

PYELONEPHRITIS
IN INFANCY AND CHILDHOOD

by

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SECTION I.

INTRODUCTION.

I. I N T R O D U C T I O N.

Pyuria in children is indicative of some acute inflammatory condition in the genito-urinary tract, and to this the term "pyelitis" is often applied. This term implies that the inflammatory lesion is limited to the pelvis of the kidney, but in the present investigation, it has been found that it was only exceptionally that the pelvis of the kidney alone was involved. The more common lesion consisted of inflammatory foci in the substance of the kidneys, with often signs of inflammatory mischief in the pelvis. Thus the term "pyelonephritis" more accurately describes the lesion found in the kidneys in the great majority of cases of pyuria in children. Other investigators have made observations similar to ours in this respect, and prefer the term "pyelonephritis" rather than "pyelitis".

A. SURVEY OF LITERATURE.

Thomson and McDonald (1909) reported 25 cases of pyuria which they classify according to the severity of the symptoms and the urinary findings into 4 types:- simple bacilluria,

cystitis, pyelitis and suppurative nephritis. Only 2 of these cases, both male children aged 3 and 7 months respectively, came to autopsy, and on histological examination areas of mononuclear infiltration were found in the interstitial tissue of the kidneys and beneath the pelvic mucosa. The tubules were filled with polymorphonuclears and desquamated epithelial cells, and in both cases coliform bacilli were seen in these lesions. West (1909) described a case of pyuria in a girl aged 10 months in whom the kidneys showed at autopsy a suppurative nephritis. The mucosa of the pelvis was rough and congested. Thiemich (1910) examined post mortem 7 children (4 females and 3 males) all under 8 months old who had suffered from pyuria. He observed abscesses in the cortex of both kidneys in 6 cases and in only one of these was there inflammation of the mucous membrane of the pelvis. The seventh case, a girl of 7 months, had a pure cystitis with no change in the kidney substance or pelvis. This author was of the opinion that organisms, of which he does not state the type, having reached the glomeruli from the blood stream, passed through them without producing any lesion but some were retained in the tubules where they caused inflammation. Jeffreys (1910-11), in a series of 60 children aged from

4 months to 11 years (53 females and 7 males), found that in 7 cases occurring in the first year of life the sex incidence was almost equal (4 females and 3 males). He noted that in 12 subjects the right kidney alone was involved, and in 3 the left. At necropsy in 6 cases the substance of the kidneys showed mottled areas and infarcts. In only 3 was there dilatation of the pelves and ureters, and in 4 slight hypertrophy of the bladder. Borrmann-Bremen (1913), in his investigation of pyelonephritis, described small areas of acute inflammation scattered through the kidney substance. He was of the opinion that these lesions might go on to abscess formation with involvement of the whole kidney or heal with the formation of scar tissue. One female infant, aged 8 months, had small depressed areas composed of fibrous tissue irregularly distributed throughout the cortex of one kidney; the other kidney was normal. Kowitz (1915), in a series of 40 children (23 females and 17 males) all under 9 months old, found lesions in the kidney substance at autopsy in most cases and very rarely inflammation of the pelves or bladder.

Cabot and Crabtree (1916)^(a) reported a case of pyuria in a girl of 15 years from whom the right kidney was removed at operation, with favourable results. The history of pyuria

dated from infancy and histological examination of the excised kidney showed areas of round-celled infiltration and slight fibrosis in the interstitial tissue. The glomeruli were normal but the tubules showed some desquamation of epithelium and polymorphonuclear cells were present in the lumina. The pelvis and ureter showed signs of inflammation and a few coliform bacilli were seen in the pelvic epithelium. In another child aged 4 months with pyuria of 3 weeks' duration the kidney substance post mortem showed only some tubular degeneration. In the pelvis there was polymorphonuclear infiltration of the submucosa and a few coliform bacilli were seen amongst the lining epithelial cells. Helmholtz (1921) cut serial sections through the pelves in cases of clinical pyelitis without being able to discover any inflammatory lesion.

In a series of cases of pyelonephritis, Chown (1927) found multiple foci of suppurative interstitial nephritis, with occasionally pyelitis and rarely cystitis. Involvement of the renal parenchyma was considered to be secondary to the interstitial suppuration. Mononuclear and polymorphonuclear cells were found in the interstitial tissue with degeneration and necrosis of the kidney substance.

Multiple suppurative foci in the interstitial tissue of the kidneys, varying from small areas of round-celled infiltration to definite abscesses were observed at autopsy by Wilson and Schloss (1929) in a series of 49 children, all of whom were under 3 years of age. In only 2 was there a definite inflammation of the pelvic mucosa, but in 7, minute areas of round-celled infiltration were found in the sub-epithelial tissue of the pelves and this, they considered, had probably no relation to the cause of the pyuria, as in all 7 cases there were definite lesions in the kidney substance.

Gregory (1929) reported 15 cases of pyelonephritis, 3 of which were fatal. Two of these came to autopsy and on examination of the kidneys multiple abscesses, chiefly in the cortex, were found in both, with very little change in the pelves or bladder. Campbell (1929) found, in a series of chronic cases of pyuria in infancy and childhood, a marked suppuration in the renal parenchyma with very little naked-eye or histological change in the pelves.

Rosenbusch (1929) observed high blood pressure as a symptom in 15 cases of chronic pyuria and concluded that the kidney substance was affected in all. At autopsy on one of

these children he found areas of plasma-cell infiltration in the kidney substance and much increase of connective tissue. There was also some round-celled infiltration of the sub-mucous layer of the pelvis.

On the other hand, early investigators of pyuria in children considered the infection to be a simple cystitis or pyelo-cystitis. Escherich (1895) was the first to describe the condition of pyuria in children, and he considered that it was due to cystitis. Finkelstein (1896) reported the autopsy findings in 8 children under 8 months old who had definite pyuria. Cystitis was present in all of these and in 4 there was also inflammation of the renal pelves. He recovered coliform bacilli from the heart-blood half an hour after death in 4 cases, and considered that the condition was a primary pyelitis due to haematogenous infection. Trumpp (1897), in 8 autopsies on children, found abscesses in the kidneys and inflammation of the pelves, ureters and bladder in 2, and cystitis alone in the remaining 6. No microscopic examination of the tissues was made, however.

Friedenwald (1910), in 20 autopsies on children under 2 years, found inflammation of the pelves and bladder in 15 cases. In the description of his cases he mentions that in

11 subjects small focal abscesses were present in the kidneys, and in 7 others there was congestion of the kidney substance, yet he does not appear to have considered these lesions to be of primary importance, as he was of the opinion that the pyuria was mainly due to inflammatory changes in the pelves and bladder.

B. MATERIAL INVESTIGATED.

The present investigation consisted of a clinical and bacteriological study of 199 cases of pyuria in children at the Royal Hospital for Sick Children, Glasgow, and of these, 170 cases came to autopsy. The macroscopic lesions in the genito-urinary tract were noted and in 70 of the necropsy cases, material from the kidneys, ureters and bladder was studied histologically. In a small series of cases the patient's serum was examined for the presence of agglutinins and complement-fixing antibodies to the organisms found in the urine. In addition, some attempts were made to produce pyuria in animals.

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SECTION II.

CLINICAL SURVEY.

II. C L I N I C A L S U R V E Y.

A. DISTRIBUTION OF LESIONS ACCORDING TO SEX, AGE, EXPECTED WEIGHT AND FEEDING.

Of the 199 cases, 138 were girls (69.34 per cent.) and 61 were boys (30.65 per cent.), while nearly three-quarters (74.3 per cent.) occurred in the first year of life. Thereafter, as the ages of the children advanced, the number of cases of pyuria decreased rapidly, only 4 (2 per cent.) being found in children between 9 and 13 years of age. (Table I.)

TABLE I.Age and Sex Distribution of Cases of Pyuria.

Age Groups	Cases		Percentage of Total Cases
	Boys	Girls	
Up to 26 weeks	35	44	39.7
26 weeks to 1 year	15	54	34.6
1+ to 2 years	5	19	12.0
2+ to 3 years	2	6	4.0
3+ to 6 years	2	5	3.5
6+ to 9 years	1	7	4.0
9+ to 13 years	1	3	2.0
Total	61	138	
Percentage	30.65	69.34	

In children under 6 months, as is shown in Table I, there was little difference in the sex incidence. This has also been noted by other investigators (Thiemich, 1910; Jeffreys, 1910; Kowitz, 1915; Stevens, 1923; Graham, 1925; Chown, 1927; Wilson and Schloss, 1928; Garrod, Batten and Thursfield, 1929; and Wilkinson, 1930). From 6 months up to 13 years the incidence was always much higher in girls than in boys. This is suggestive that in the young infant the pathway of infection in many cases may be different from that in older children. This point, however, is discussed more fully later in the light of our autopsy and histological observations.

In 106 of the 148 subjects under one year, the percentage of the expected weight had been calculated and in 75 children this percentage was over 60; thus the lesion under discussion occurred for the most part in well nourished children. The percentage of the expected weight of children of either sex with this disease was much the same, for of 38 male children, 68.4 per cent. were above 60.0 per cent. of the expected weight, while of 68 female children, 72.1 per cent. were above this percentage.

In 134 children under one year of age, 102 (76.0 per cent.)

were bottle-fed. Thus in this disease, as in many other acute and chronic diseases of infancy, the advantages of breast feeding are clearly apparent.

B. DIAGNOSIS.

Bacterial infection of the urinary tract is a common cause of pyrexia in children, and although the condition can sometimes be diagnosed by the naked-eye appearance of the urine immediately it is passed, yet a microscopic examination of the sediment from a fresh specimen is desirable. This is particularly so in the early acute cases where, on inspection, the urine may appear practically clear. The clinical histories of 193 children were available and in some the clinical symptoms were so confusing that, without an examination of the urine, a wrong diagnosis would have been made. For example, nuchal rigidity was so marked in 25 of the 193 cases of pyuria that meningitis was suspected, but the cerebro-spinal fluid obtained by lumbar puncture showed no abnormality; in other 44 cases there was profuse diarrhoea, suggesting the presence of acute gastro-enteritis.

The 193 cases have been divided into two groups, viz. acute and chronic, but this has been done only for convenience

in description as there was some overlapping of the two groups.

(a) Acute Cases.

