

As seen in Table I, 26 patients of a total of 92 displayed X-ray changes. Two of the 4 children under the age of 3 years exhibited pulmonary changes, but this incidence is disregarded on account of the small number of cases.

TABLE I

| Age (yrs) | X-ray positive | X-ray negative | Percentage of positive cases |
|---|---|---|---|
| Under 3 ..... | 2 | 2 | 50 |
| 3— 6 ..... | 8 | 17 | 32 |
| 6—10 ..... | 10 | 25 | 29 |
| 10—15 ..... | 6 | 22 | 21 |
| Total ..... | 26 | 66 | 28 |

The frequency of pulmonary affection was about equal in the age groups 3 to 6 and 6 to 10 years, and became less in the higher age groups. Thus, although with different frequencies, radiologically demonstrable pulmonary disorders occurred in all age groups.

Table II shows the distribution of the material according to the NPN level.

TABLE II

| NPN, mg per 100 ml | X-ray positive | X-ray negative | Percentage of positive cases |
|---|---|---|---|
| 20—40 ..... | 15 | 54 | 22 |
| 40—60 ..... | 8 | 8 | 50 |
| 60—100 ..... | 2 | 3 | 40 |
| Above 100 .. | 1 | 1 | 50 |
| Total ..... | 26 | 66 | 28 |

As is evident from Table II, pulmonary changes were registered even in those cases in which the NPN level was within the normal limits of 20 and 40 mg per 100 ml, while the incidence of positive cases rose to double when the NPN value was above normal.

Correlations between pulmonary changes and systolic, diastolic and venous pressures are shown in Tables III, IV and V.

TABLE III

| Systolic blood pressure, mm Hg | X-ray positive | X-ray negative | Percentage of positive cases |
|---|---|---|---|
| Under 100 ... | — | 2 | — |
| 100—130 .... | 10 | 42 | 31 |
| Above 130 ... | 16 | 22 | 42 |
| Total ..... | 26 | 66 | 28 |

TABLE IV

| Diastolic blood pressure, mm Hg | X-ray positive | X-ray negative | Percentage of positive cases |
|---|---|---|---|
| Under 70 ..... | — | 6 | — |
| 70—90 ..... | 7 | 30 | 19 |
| Above 90 ..... | 19 | 30 | 39 |
| Total ..... | 28 | 66 | 28 |

TABLE V

| Venous pressure, mm $H_2O$ | X-ray positive | X-ray negative | Percentage of positive cases |
|---|---|---|---|
| Under 60 ..... | — | — | — |
| 60—100 ..... | 3 | 11 | 21 |
| Above 100 .... | 12 | 13 | 48 |
| Total ..... | 15 | 24 | 38 |

The number of radiologically positive cases was quite considerable even at normal systolic pressure, but their frequency was highest at pressures above 130 mm Hg. Only two patients had a systolic pressure below 100 mm Hg, but both belonged to the radiologically negative group.

The connexion between pulmonary affection and diastolic pressure was more pronounced; 6 children showed values below 70 mm Hg, and all were radiologically negative. At diastolic pressures exceeding 90 mm Hg, the number of X-ray positive cases was higher than in the normal group, although the number of negative children was equal in both groups.

It was not possible to determine venous pressure in all cases. Its normal value is, according to NÁDAS [6], 40 mm $H_2O$ between 3 and 5 years, and 58 mm $H_2O$ between 5 and 10 years of age. In the present material there was no case with a normal venous pressure. Slightly increased venous pressure was accompanied by X-ray positivity in 3 cases only, while the incidence was about 50 per cent at venous pressures exceeding 100 mm $H_2O$.

Correlations between X-ray positive pulmonary changes and clinically demonstrable oedema are shown in Table VI.

TABLE VI

| | Oedematous | | Non-oedematous | |
|---|---|---|---|---|
| | X-ray positive | X-ray negative | X-ray positive | X-ray negative |
| Number of cases | 23 | 26 | 3 | 36 |

Local or generalized oedema was present in 49 children; 23 of these displayed pulmonary symptoms, whereas only 3 of the non-oedematous 39 patients were X-ray positive.

The difference between the body weight at admission and that which had become stable after the onset of diuresis was considered to indicate the degree of oedema.

TABLE VII

| Loss of weight (kg) | X-ray positive | X-ray negative | Percentage of positive cases |
|---|---|---|---|
| Under 1 ..... | 2 | 30 | 6 |
| 1—2 ..... | 9 | 20 | 31 |
| 2—3 ..... | 8 | 13 | 38 |
| Above 3 ..... | 7 | 3 | 70 |
| Total ..... | 26 | 66 | 28 |

It follows from Table VII that the incidence of pulmonary changes was proportional to the degree of oedema, and depended on the length of time elapsed since the appearance of symptoms.

TABLE VIII

| Length of time from onset of disease to examination (days) | X-ray positive | X-ray negative | Percentage of positive cases |
|---|---|---|---|
| Under 3 ..... | 20 | 31 | 35 |
| 3—7 ..... | 6 | 20 | 23 |
| Above 7 ..... | — | 15 | — |

Pulmonary processes were registered in the first week only. None of the 15 patients who had been admitted more than seven days after onset of the disease displayed pulmonary lesions. Where such changes were demonstrated, they disappeared spontaneously after a few days.