Of the 193 cases investigated, 143 (74.8 per cent.) were considered acute on account of the sharp onset, the severity of symptoms and the short duration of the disease. Death occurred in 102 of the acute cases within two weeks of the onset of the illness; 19 recovered from the acute symptoms and passed into a subacute stage with periods of intermittent fever from time to time, and 12 cleared up within a few weeks. The onset in most of these cases was sudden, with a sharp rise of temperature and an increase of the pulse and respiration rate. The fever during the acute stage was usually remittent in type and fell by lysis in those cases which recovered. The children looked pale and acutely ill. They were usually drowsy, irritable when roused, and often had vomiting and diarrhoea. On physical examination, both kidneys were palpable in 13 cases, in 8 only the left could be felt and in 4 only the right. In 14 children there appeared to be tenderness on pressure in the flanks.

(b) Chronic Cases.

In 50 cases (25.2 per cent.) the condition appeared to be of a more chronic nature. The children were generally fairly well nourished and had little constitutional disturbance. There was a history of pain and frequency of micturition in 11, and constipation in 4 of these. On physical examination, both kidneys were enlarged in 2 cases, the left alone in 8 and the right in 3. The temperature rarely rose above 101°F. (rectal) and in some children remained normal throughout the illness.

C. TREATMENT.

There are various methods of treating urinary infections, but the most widely used remedy is alkalization of the urine by the oral administration of sodium bicarbonate and potassium citrate, as advocated by Thomson (1902). Although these drugs are not bactericidal they have a diuretic action and render the urine non-irritating, and according to Hoppe (1924) they stimulate leucocytic action and antibody formation. An increase in the fluid intake is an essential part of treatment with alkalies. This can be achieved in

infants by giving sweetened water at intervals between the usual feeds, and in older children by the administration of lemon drinks and barley water. On the other hand, when any of the antiseptics described below are being employed, fluids should be restricted in order to allow time for the drug to act. Accordingly, it is advisable to give antiseptics and alkalies along with increased fluids on alternate weeks. In acute cases Helmholtz and Milliken (1925)^(a) and Wilkinson (1930) recommended changing the reaction of the urine as quickly as possible during the course of treatment, to retard the growth of the organisms.

Antiseptic substances may be administered intravenously, orally or by lavage of the bladder and renal pelves, while vaccine and antiserum treatment are also used. Fairly good results were obtained by Young (1926) and Braasch and Bumpus (1926) using mercurochrome and gentian violet intravenously. There is great difference of opinion about the administration orally of hexamine, for example, Langdon Brown (1928-29) found that along with methylene blue it was of use in chronic cases when treatment with alkalies had failed. Kerley (1909), Porter and Fleischner (1910) and Levy (1928) found this drug of value also in acute cases. Cabot and Crabtree (1916)^(a & b)

advised hexamine, because it could reach the pelvis of the kidney, though Wood (1915) stated that it damaged the secreting portion of the kidney. Hoppe (1924) had poor results with it, and Barash (1929) and Shawki (1930) found that it produced haematuria in some cases. Acid sodium phosphate is generally employed to make the urine acid when administering hexamine, but Blaustein (1926) and Muschat (1926) stated that calcium chloride and ammonium chloride were better. Benzoic acid and benzoates may be tried if the urine is alkaline. Hexyl-resorcinol was also employed by Langdon Brown (1928-29) and Scott and Leonard (1926) with good results, but as this drug is costly its extensive use is limited. Helmholtz (1926), Helmholtz and Field (1926) and Dukes (1928-29) had poor results with this substance while, on the other hand, Hamill (1928-29) found it of value in Staphylococcus aureus infections. Leonard and Frobisher (1926) and Leonard and Freirer (1927) stated that as hexyl-resorcinol lowers the surface tension in urine it has a very powerful bactericidal action. It should not be given along with sodium bicarbonate or large amounts of fluid because both of these raise the surface tension. Acriflavine, in capsules, has also been employed with good results by

Feilden (1928-29). Quinby (1916), Hinman (1919), Kretschmer and Helmholtz (1920) and Stevens (1921) advised pelvic lavage with $\frac{1}{4}$ to 2 per cent. solution of silver nitrate, after cystoscopy and ureteral catheterization, and had good results from this treatment. Good results from vaccine therapy have been reported by Porter and Fleischner (1910), Barash (1929), Nabarro (1930) and Shawki (1930). An anti-colon bacillus serum was recommended by Box (1908) and Dudgeon (1908) but this is unlikely to give good results owing to the great specificity of these organisms for the homologous antiserum, as is described later. Torres (1917) found that the reaction of the urine could be more easily changed by treatment with alkalies when a suitable diet was given. By cutting down the protein of the diet to 2 to 3 grams. per kilo. of body weight, he found that this alone often rendered the urine alkaline. The addition of vegetables to the diet also helped to diminish the acidity. Freeman (1924) also found that by regulation of the diet it was easier to render the urine either alkaline or acid when he was using sodium bicarbonate or hexamine. Band, Dunlop and Dick (1932) obtained good results in chronic and intractable urinary infections by using a ketogenic diet, that is, one containing a minimum quantity of carbohydrate, a

small quantity of protein and a maximum quantity of fat. Cockayne (1928) recommended bowel lavage in all cases of pyuria whether they were primary infections or secondary to gastro-enteritis. It is generally agreed (Hyman, 1918; Hinman, 1919; Abt, 1926; Blaustein, 1926; and Hill, 1931) that all cases which do not clear up with medical treatment should be submitted to a cystoscopic examination.

In the present series of 29 non-fatal cases the urine in 4 became free from pus with no treatment, apart from rest in bed and plenty to drink. In 10 cases the urine was rendered alkaline by the oral administration of sodium bicarbonate (20 to 30 grains four-hourly) and in 9 of these cases the temperature fell to normal within one week, and in one case after 2 weeks. In 6 of these children the urine became clear with no further treatment. Treatment with alkalies failed to cure 11 other cases and in these 5 to 10 c.c. of protosil were injected daily for 7 to 10 days into the bladder. Four did not improve with this treatment, but in 6 the urine became free from pus within 10 days, and in one other after 4 weeks. In these 7 children in whom the pyuria cleared up, the lesion was probably only cystitis as they were all girls; in 2 of them a cystoscopic examination

showed a cystitis, while the urine from the ureters was free from pus. In one case an autogenous vaccine was tried as a last resort after treatment with sodium bicarbonate and protosil had been employed over a long period without success. Improvement was noted after the first dose of the vaccine. In using vaccines, however, it is advisable to start with very small doses, e.g. $\frac{1}{2}$ million organisms and then very gradually increasing up to 1,000 million. The remaining 4 cases of this series of 29 received hexamine by the mouth, but in all the pyuria persisted and in 2 haematuria developed. In 15 other cases, however, which were also specially studied clinically, and which were treated orally with sodium bicarbonate in a similar manner to the above 29 non-fatal cases, death occurred from 7 to 10 days after the onset of clinical symptoms.

SECTION III.

PATHOLOGY.

III. P A T H O L O G Y.

A. MATERIALS and METHODS.

At autopsy the kidneys, renal vessels, ureters and bladder were carefully dissected out en masse and any anatomical abnormality, such as an aberrant artery or vein or kinking of the ureter or narrowing of the urethra was noted. Special attention was paid to the size of the kidneys and the presence of any abnormality on their surface. After making a vertical cut right through the kidneys, the substance of the organs and pelves was examined for any morbid change. In many cases the autopsies were performed a few hours after death, and in the interval the bodies were chilled below 10°C., consequently post-mortem changes were practically absent in the specimens examined. Portions of both kidneys, ureters and bladder were examined histologically, sections being stained with haematoxylin and eosin; with Mallory's stain for connective tissue, or with one of its modifications; and also with Gram's stain and carbol thionin blue to demonstrate micro-organisms. In some cases eosin and methylene blue were also used. In several instances, in order to map out the topography of the focal lesions, serial

sections were cut and every fifth one examined. In the sections of the kidneys special attention was paid to any changes in the glomeruli and tubules and to cellular infiltration of the interstitial tissue. The pelves, ureters and bladder were examined for any sign of inflammation.

B. MORBID ANATOMY.

The affected kidneys were larger than normal in 44 of the 170 subjects (i.e. 25.9 per cent.), the left in 9 cases, the right in 6, and both in 29.

Definite inflammatory lesions were noted in the kidney substance on naked-eye examination in 84 of the 170 cases. In 44 instances only one kidney was involved, the left kidney being affected in 27 and the right in 17. This preponderance of involvement of the left kidney is different from that observed by other workers; e.g. Jeffreys (1910 - 11), Chown (1927) and Thursfield (1929) found the right kidney more frequently affected than the left. As to the distribution of the lesions in the kidney substance, both cortex and medulla were involved in 47, while in 32 only the cortex was affected and in 5 only the medulla. Definite acute abscesses were present in 71 cases; in 33 of these there was, in

addition, congestion of both the mucosa of the pelves and the bladder, in 25 the pelves alone were affected and in 6 the bladder alone. In the remaining 13 of these 84 cases the lesions appeared to be of a more chronic character, and were composed of pale yellow areas with ill-defined margins, which were scattered throughout the kidney substance, but were chiefly situated in the cortex. In 6 of these 13 cases both the pelves and the bladder showed congestion, in 3 only the pelves were involved and in 2 only the bladder. The acute abscesses and the more chronic lesions in the cortex were sometimes wedge-shaped with their bases towards or even involving the surface of the kidney, where they were readily seen under the capsule (Fig. X). The medullary abscesses appeared as yellow streaks, sometimes continuous with abscesses in the cortex and occasionally extending as far as the apices of the pyramids.

In 86 cases in which there had been definite pyuria or bacilluria, no abscesses were present and the only changes visible on naked-eye examination were cloudy swelling and varying degrees of congestion. In 14 of these 86 cases the pelves and the bladder both showed congestion, in 52 the pelves alone were affected, and in 18 the bladder alone. In

the remaining 2 cases no lesions were noted in the pelves and the bladder, although coliform bacilli and pus cells were found in the urine during life.

C. HISTOLOGICAL FINDINGS.

As previously mentioned, material was available for histological examination in 70 cases, a number sufficient to furnish a series from which it was possible to study the manner in which the more important lesions were brought about. For investigating the early stage of acute septic lesions in the kidneys material was obtained from children in whom pyuria developed shortly before death and who had died from other diseases, e.g. gastro-enteritis, broncho-pneumonia, pyloric stenosis. Histologically the cases were divided into four classes.

(a) Cases of pyuria with minor histological changes in the kidneys.

In the first group there were 18 cases in all of which definite pyuria was noted clinically. In these, very little histological change was found in the kidneys, apart from congestion of some of the glomeruli and cloudy swelling in

some of the tubules. No definite cellular exudate was noted, but in one case, a male aged 9 weeks with a history of loss of weight for one week and fever for 2 days, Gram-negative diplococci were found in the subcapsular space and in some of the vessels; this, however, may have been due to a terminal septicaemia.

The pelves in 9 of these cases showed only a slight perivascular round-celled infiltration in the submucosa, or some desquamation of the lining epithelium, and in 4 of these, Gram-negative bacilli were seen lying between the lining epithelial cells and in one, Gram-positive cocci were also present. In other 5 subjects the pelves were more markedly affected, desquamation of the lining epithelium being noted together with round-celled infiltration in the submucosa and pus cells on the surface (Fig. 1); organisms were observed on the surface of the lining of the pelves in 3 of these. On examination of the bladder, only 7 of the 18 cases showed any evidence of inflammatory reaction in the mucosa.

In 16 of the children in this group, pyuria arose during the course of some other illness and was not directly the cause of death. In the remaining 2 cases, both suffering from wasting, no lesion was found in any of the organs that

could account for death. Coliform bacilli and pus cells were noted in the urine in 14 of the 18 subjects during life. In the remaining 4, the urine had not been bacteriologically examined but contained pus.

It is difficult to know what changes might have developed in the kidneys if these children had survived for longer periods. It would appear, however, that in some children dying with a history of pyuria, little histological change may be present in the kidneys or urinary tract, in spite of organisms being present. In this connection it is interesting to note that Samson (1903) showed from his experiments on dogs that coliform bacilli may gain access to the blood stream and be destroyed or excreted by the kidney without giving rise to any symptoms or in any way injuring the kidney. Organisms might be found in the kidney and bladder and yet the kidney appear normal.

The following is an example of a case of this first group: Female child, aged 9 months, with a history of vomiting and diarrhoea of 8 weeks' duration. Broncho-pneumonia developed just after admission and the urine contained albumen, epithelial casts, pus and organisms. The child died 3 weeks later. At autopsy gastro-enteritis, pyelitis and broncho-pneumonia were found. Both kidneys and pelves showed

congestion. On histological examination of the kidneys many of the glomeruli almost filled Bowman's capsules and there was some desquamation of the epithelial cells covering the tufts and lining the capsules. The tubules showed catarrhal change and some of them contained uric acid infarctions in the cortex and medulla. The interstitial tissue showed no cellular infiltration. There was some round-celled infiltration of the submucous lining of the pelves; thickening and desquamation of the epithelial lining was also noted. A few Gram-negative organisms were seen between the epithelial lining cells.

(b) Cases of pyuria with more advanced histological changes in the kidneys.

Only 4 cases fell into the second group. All died in about 2 weeks of an acute febrile illness which was accompanied by the appearance of pus and coliform bacilli in the urine. In these the histological changes were more marked than in the first group. Small areas of dense round-celled infiltration (Fig. II) were present in both cases in the interstitial tissue of the kidney but no polymorphonuclear leucocytes were found in the tubules. Only slight desquamation of the lining epithelium was noted in sections of the pelves from one case,

but in those of the bladder wall congestion was observed in the vessels of the mucosa, on the surface of which there were Gram-negative bacilli; in this case coliform bacilli and streptococci were isolated from the urine during life. In the other 3 cases a few round cells were present around the vessels in the submucous tissue of the pelves and there was some desquamation of the lining epithelium, on the surface of which in 2 of the cases Gram-negative bacilli were seen; the bladder, however, appeared healthy in all 3.

The following is an example of a case of this type: Female child, aged 7 months, was irritable for one week before admission and nuchal rigidity was the only physical sign noted. The temperature was 102°F. intermittently for 9 days and the urine contained pus and coliform bacilli. These organisms along with streptococci were found on blood culture 3 days before death. At autopsy the kidneys showed pallor of their substance and some irregular congestion; the mucosa of the pelves was congested. On histological examination the glomeruli were congested, many of them completely filling Bowman's capsules. The tubules showed cloudy swelling and catarrhal change in the endothelial cells lining them. In the interstitial tissue two areas of dense, perivascular,

round-celled infiltration were present at the junction of the cortex and medulla (Fig. II). In the submucous tissue of the pelves there was some perivascular round-celled infiltration and desquamation of the epithelial lining cells was also noted.

(c) Cases of pyuria with definite acute inflammatory changes in the kidneys.

The third group consisted of 16 cases which were more severe clinically, death having occurred within 7 to 10 days from the onset of the illness. In 14 cases it was not possible to be certain of the time of onset of definite pyuria, which may have coincided with the first appearance of the clinical symptoms. Indeed in 2 cases which were under observation for some other condition, the occurrence of pyuria was noted at the same time as a sharp rise in temperature and change in the general condition of the patient. For example, one female child aged 1 year 4 months, admitted with tetany, had a sudden rise of temperature 12 days after admission when pyuria was noted for the first time; she died in 5 days with acute pyelonephritis which was verified at necropsy. Another female child aged 45 weeks, admitted with convulsions, developed pyuria 3 days after admission and died 11 days later, the kidneys showing several small abscesses at autopsy. In

all the cases in this group acute inflammatory changes were very marked in the cortex, and occasionally actual abscess formation with destruction of kidney tissue was present. The commonest lesion, however, was composed of foci of polymorphonuclear infiltration in the interstitial tissue (Fig. III), whilst sometimes the accumulations of these cells formed wedge-shaped areas with the base along the surface of the kidney. In 11 of these cases organisms, chiefly coliform bacilli, were seen in the foci of polymorphonuclears and in the tubules. In this type, as contrasted with the first two described, the tubules showed localised catarrhal changes and were distended with polymorphonuclear and desquamated epithelial cells (Fig. IV). Some of the glomeruli were swollen and there was slight desquamation of epithelium of the tuft and of the capsule.

It is possible in these cases that the organisms reached the glomeruli from the blood stream, gained entrance to the tubules and proliferated there from whence the infection spread to the interstitial tissue. In support of this assumption, Cabot and Crabtree (1916)⁽⁸⁾ considered from their experimental work that coliform infection of the kidneys was mostly haematogenous. They were of the opinion that

organisms passed through the glomeruli without causing any lesions, affecting first the convoluted tubules, causing cloudy swelling, settling in the mucous membrane of the pelvis with a strong tendency to produce a chronic infection which, they thought, later spread up the tubules to involve the interstitial tissue. Later, Lepper (1921) in experiments in rabbits found the sequence of events to be as follows. Firstly, after intravenous inoculation of bacteria there occurred a bacillary embolism, generally in the capillary vessels of the papilla of the kidney, followed by round-celled infiltration in the connective tissue around the affected vessels. The infection then spread to the tubules the epithelial cells of which took up the bacilli. The damaged cells desquamated and, accompanied by polymorphonuclears and bacilli, collected in the tubules. Necrosis of the tip of the papilla occurred in severe cases and in others the inflammation subsided and left very little trace.

The possibility of organisms invading the interstitial tissue from the intertubular capillaries must also be considered, since the glomerular changes are not strikingly different in these cases with severe kidney lesions from those in the milder cases.

The lining of the pelvis in only 3 of these 16 acute cases showed definite inflammation with dense round-celled infiltration of the whole submucosa, though in 6 cases organisms (chiefly coliform bacilli) were present on the surface. In 3 cases there were inflammatory changes in the bladder but in only one of these was a similar lesion present in the pelvis.

In 15 of the 16 cases in this group, coliform bacilli were isolated during life from the urine and in 2 of these, streptococci were also present. In the remaining case the urine had not been examined bacteriologically but *Staphylococcus aureus* was obtained at autopsy in films from the kidney abscesses.

A typical example of one of the cases composing this group is as follows: Male child, aged 11 months, who was ill for 6 days and was admitted with a history of diarrhoea of 4 days' duration. There was generalised oedema of the body and a septic rash; on examination of the urine pus and coliform organisms were found. The child died 2 days after admission and post mortem numerous small abscesses were found in the kidneys. Areas of infiltration of the interstitial tissue of the cortex and medulla with polymorphonuclear cells

and destruction of kidney tissue were noted histologically. Clumps of Gram-negative organisms were demonstrated in the centre of these areas. There was slight desquamation of the cells covering the glomerular tufts and lining Bowman's capsules, and polymorphonuclears were noted in the walls of the tubules which showed catarrhal change, the lumen being plugged with desquamated cells and polymorphonuclears. Only a slight round-celled infiltration of the submucosa of the pelvis was present. In the bladder there was slight injection of the vessels with catarrhal change in the region of the trigone.

(d) Cases of pyuria with chronic lesions
in the kidneys.

The fourth group consists of 32 cases which were of a more chronic type, both in their clinical course and in the nature of the lesions found. The most striking pathological changes consisted of patches of round-celled infiltration in the interstitial tissue with, in some cases, areas of early fibrosis (Figs. V and VI). The patches of infiltration were often localised, forming wedge-shaped areas corresponding roughly in distribution to the areas of polymorphonuclear infiltration described in the acute cases above. Organisms,

however, were never found microscopically in these lesions.

The glomeruli in such kidneys showed only very slight desquamation of the cells covering the tuft and lining the capsule, and there was often some lobulation of the tuft, similar to those changes already described in the more acute cases. In 5 cases organisms were present in the subcapsular space and in 4 of these also in the intertubular capillaries. This may have been due to a terminal septicaemia. It is striking that even in the chronic cases marked glomerular lesions were never seen and it would appear that if the kidney lesions are due to a blood infection the glomeruli largely escape, though the organisms may pass through them only to cause the lesions described in the tubules. In 18 of these chronic cases there were many pus cells and desquamated epithelial cells in the lumina of the collecting tubules around which there was a diffuse infiltration of round cells, as shown in Fig. VII.