Two X-ray pictures are presented. In Fig. 1, a fairly extensive patchy infiltration can be seen beside enlarged hila, on the right side in particular. The left heart is enlarged. In Fig. 2, a pleural fluid collection with a horizontal level above the right dia-

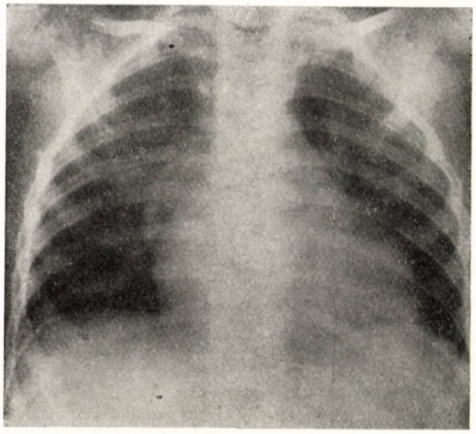

FIG. 1

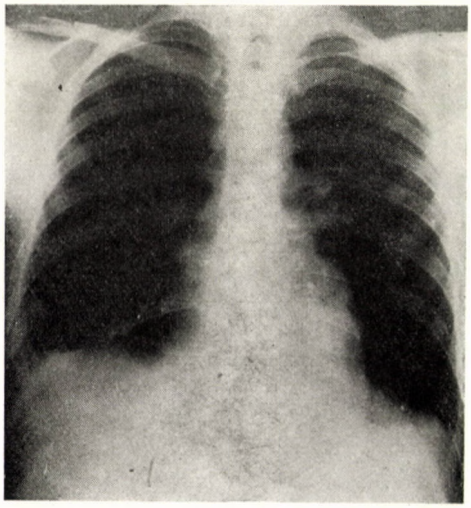

FIG. 2

phragm is visible. Neither of the two sinuses is free. This symptom disappeared after two days.

No connexion was observed between pulmonary changes on the one hand, and erythrocyte count, serum electrolyte levels and ESR, on the other.

Radiograms revealed pulmonary changes only at the first onset of the disease, and in none of the 8 cases of relapse.

## Discussion

The observed pulmonary changes were presumably due to oedema. If the alveoli are filled with oedematous fluid, this appears in the form of infiltration; if the fluid accumulates in the interstitial spaces and invades the bronchioles, the picture is one of atelectasis, whereas an interlobar or pleural effusion is seen if the oedema fluid gains access to the pleural cavity. All these phenomena disappear after a few days, a fact indicative of their non-infectious character. Were they of infectious origin, they would take a longer time to disappear and even necessitate antibiotic therapy.

To explain the pulmonary changes, numerous theories have been put forward such as a high blood pressure, hypertrophy and failure of the left ventricle, increased pulmonary capillary pressure, increased capillary permeability due to the uraemia, etc., in other words, most authors accepted Starling's explanation of the mechanism involved.

According to earlier notions, pulmonary oedema was due to the high NPN level [1, 2, 3, 4, 7, 8]. Such theories were due to that in adults the frequency of pulmonary complications is high in connexion with chronic nephritis. However, such pulmonary processes are of a chronic character, as repeatedly demonstrated at necropsy. Although our observations revealed a certain connexion between the NPN level and the incidence of pulmonary complications, X-rays were often positive at normal or slightly increased NPN values [5]. As has repeatedly been mentioned, the observed pulmonary changes disappeared rapidly.

The connexion between pulmonary complication and blood pressure — especially diastolic and venous pressure — was more pronounced. X-rays were invariably negative with normal diastolic pressure; positive cases were encountered only at elevated values [5]. Venous tension was always above normal so that the increase in the pressure of the venous portion of Starling's mechanism was certainly involved in the arisal of oedema.

Rubin and Rapoport [9] claimed that the heart was often affected in acute glomerulonephritis. In fact, the left heart was enlarged in all oedematous children with positive X-rays. In none of the cases were, however, pathological ECG changes observed; occasional low voltage was due to oedema. The requirements of Starling's mechanism were undoubtedly satisfied in all the X-ray positive cases, and the development of pulmonary processes seemed to go hand in hand with that of the oedema. Pul-

monary symptoms subsided before the disappearance of oedema; it often preceded or was synchronous with the onset of diuresis.

The observed pulmonary changes were benign and had no prognostic significance; none of the 92 patients was lost.


## Summary

In 26 of a total of 92 cases of acute glomerulonephritis, X-rays revealed pulmonary changes. These appeared at the very onset of the renal disease, usually together with other oedematous manifestations, presumably as a part of these phenomena. Pulmonary processes subsided in a few days; their disappearance preceded the onset of diuresis and the relief of oedema. This and the fact that no pulmonary process was demonstrable by X-rays after the 7th day from the onset of the primary disease, shows that they were not due to infection.

A close connexion was observed between the pulmonary changes and diastolic and venous pressure. Pulmonary affection was not present in any of the cases with a normal blood pressure, while the incidence of pulmonary complications grew in accordance with the elevation of blood pressure. X-rays showed an enlargement of the left heart in all oedematous cases. ECG records were normal throughout.

Pulmonary processes of the observed nature have no prognostic significance.


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