Occasionally areas of polymorphonuclear infiltration were also present, apart from the foci of round-celled infiltration, but it is probable that these represented a recrudescence of infection in a kidney in which chronic changes were already present. By cutting serial sections

through such areas of round-celled infiltration it was demonstrated in all of the cases that they were entirely of chronic nature and not merely the marginal zone of more acute inflammatory foci. Areas of infiltration with round cells and polymorphonuclears were noted in the submucosa of the pelvis in 6 of these 32 chronic cases (Fig. VIII), and in 11, organisms were noted on the surface. In 4 cases of this group cystitis was present, and 2 of these also showed pyelitis. During life, coliform organisms were found in the urine in 22 cases, coliform bacilli and streptococci in 8, in one Staphylococcus aureus, and in one the urine had not been examined bacteriologically.

The following is an example of a case of chronic type: Female child, aged $5\frac{1}{2}$ months, duration of illness 3 months. The child was admitted with a history of vomiting and wasting for one week. Pyuria developed 8 weeks after admission and continued for 3 months but cleared up one week before death, which was due to terminal broncho-pneumonia. At autopsy acute bilateral otitis media and early broncho-pneumonia were found, while the left kidney showed numerous small, rather vascular depressions scattered over the surface (Figs. XII and XIIIa). These areas were widely separated and not diffuse as

in a true chronic nephritis. On microscopic examination areas of distinct fibrosis with round-celled infiltration were found in the cortex (Fig. IX). These areas extended for some distance through the cortical tissue, and were approximately wedge-shaped with their base at the surface of the kidney. The glomeruli showed some lobulation and desquamation of the epithelium covering the tuft and lining the capsule, and the tubules showed cloudy swelling. In the pelvic submucosa there was perivascular round-celled infiltration and the epithelium of the pelvis was thickened and desquamating. The only change in the bladder was a slight round-celled infiltration of the submucosa and some desquamation of epithelium.

SECTION IV.

BACTERIOLOGY.

IV. B A C T E R I O L O G Y.

1. METHODS.

A special study was made of the types of organisms found in catheter specimens of urine from 87 children out of the above series of 199. In many of the cases more than one specimen was examined. For critical cultural work catheter specimens are essential, though in the case of boys, freshly passed urine, if examined at once and if taken with precautions regarding cleanliness, is often sufficient for diagnosis. Similar specimens from female children, however, are not satisfactory as vaginal discharges and uncleanly conditions of the external genitals often contaminate the naturally passed specimens. Indeed, in some cases of acute gastroenteritis with profuse diarrhoea in girls, there is occasionally some difficulty in even obtaining a clean catheter specimen on account of the heavy contamination of the external genitals with fluid faecal material.

In this investigation cultures were made directly from the urine by inoculating one plate of MacConkey's medium and one of nutrient agar, each with one or two platinum loopfuls

of urine. Cultures were sometimes also made from the sediment obtained by centrifuging 10 c.c. of urine for 5 minutes at 3,000 revolutions. On a few occasions, however, when only a few colonies resulted in cultures inoculated from the sediment, it was difficult to decide whether these were contaminants. Accordingly, more diagnostic significance was attached to the growth obtained in cultures inoculated directly from a well mixed catheter specimen. The progress of the cases, also, could be judged better by this method, as in those which were clearing up, the number of colonies obtained on the plates became progressively less. Films were made from the centrifuged sediment and examined for organisms and cells in wet preparations and in films stained by Gram's and by Ziehl-Neelsen's methods. From the plates, colonies showing different characters were picked off and subcultured on agar, the resulting growths then being inoculated into media containing the following sugars:- glucose, lactose, saccharose, maltose, mannite, dulcete and inosite. The formation of indol, the presence or absence of motility in young broth cultures, the power of liquefying gelatin, the changes produced in litmus milk, and the Voges-Proskauer reaction were also noted. In the case of streptococci, their

resistance to heat and their power of producing lysis on blood agar plates, as described by Dible (1923), were also investigated.

2. PREPARATION OF ANTISERA.

As Mackie (1921) has shown, coliform bacilli are very specific in their agglutination reactions. Accordingly, we prepared antisera by inoculating rabbits intravenously with graduated doses of killed cultures of the following organisms — B. coli communis, B. MacConkey 71 and B. paracolon, isolated from the urine of children suffering from pyuria. No difficulty was experienced in making the antiserum to B. MacConkey 71. On the other hand, the rabbits inoculated with B. coli communis and B. paracolon lost weight rapidly and died before their sera showed any appreciable agglutinin content for the organisms inoculated. This difficulty was successfully overcome by injecting at the same time as the organisms, for which antisera were desired, 0.5 c.c. of collosol manganese intramuscularly, as recommended by Madsen (1923). Further, we noted that as regards these two organisms, living emulsions were tolerated better by the

animals than killed ones. The titres of the antisera to each of these organisms obtained as just described, were as follows — B. coli communis 1 in 3,200, B. MacConkey 71 1 in 6,400 and B. paracolon 1 in 12,800. The antiserum to B. MacConkey 71 was tested against 12 other strains of organisms all of which gave reactions, in the various differential media (sugars, etc.), identical with those of the strain from which the antiserum was prepared. All of these 12 organisms, however, were only agglutinated in high concentrations of the serum, e.g. 1 in 40. Coliform bacilli giving reactions different from these obtained with the various strains of B. MacConkey 71 were not agglutinated at all. Somewhat similar findings were obtained with 13 strains of B. coli communis and 4 strains of B. paracolon which were isolated from the urine of pyuria cases. Thus, while antisera are of use in identifying individual members of the coliform group, yet on account of their strict specificity they are of limited value as far as groups of organisms giving the same biological tests are concerned.

3. CLASSIFICATION OF ORGANISMS.

For the classification of the coliform strains isolated, we adopted in a general way the criteria given by MacConkey (1905 and 1909), using the results obtained from the above tests.

TABLE II.

87 cases	{	Pure coliform 51	{	21 <u>B. coli communis</u>
				17 <u>B. MacConkey 71</u>
				3 <u>B. paracolon</u>
				3 <u>B. proteus</u>
				3 Non-lactose fermenters
			2 {	<u>B. paracolon</u>
				<u>B. MacConkey 71</u>
			1 {	<u>B. paracolon</u>
				<u>B. lactis aerogenes</u>
			1 {	<u>B. paracolon</u>
				<u>B. acidi lactici</u>
		Pure streptococcal 11	11	<u>enterococcus</u>
		Pure staphylococcal 2	2	<u>Staphylococcus aureus</u>
		Mixed 23	{	7 <u>B. coli communis</u>
		Enterococci together with		7 <u>B. MacConkey 71</u>
				5 <u>B. proteus</u>
				2 <u>B. paracolon</u>
				1 <u>B. lactis aerogenes</u>
			1 Non-lactose fermenter	

Over the whole investigation, 114 strains of organisms were isolated from 87 specimens of urine. The various coliform strains either alone or in combination with streptococci were the commonest organisms found. Of the different individual bacteria isolated, enterococci occurred most frequently either alone or in combination with other organisms and then, in order of frequency, the various coliform bacilli as follows:-

<u>Enterococci</u>	- - - - -	34
<u>B. coli communis</u>	- - - - -	28
<u>B. MacConkey 71</u>	- - - - -	26
<u>B. paracolon</u>	- - - - -	9
<u>B. proteus</u>	- - - - -	8
Non-lactose fermenters	- -	4*
<u>B. lactis aerogenes</u>	- - -	2
<u>B. acidi lactici</u>	- - - -	1

Staphylococcus aureus was isolated in only 2 cases.

*none of these organisms produced clotting of milk, 3 formed indol and 1 did not, and all formed acid and gas in all the other sugar media used.

Of the coliform strains B. coli communis and B. MacConkey 71 were isolated most frequently from the urine. This corresponds with the results obtained by Mackie (1921) in a study of 90 cases of urinary sepsis from which were isolated

107 strains of coliform bacilli, B. MacConkey 71 being obtained on 16 occasions and B. coli communis on 9. These two organisms are among the commonest of the organisms found in the human faeces. For example, MacConkey (1909) found B. MacConkey 71 on 42 and B. coli communis on 37 occasions among 178 strains of coliform bacilli isolated from human faeces. Mackie (1921) in a study of the bacterial flora of human faeces obtained B. coli communis 17 times and B. MacConkey 71 12 times out of 111 strains isolated. Both these authors found the incidence of all other types of coliform bacilli much less than those two organisms.

Thus the coliform bacilli found most often in cases of pyuria are among the commonest normal inhabitants of the bowel, whereas the ordinary suppurative organisms, e.g. Staphylococcus aureus, are only rarely met with. This fact is strongly in support of the view that the lesions are due to an auto-infection from the bowel.

Cultures were made from the blood of 40 of the 199 children with pyuria, but in only 4 (10 per cent.) were coliform bacilli isolated.

4. SEROLOGICAL FINDINGS.

A. Agglutination Tests.

(a) Methods.

In 25 of the cases with pyuria, agglutination tests were carried out with the patient's serum against the organisms found in the urine. In these cases a single colony was selected from the MacConkey plate originally inoculated and subcultured several times on agar slopes, after which a saline suspension with a density of 2,000 million per c.c. was made from a 24 hours' growth on an agar slope. The organisms in the suspension were killed by heating in the water-bath at 55°C. for 30 minutes. The serum from a sample of the patient's blood was allowed to separate overnight in the ice-chest. As a preliminary test, 0.5 c.c. of 1:10, 1:20, 1:40 and 1:80 dilution of serum in saline was added to 0.5 c.c. of bacterial emulsion, giving ultimate dilutions of serum of 1:20 to 1:160. The tubes with this mixture were placed in the water-bath at 55°C. for 2 hours, after which they were left at room temperature for quarter of an hour, when the dilutions in which agglutination had taken place were noted.

A further reading was made at the end of 24 hours, the tubes having been left at room temperature since the first reading was made. When agglutination had taken place in the highest dilution of serum (1:160) in the preliminary experiment, another test was made in which the final dilutions of serum ranged from 1:100 to 1:3,200.

(b) Positive Results.

Agglutinins to the infecting organisms were demonstrated in the serum of 13 (52 per cent.) of the 25 cases tested, the titre varying from 1:40 up to as high as 1:3,200 in different cases. Of the cases with positive agglutination tests 6 children under one year of age — 3 boys and 3 girls — died, 5 within one week after admission and one during an acute exacerbation after 3 months in hospital. The agglutination test in this last case was negative shortly after admission. In 2 of these fatal cases the infecting organism was B. coli communis and the agglutination titre was 1:80 and 1:40. In other 2 children the organism isolated was B. paracolon and the titre of the patients' sera was 1:2,560 and 1:160 respectively. In the remaining 2 subjects who

died, B. MacConkey 71 was present in the urine and the titre of the patients' sera was 1:640 and 1:160 respectively. In the 7 children who did not die and who had positive agglutination tests — 6 girls and one boy — 3 were under one year and 4 were aged 3, 4, 7 and 8 years respectively. Six of these children were acutely ill for several weeks with high fever and then gradually recovered. In these 6 cases B. coli communis was present in 5, and in the remaining one B. MacConkey 71. The titre of the sera of the patients infected with B. coli communis was 1:3,200, 1:400, 1:320, 1:160 and 1:40 and that of the child infected with B. MacConkey 71 was 1:40.

The case where the highest titre (1:3,200) was obtained is of interest and the following are the chief details. The patient — a girl aged 34 weeks — was breast fed for 3 months when this was supplemented with bread and whole milk. She had always been healthy till one week before admission when diarrhoea began. On admission the child was drowsy, feverish and appeared acutely ill. Both kidneys were palpable but more especially the left. The urine contained abundant pus cells and B. coli communis. A fortnight after the onset of the illness an agglutination test was performed

when it was found that with a 1:3,200 dilution of the patient's serum the infecting coliform bacilli were completely agglutinated. Six weeks later when the child's condition had improved slightly, the test was repeated but the agglutination titre of the patient's serum had fallen to 1:400. An autogenous vaccine was then prepared and given to the patient at weekly intervals. Three days after the first dose the titre was 1:160 and a month later, 1:80. The child was dismissed well one month later and the urine was free from pus and organisms, while the kidneys were no longer palpable.

(c) Negative Results.

Of the 12 cases which showed no agglutination 7 were in children under one year of age. Of these, 2 (one boy and one girl) showed little constitutional disturbance, the pyuria occurring during convalescence from pneumonia, the organisms present in the urine being B. proteus and B. paracolon respectively. Other 4 girls were acutely ill with high fever but the condition cleared up rapidly under treatment with sodium bicarbonate. The organisms isolated

from these 4 cases were B. coli communis in two children, B. paracolon in one and B. lactis aerogenes in one. The seventh case — a boy of 25 weeks — died 9 days after the onset of the disease. The blood serum was tested for agglutinins with negative result on the fourth day of illness. This child was, however, probably too ill to produce agglutinins. In children over one year of age there were 5 cases and all were girls, two were 3 years of age, two were 7 years and one was 10 years. The infecting organisms in 2 cases were B. coli communis, in 2 B. MacConkey 71 and in one B. proteus. In 4 of these, frequency and pain on micturition were prominent symptoms and in 2 of these 4, acute cystitis was observed on cystoscopic examination. The fifth case, aged 3 years, was acutely ill on admission with high fever, but all cleared up rapidly under treatment with sodium bicarbonate.

TABLE III.

Infecting Organism	Agglutination with patients' sera	
	Positive	Negative
<u>B. coli communis</u>	8	5
<u>B. MacConkey 71</u>	3	2
<u>B. paracolon</u>	2	2
<u>B. proteus</u>	0	2
<u>B. lactis aerogenes</u>	0	1
<u>Total</u>	13	12

The different organisms to which agglutinins were found in the patients' sera are shown in Table III, from which it is evident that the type of infecting organism did not appear to influence the result of the agglutination test, for almost equal numbers of positive and negative results were obtained with each organism. Further, positive agglutination did not depend on sex or age. It would thus appear that the condition of the patient, the severity and extent of the lesion are the determining factors in the production of agglutinins in these cases. The children who were acutely ill but recovered quickly under treatment, produced no agglutinins, whereas cases which appeared to be of similar severity at the onset but which became steadily worse and died within one week usually showed positive agglutination tests. Thus the presence of agglutinins may depend on the extent and severity of the lesions in the substance of the kidney, as in such cases there would be opportunities for a better antibody response on account of the close association of the infecting organisms with the tissues of the host. On the other hand, where the chief lesions were confined to the pelves and bladder, i.e. in mild cases, there would not be the same close association and accordingly antibody response

might be expected to be poor.

It is interesting to note that as early as 1898 Pfaundler observed the phenomenon of "Fadenbildung" during the febrile period in inflammatory conditions of the bowel and urinary tract of children when the serum of the patient and a suspension of the causal organisms were brought together. On the other hand, during the non-febrile period he observed agglutination when the serum and organisms were mixed together. That it was a specific antibody response to the infecting organism was shown by the fact that saprophytic organisms from the patients' faeces were not agglutinated by their sera. Further, Holt (1928)⁽⁶⁾ mentions that agglutinins are frequently found in the blood of children suffering from pyuria.

B. Complement Fixation Tests.

(a) Methods.

The sera of 9 of the children already examined for agglutinins were also studied by complement fixation tests for the presence of immune-bodies to the infecting organism. For this test a suspension of the organism isolated from the

patient's urine was used as antigen. The suspensions were similar to those used in the agglutination tests. Into each of a series of 8 tubes 0.5 c.c. of the bacterial suspension was pipetted and then 0.05 c.c. of the patient's serum (immune-body) previously heated to 55°C. for half an hour. Next there was added in order, 2, 4, 7, 10, 15, 20, 30, 40 doses of complement (fresh guinea-pigs' serum) to the antigen-antibody mixture and the whole was incubated at 37°C. for 1½ hours. Sensitised sheep's red blood corpuscles (0.5 c.c. in each tube) were used as the indicator to demonstrate whether complement was fixed by the mixture of serum and organisms. After the addition of sensitised red cells the tubes were incubated for 1¼ hours, being shaken every quarter of an hour. Controls were also made with antigen, antiserum and complement. One of the organisms, a strain of B. coli communis, used as antigen was found to produce marked zonal fixation of complement, the degree of fixation increasing as the amount of complement increased from 2 up to 7 doses, after which fixation decreased up to 40 doses. Thus in the middle of the series of tubes there was a zone of complement fixation. This type of fixation of complement is due to the presence of natural immune-bodies

to certain members of the coli-typhoid group of organisms in guinea-pigs' sera. Dunlop (1928) has shown, however, that by using guinea-pigs' sera treated with powdered charcoal (treated complement) this natural immune-body can be removed. In view of this zonal type of fixation all the experiments were carried out in duplicate, using in one set of experiments fresh complement and in the other, treated complement.

Results.

A. Positive. { Treated complement 4
Untreated complement 5

B. Negative. { Treated complement 5
Untreated complement 4

In the case which showed zonal fixation of complement the result was positive with untreated complement and negative when the complement was treated with charcoal. In the other 8 cases the results were the same whether the complement was treated or not.

(b) Positive Results.

In 2 of the 4 positive cases, a girl aged 10 months and a boy aged 8 months, the infecting organism was B. coli communis; both these children were acutely ill and their sera gave positive agglutination reactions as well as positive complement fixation tests. In the two older girls one had a urinary infection with B. MacConkey 71 and the other with B. coli communis; in the former the patient's serum agglutinated the infecting organism but in the latter this did not occur, although in both the complement fixation tests were positive.

(c) Negative Results.

The 5 negative results were all in girls, aged 17 weeks, 6 months, 9 months, 7 years and 10 years respectively. The two youngest were acutely ill and died within one week of the onset of illness, the infecting organism being B. MacConkey 71 in the one case and B. coli communis in the other; in both, the agglutination tests were positive. The serum from the girl of 9 months gave the zonal fixation of complement and agglutinated the infecting organism, B. coli communis.

The onset of the disease in this child was acute and the infection cleared up rather slowly under treatment. The other 2 girls of 7 and 10 years had pain and frequency of micturition but were cured quickly under treatment. The infecting organisms in these last 2 cases were B. coli communis and B. MacConkey 71 and were not agglutinated by the patients' sera. From these findings, shown in Table IV, it is evident that the results of the complement fixation tests did not run parallel with the agglutination tests.

TABLE IV.

Organism	No. of Cases	Complement Fixation	Agglutination
<u>B. coli communis</u>	2	+	+
	2	—	+
	1	+	—
<u>B. MacConkey 71</u>	1	+	+
	1	—	+
	1	—	—

SECTION V.

EXPERIMENTAL WORK.

V. EXPERIMENTAL WORK.

A. Introduction.

In an endeavour to discover whether lesions could be produced in the kidneys or urinary tract of animals, some of the organisms isolated from the urine in cases of pyuria in children were inoculated intravenously into rabbits. Into the marginal ear vein of these animals living organisms were injected at weekly intervals, the dose being gradually increased from 2 million to 2,000 million organisms.

B. MacConkey 71, B. coli communis and B. paracolon were used in these experiments, several animals being inoculated with these organisms. Antisera to each of these strains were also prepared so that any bacilli found in the urine could be positively identified. The rabbits were placed in a special sink and the urine collected daily over a period of time, but this was always, unavoidably, contaminated with faeces. In addition, catheter specimens of urine were taken, using a ureteral catheter sterilised in formalin vapour.

B. Animal Experiments with B. MacConkey 71.

(a) The first rabbit inoculated with B. MacConkey 71 received in all, 8 injections (approximately 7,140 million organisms). In the urine collected in the sink organisms with the cultural characters of B. MacConkey 71 were isolated on 6 occasions, but they did not correspond serologically with the strain inoculated. When the urine was obtained by catheter B. MacConkey 71 was never recovered, although on 3 occasions one or two colonies of B. coli communis were obtained.

The animal was killed 6 days after the last injection, and 12 weeks from the beginning of the experiment. At autopsy the kidneys, pelves, ureters and bladder showed no gross lesion but microscopically a slight localised round-celled infiltration was found in the submucosa of the bladder. No organisms were found microscopically in sections of the kidneys, pelves and bladder.

(b) A second rabbit was inoculated with the same strain of B. MacConkey 71 as that already used, beginning with 1 million organisms and increasing to 2,000 million, receiving altogether 7 injections (approximately 5,260 million

organisms). On one occasion an organism with similar cultural and serological characters to the strain of B. MacConkey 71 inoculated was recovered from a catheter specimen of urine 24 hours after the second inoculation of 2,000 million organisms.

The rabbit died 5 days after the second dose of 2,000 million organisms. At the post-mortem examination the kidneys appeared slightly congested. Microscopically the glomeruli showed some congestion, and there was some round-celled infiltration in the kidney substance. A few blood cells were found in the pelves of both kidneys, but no organisms were seen in any of the sections.

(c) A third rabbit inoculated with this strain, beginning with 200 million organisms intravenously and 1,000 million subcutaneously, died in 14 days. At autopsy there was slight thickening of the parietal pelvic epithelium and a few polymorphonuclear cells were present in the submucosa and blood cells in the lumina of the pelves. These were the only changes noted in the kidneys. The bladder was normal. An area of thickening was found in the subcutaneous tissue where the injection was given. This was composed of fibrous tissue with many new capillaries, and was densely infiltrated

with round cells. No organisms were seen in sections made from this lesion.

These experiments show that large numbers of coliform bacilli from human sources may be injected intravenously into rabbits without causing any gross damage to the kidneys or urinary tract. This is in accordance with the results of Lepper (1921) and Helmholtz and Milliken (1925) who, after intravenous inoculation of living coliform bacilli, all found that these were not excreted by the normal kidney in the time interval usually considered adequate for that purpose.

C. Animal Experiments with *B. coli communis*.

(a) The first rabbit inoculated with *B. coli communis* received in all, 6 injections (approximately 1,630 million organisms). On 2 occasions organisms with the cultural characters of *B. coli communis* were found in the urine collected in the sink, and once in a catheter specimen. Serologically, however, none of these organisms corresponded to that injected.

The animal died 6 days after receiving a dose of 1,000 million organisms, that is $8\frac{1}{2}$ weeks from the commencement of

the experiment. Histologically, the cortex of the kidneys showed no change, but a small area of cellular infiltration was noted at the tip of the papilla in one kidney and also extending for a short distance upwards in the papilla. The cells were mostly polymorphonuclears. A few Gram-negative bacilli and many pus cells were found in the pelves, and a few Gram-negative bacilli were also present between the epithelial cells of the bladder, some of which were desquamating.

(a) A second rabbit was inoculated with the same strain of B. coli communis as that used in experiment C (a). An initial dose of 200 million organisms intravenously and 1,000 million subcutaneously was given.

This rabbit died in 6 days. Microscopically, both kidneys showed areas of increased fibrous tissue in the form of bands spreading from the surface of the cortex into the medulla. Mallory and Parker (1927) and Mackey (1931) found that such lesions were not uncommon in apparently healthy laboratory animals. Many round cells were present in these areas and also a few in the pelvic submucosa. A few round cells were also present in the bladder submucosa and there was some congestion of the vessels. Many of the cells in

the submucosa of the bladder were polymorphonuclears.

As the organism isolated from the urine in the first case in these experiments did not correspond serologically with that injected, it is doubtful whether the slight pyelitis was caused by the inoculated organism, or was a spontaneous infection. These two experiments with B. coli communis, in addition to those already described with B. MacConkey 71, show that organisms injected intravenously into rabbits do not commonly appear in the urine.

D. Animal Experiment with B. paracolon.

A rabbit injected with B. paracolon was killed after 3 months, having received during that time 10 injections of living bacilli (approximately 11,620 million organisms). On only one occasion was a non-lactose fermenting coliform organism recovered from a catheter specimen of urine, but it did not correspond serologically with the organism inoculated. Further, the inoculated organism produced indol but that isolated did not.

On examination of the kidneys and bladder at autopsy no naked-eye changes were seen and histologically no abnormality was noted.

This experiment confirms the results of the two previous sets with B. coli communis and B. MacConkey 71 in which it has been shown that it is difficult to cause lesions in the kidneys or urinary tract of animals (rabbits) by intravenous inoculations of suspensions of living coliform bacilli. Further, it is only exceptionally that the organism inoculated can be recovered from the urine. Similar findings have been recorded by Lepper (1921), who found that only 2 out of 24 rabbits inoculated intravenously showed lesions in the kidney. Helmholtz and Beeler (1917) produced lesions in only 11 out of 66 rabbits, using organisms from human cases of pyuria. In 1918, however, working with a coliform bacillus isolated from a case of spontaneous pyelitis in a rabbit, they produced pyelitis in 17 out of 31 rabbits and 13 of these showed abscesses in the kidneys. Helmholtz and Milliken (1925)^(e) have shown that when rabbits are inoculated intravenously with coliform bacilli, these do not appear in the urine in most cases, even after 48 hours. When the kidneys were removed at intervals of from 10 minutes to 4 hours after intravenous injection of organisms and were incubated in vitro, colonies of bacilli were found mostly in the glomeruli, the numbers decreasing as the period of

survival was prolonged. Helmholtz and Bowers (1926) found that coliform bacilli did not appear in the urine of rabbits when they were injected intravenously after a previous injection of staphylococci. Rosenow (1915) inoculated rabbits intravenously with coliform bacilli alone and along with streptococci, and in only one case were lesions found in the kidney. Helmholtz (1922), in a series of experiments in rabbits where he made complete cross-sections of the kidneys, found that the lesions produced by haematogenous infection tended to localise in the kidney substance and in the papilla and adjacent lining of the pelvis. On the other hand, lesions produced by intravesical injection tended to localise in the small finger-like projection of the parietal wall of the pelvis. Helmholtz (1929) found from a series of experiments in rabbits that an ascending infection was more difficult to produce than a haematogenous one. In 66 to 100 per cent. of the animals inoculated intravenously he got positive results, but with only one organism was it possible to produce with consistency an ascending infection after intravesical injection of coliform bacilli.

SECTION VI.

SUMMARY and DISCUSSION.

VI. S U M M A R Y A N D D I S C U S S I O N.

In this investigation cases of pyuria in children have been studied clinically, pathologically, bacteriologically and serologically. In addition, some attempts were made to produce pyuria in animals.

1. C L I N I C A L S U R V E Y.

From a study of 199 cases it was found that about three-quarters (74.3 per cent.) of the cases occurred in the first year of life. Girls were more frequently affected than boys, in a proportion of 7 to 3, but in children under 6 months there was little difference in the sex incidence (girls 44; boys 35). The lesions occurred as a rule in well nourished children and of 134 under one year, 102 (76 per cent.) were in bottle fed infants. In this connection it is of interest to note that Huët (1915) reported 5 cases of pyuria in which it was probable that the infection had been spread from one child to another by feeding bottles contaminated by a nurse, as in his series of cases one night nurse attended children in various wards. One child had pyuria and some time after her admission 4 children in other wards developed pyuria due to the same type of coliform bacillus as in the first child.

In the case of pyuria as in many other acute and chronic diseases of infancy, e.g. gastro-enteritis and tuberculosis (Blacklock, 1932), the advantages of breast feeding are clearly seen.

The 193 cases which were fully investigated were divided into 2 groups, 143 being acute and 50 chronic. Of the acute cases 102 died within 2 weeks of the onset of the illness. In these cases the disease ran a rapid course with high fever and sudden onset of symptoms. In the chronic cases there was seldom much elevation of temperature and little constitutional disturbance. It was noted that the symptoms accompanying the pyuria were often very confusing and, unless a careful bacteriological examination of the urine had been made, in cases of obscure fever in some of the infants the condition might easily have been overlooked.

Treatment.

In 10 of the series of 29 non-fatal cases which were specially studied clinically, the urine was rendered alkaline by the oral administration of sodium bicarbonate; in 9 of these the temperature fell to normal in one week, and in the remaining case after 2 weeks. In 11 cases which did not improve with alkaline treatment 5 c.c. of protosil were

injected into the bladder daily and in one of these the urine became free from pus and organisms. Hexamine was given orally to other 4 cases but the results were not satisfactory as it gave rise to slight haematuria in 2 children. In the remaining 4 cases the pyuria cleared up without any treatment except rest in bed and plenty to drink. In one case which had resisted treatment, an autogenous vaccine was given, with good results. Death occurred 7 to 10 days after the onset of clinical symptoms in 15 other cases which were also specially studied clinically, and which were treated with sodium bicarbonate in a similar manner to the above 29 non-fatal cases. A post-mortem examination was made in 11 of these 15, and in 9, abscesses were found in the kidney substance. Accordingly, it would appear that treatment with alkalies may have little effect in those cases where there are abscesses in the kidney substance. Most of these cases were admitted some time after the onset of symptoms and it is possible that if intensive treatment had been commenced earlier the children might have been able to overcome the infection before any gross damage was produced in the kidney substance. Of course, other factors must be taken into account, for example, type of infection,

age and general resistance of the patient, for, as we have shown by histological examination, healing actually does take place in the kidneys of some children who have had attacks of acute pyelonephritis. Unless there is complete bacteriological cure of the condition exacerbations of the disease are likely to occur.

2. PATHOLOGY.

In the study of the morbid anatomy of pyelonephritis in children 170 cases were investigated. Definite inflammatory lesions were noted in the kidney substance in 84, whilst the pelves were congested in 58 of these, and the bladder in 39. In the remaining 86 cases there were varying degrees of congestion and cloudy swelling in the kidneys. In 66 of these the pelves showed some congestion and in 32 the bladder was affected. It must be pointed out, however, that post-mortem material is not always a reliable guide to the various stages of acute inflammatory lesions, as generally it is only the most severe cases that die. To overcome this difficulty we have also studied the lesions found in cases of pyuria of a very short duration in children dying from other diseases.

Of the cases coming to autopsy portions of the kidneys,

pelves, ureters and bladder of 70 were examined histologically, and were divided into four groups according to the severity of the microscopic lesions present. In the first group there were 18 cases in which very little change was noted in the kidneys, apart from congestion of some of the glomeruli and cloudy swelling in the epithelial cells of the convoluted tubules. The pelves in 14 of these showed varying degrees of acute inflammatory reaction, and similar changes were noted in the bladder in 7. In 16 of these children pyuria arose during the course of some other illness and was not directly the cause of death. Further, the pyuria was often of short duration, in some cases being present for only two or three days before death. These minor lesions in the kidneys, such as congestion of the glomeruli and cloudy swelling in the tubules, may probably represent the earliest stage of the reaction to the infection. Indeed in one case showing these slight microscopical changes, coliform bacilli were actually seen in sections of the glomeruli. In these cases which were mostly of secondary nature, it is unlikely that the reactive changes to the infection should be different from those met with in primary cases. The remaining 2 cases in this group were primary pyurias. From the histological

findings in this group it would appear that in some cases of pyuria, organisms may be present and multiply in the kidney substance or other parts of the urinary tract without producing any marked reaction.

The second group was composed of 4 cases in which the histological changes were more marked in the kidney substance than in the first group. Small foci of dense, round-celled infiltration were present in the interstitial tissue as well as the slight changes, e.g. congestion of the glomeruli and cloudy swelling in the epithelial cells of the tubules, which were noted in the first group. The cases in the second group were considered to have died at a more advanced stage of the disease than these in the first group.

The third group, in which there were 16 cases, showed definite acute inflammatory lesions in the kidney substance and other parts of the urinary tract. In the kidney widely separated foci of polymorphonuclear infiltration of the interstitial tissue were found, and in some these formed actual abscesses. In these areas, which were often wedge-shaped with the base of the wedge towards the surface of the kidney, the tubules were distended with polymorphonuclears and desquamated epithelial cells. The glomeruli showed varying

degrees of congestion. Such inflammatory foci were situated chiefly in the cortical regions. The pelves in only 3 of these 16 cases showed definite inflammatory change, and a similar lesion was noted in the bladder in one of these. In other 2 cases, besides the lesions in the kidneys, foci of inflammation were found in the bladder microscopically but not in the pelves.

In the fourth group comprising 32 cases, more chronic lesions were noted than in any of the foregoing groups. These lesions consisted of widely separated foci of round-celled infiltration of the interstitial tissue and, in some cases, areas of early fibrosis. Some of the tubules in these areas contained polymorphonuclears and desquamated epithelial cells, and the glomeruli showed only minor degrees of congestion. The lesions were often wedge-shaped with their bases along the surface of the cortex, causing small irregular, vascular, depressed areas on the surface of the kidney. Such areas corresponded roughly in shape and distribution to the polymorphonuclear areas noted in the acute cases. In some of the cases foci of polymorphonuclears were also scattered through the kidney substance but the cellular exudate probably represented a recrudescence of infection. In only 6 of the

32 cases in this group were inflammatory changes noted in the pelves. In 4 cystitis was present and 2 of these had pyelitis.

From the morbid anatomical and histological part of this investigation it is evident that in the great majority of cases of pyuria in infancy and childhood which come to autopsy, the kidney substance often shows more marked inflammatory change than the pelvis; that is, the common lesion is a pyelonephritis rather than a simple pyelitis. Other workers have also noted similar findings, West (1909), Thomson and McDonald (1909), Thiemich (1910), Jeffreys (1910-11), Borrmann-Bremen (1913), Kowitz (1915), Cabot and Crabtree (1916^(a) and 1917), Helmholtz (1921), Chown (1927), Holt (1928^(a)), Thursfield (1928), Campbell (1929), Gregory (1929), Rosenbusch (1929), Wilson and Schloss (1929) and Garrod, Batten and Thursfield (1929), all of whom described cases of pyuria where there were areas of infiltration with polymorphonuclears in the kidney substance and comparatively little change in the pelves and bladder. While many children die when the lesion in the kidney is in an acute stage yet, in a number of cases, there is evidence of an attempt at healing as shown by areas of fibrosis, or the condition may become subacute as seen by

the appearance of scattered patches of round-celled infiltration. It is possible that, in cases where infection is overcome, the only permanent damage may be foci of fibrosis which are widely separated and not diffuse as in a chronic interstitial nephritis. This was particularly well demonstrated in one case where pyuria had been present for three months and cleared up one week before death from acute broncho-pneumonia. Cases with more chronic lesions seem to be liable to acute exacerbations which may prove fatal.

Pathway of Infection.

There is great diversity of opinion as to whether pyelonephritis is due to a haematogenous or an ascending infection. Most of the recent investigations, and some of the earlier ones on this subject are in favour of the former (Finkelstein, 1896; Göppert, 1908; Thiemich, 1910; Kowitz, 1915; Smith, 1916; Cabot and Crabtree, 1916^(a+b) and 1917; Helmholtz, 1921; Lepper, 1921; Findlay, 1922; Stevens, 1923; Chown, 1927; Schlack, 1927; Gregory, 1929; Wilson and Schloss, 1929; and Shawki, 1930). The preponderance of females affected has always been held to be in favour of an ascending infection, but in this investigation the sex incidence in children under 6 months was found to be almost equal. This

has also been noted by Thiemich (1910), Jeffreys (1910), Kowitz (1915), Stevens (1923), Graham (1925), Goreter (1926), Chown (1927), Wilson and Schloss (1929) and Wilkinson (1930). In young infants contamination of the external genitals by faeces often occurs and, in consequence, if the disease was mainly due to an ascending infection one would expect more female than male infants to be affected. As we have already shown, however, the sex distribution is almost the same. Such a fact indicates that infection in infancy takes place by some other route in the majority of cases. The most likely one would appear to be by the blood stream. In older children, however, more females are affected and it is possible that, in a number of these older subjects, ascending infection does occur. It is to be remembered that the subjects of this investigation belonged to the poor and working classes in whom the chances of contamination from outside sources of the external genitals, particularly in young girls who are often insufficiently clad, is more likely to occur than in better class children. This has already been pointed out in connection with primary pneumococcal peritonitis by McCartney and Fraser (1921-22), who were of the opinion that the pneumococcus invaded the peritoneum by way of the genital

passages, due to direct infection of the external genitals. Similarly, it would seem likely that infection in these children might also spread up the short urethra and so cause urinary disease. Although vulvo-vaginitis was not common in our series of cases, occurring in only 2 instances (1 per cent.) it is interesting to note that Wood (1932) found B. coli communis 18 times and non- and late-lactose fermenting Gram-negative bacilli 18 times in 71 consecutive cases of non-gonorrhoeal vaginal discharge in children. Further, Smith (1916) found colon bacilli in cultures made from the vaginal secretions of infants as young as 5 days old. Also in favour of ascending infection is the fact that it is not uncommon to find coliform bacilli in the normal urethra. Indeed, Helmholtz and Beeler (1916) found in a series of sick children, under 2 years of age, with no evidence of genito-urinary disease that coliform bacilli were present in the urethra in one-third of the cases.

Kaufmann (1929), in support of the ascending spread of the infection, stated that the linear abscesses in the medulla were evidence of ascending infection. But in haematogenous infection of the kidney in tuberculosis, similar abscesses are not infrequently found (Blacklock, 1933), as shown in Fig. XI which

was taken from a case of miliary tuberculosis. Fig. X is the kidney from a child who died of coliform pyelonephritis; the site and shape of the lesion is the same as in the known haematogenous tuberculous lesion. In addition, linear medullary abscesses have been found in the kidneys in staphylococcal infections of the bones, which have given rise to a pyaemia. Another pathway of infection which must also be considered is the lymphatic one. Eisendrath and Kahn (1916), Eisendrath and Schultz (1916-17) and Sweet and Stewart (1914) all produced evidence from their experiments on dogs in favour of ascending infection by lymphatics. But the lesions found by these authors were not unlike those seen in a haematogenous infection with coliform bacilli. David (1918) found pyonephrosis in dogs in which he had injected coliform bacilli intravesically and then ligated the ureter. He thought the spread was via the peri-ureteral lymphatics because in all the results of blood cultures the findings were negative. Another mode of spread is from the colon by direct contiguity of tissue to the kidney. In infants the left kidney is more directly in association with the bowel than the right, and in our series the left was more often affected, but this preponderance has not been found by other workers. Also, if this mode of

infection occurred, one would expect to find lesions more commonly in the lower pole of the kidney than in the upper. Such a distribution in our experience and in that of others is most unusual.

In support of the blood stream being the pathway of infection, blood cultures were made in 40 of the cases of pyuria investigated, but in only 4, coliform bacilli were obtained. This small percentage of positive results may be due to the fact that many of the lesions were slight, or that the blood was not taken soon enough after the onset of illness and the organisms had already left the blood stream and settled in the urinary system. Other workers, Kowitz (1915), Cabot and Crabtree (1916)^(a) and Schlack (1927), have been more successful with blood cultures and have reported many positive results in cases of pyuria. Further, it is not uncommon to find coliform bacilli in blood cultures taken from children suffering from pyrexia (Blacklock, 1933), and it is just possible that in some of these cases bacilli might settle in the kidneys and cause a pyelonephritis. Findlay (1922) stated that organisms were always being excreted by the kidneys and some other condition caused them to be held up and produce inflammatory change there. In favour of this view are the

experiments of Lepper (1921) who found that intravenous injection of coliform bacilli produced only slight lesions in the kidneys of 2 out of 24 normal rabbits; if, however, the ureters were previously obstructed for 15 minutes the kidneys became vulnerable to attack and lesions of a severe nature were readily produced. On the other hand, Helmholtz and Field (1926) observed that organisms inoculated intravenously into rabbits were not recovered from the urine in the pelvis till $1\frac{1}{2}$ to 3 hours after the ureter had been obstructed. This occurred even in the presence of sucrose as a diuretic, while pus was usually found in the urine after 24 hours.

In our series, gross obstruction was rarely seen, and in support of this is the fact that we seldom observed any dilatation of the pelves or ureters, or hypertrophy of the bladder. Obstruction may be due to kinking of the ureter, to valve-like structures in the ureter or male urethra (Frontz, 1932) or occasionally to local spasm or achalasia of these tubes, which, of course, might not be demonstrable at autopsy. Further evidence pointing to a blood borne infection is that in the majority of cases, the pelves and bladder were generally less severely affected than the kidney substance, and in many cases no lesion was found in these situations on

microscopical examination. The cellular reaction in the kidneys in the acute cases was mostly cortical and organisms were found microscopically in the glomeruli and blood vessels in 4 of the 70 cases which were examined fully. It is possible that infection of the kidney due to coliform bacilli may be from the blood stream in some cases, and in others may be an ascending one from the bladder or urethra. Comparing acute pyelonephritis with tuberculous infection of the kidney, we know that the latter may be caused in some cases by blood spread of the organisms from a focus elsewhere, such as tuberculous tracheo-bronchial or mesenteric glands, or, on the other hand, by ascending infection from a tuberculous epididymitis. In our opinion such would also appear to be the case in acute pyelonephritis. In only 2 cases out of the 70 studied did the kidney lesion definitely appear to be due to ascending infection, as the medulla was more involved than the cortex, and in both of these children there was obstruction in the urinary tract below the kidneys. In conclusion it would appear to us that in cases of pyelonephritis a blood borne infection is commoner in the child than an ascending one.

3. BACTERIOLOGY.

In this part of the investigation cultures were made from well mixed catheter specimens of urine and also from the sediment. More reliance, however, was placed on the results obtained from the former, as in the latter it is difficult to be certain that the resulting growth, when scanty, is not due to contaminants. This fact may explain the results obtained by Langer and Soldin (1919), who examined catheter specimens from 138 infants, who did not suffer from pyuria, and found Streptococcus lacticus in 112 and coliform bacilli in 26 instances. They concluded that Streptococcus lacticus was normally present in infants' urine and occasionally coliform bacilli, and that there was bacterial antagonism between the two, normally suppressing the coliform bacilli, but in pyelitis the condition was reversed in favour of the latter bacilli. Further, Schwartz (1918), in a series of 63 cases of gastro-enteritis mostly under 2 years of age, recovered Gram-negative bacilli from catheter specimens of 32 of the 41 girls and 6 of the 22 boys.

Some difficulty was experienced in preparing antisera to organisms isolated from the patients' urine, owing to the animals, which were used for this purpose, losing weight

rapidly after the commencement of the inoculations. This was overcome by inoculating at the same time as the organisms 0.5 c.c. of collosol manganese intramuscularly. Further, it was noted that living organisms were tolerated better by the animals than killed ones.

From 87 specimens of urine 114 strains of organisms were isolated; the commonest bacteria present were the various coliform strains. Of the individual organisms enterococci were the most often found, then in order of frequency came B. coli communis, B. MacConkey 71 and lastly various other coliform strains. Staphylococcus aureus was found only twice. Enterococci and the various coliform bacilli found in the urine in this investigation are amongst the common normal inhabitants of the bowel (MacConkey, 1909; and Mackie, 1921). This fact is in favour of the infection having come from the intestinal tract by one of the routes already discussed.

4. SEROLOGICAL FINDINGS.

In 25 cases of pyuria agglutination tests were carried out with the sera from the patients against the organisms found in the urine. Of these, 13 (52 per cent.) showed positive results and the remaining 12 (48 per cent.) were negative. From the tests it was noted that the type of

organism, sex and age of the patient did not seem to affect agglutination results. The production of agglutinins appeared to depend on the general resistance of the patient, and the severity and extent of the lesions. In support of the latter it was found that all but one of the acute fatal cases showed positive agglutination tests, whereas the children who were also acutely ill on admission but recovered quickly with alkaline treatment, gave negative results.

Complement Fixation.

In 9 of the 25 cases in which agglutination tests were performed, the sera were also examined for antibodies by complement-fixation tests. Of these, 4 showed positive results and 5, negative. Throughout the experiments we used both untreated complement and complement treated with charcoal to remove natural immune-bodies to certain members of the colityphoid group of organisms normally found in the sera of guinea-pigs. The results of these tests, however, did not run parallel with the agglutination findings. The production of complement-fixing antibodies did not appear to depend on the type of organism or the age or sex of the patient. It did not appear to depend on the general condition of the patient or on the extent of the lesion in the urinary system.

5. EXPERIMENTAL WORK.

Experimentally it was found in this investigation that large numbers of coliform bacilli could be injected intravenously into rabbits without causing a pyelitis and without appearing in the urine. It would appear that some other factor must be present before these organisms can cause damage to the kidney in animals, e.g. obstruction (Lepper, 1921; and Helmholtz and Field, 1926), as already described. Presumably the inoculated bacilli when they reach the kidney are destroyed there by the phagocytic action of the endothelial cells (Pappenheimer, Hyman and Zenman, 1916) and are not excreted. Other authors (Lepper, 1921; Helmholtz and Beeler, 1917; Helmholtz and Bowers, 1926; and Rosenow, 1915) have had similar difficulty in producing pyelonephritis in animals with coliform strains taken from the human subject. When, however, organisms from animal sources were introduced by intravenous or intravesical inoculation, lesions were produced more easily in the group receiving intravenous injections, and the appearances suggested that the organisms had reached the kidneys by way of the blood stream; intravesical inoculation only very rarely produced ascending infection of the kidneys.

SECTION VII.

PLATES.

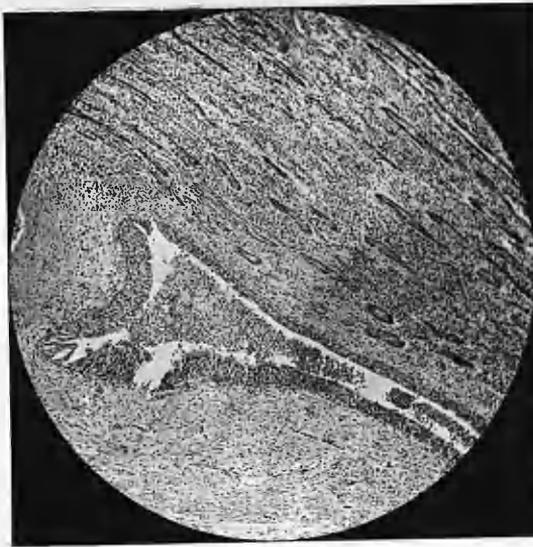


Fig.I. Male, aged 4 weeks. (Acute Pyelitis;
Acute Cystitis.)

The pelvis of the kidney is filled with polymorphonuclear cells and there is some desquamation of the epithelium. A small patch of round cells is present in the submucosa.

Haematoxylin and Eosin. x 57.

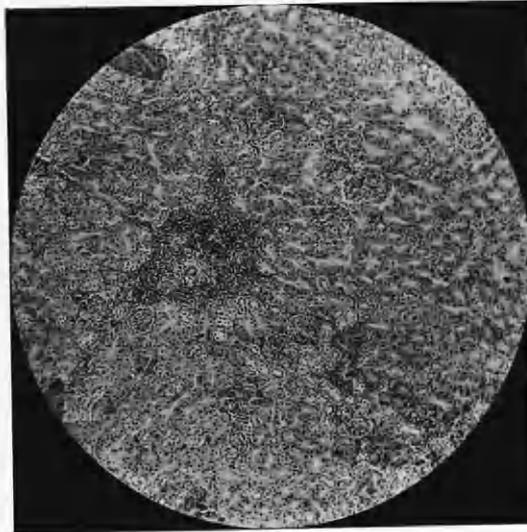


Fig.II. Female, aged 7 months. (Pyelonephritis.)

The cortex of the kidney shows a small perivascular area of round-celled infiltration.

Haematoxylin and Eosin. x 60.

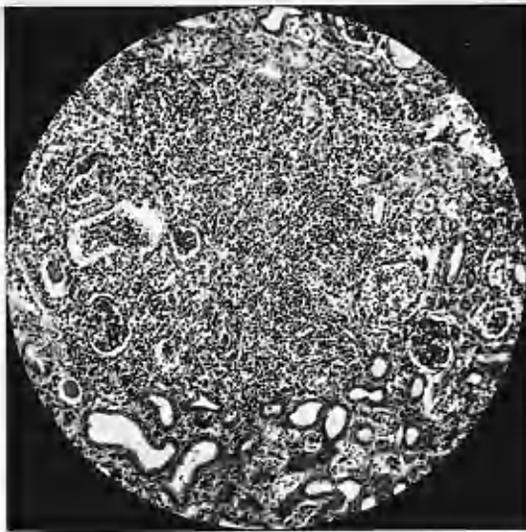


Fig.III. Male, aged 2 months. (Pyelonephritis.)

The cortex of the kidney shows an area of interstitial polymorphonuclear infiltration, and tubules filled with polymorphonuclears.

Haematoxylin and Eosin. x 92.

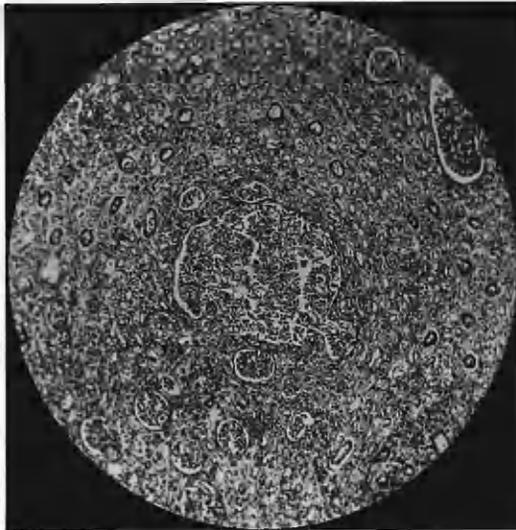


Fig.IV. Male, aged 4 weeks. (Acute Pyelonephritis.)

The medulla of the kidney shows a tubule greatly distended with polymorphonuclear cells.

Haematoxylin and Eosin. x 60.

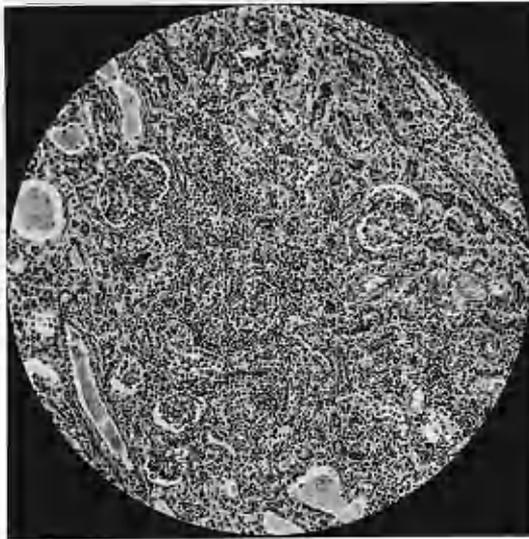


Fig.V. Female, aged 5 months. (Cystitis and Chronic Pyelonephritis and Right Hydronephrosis.)

The cortex of the kidney shows a patch of round-celled infiltration of the interstitial tissue.

Haematoxylin and Eosin. x 92.

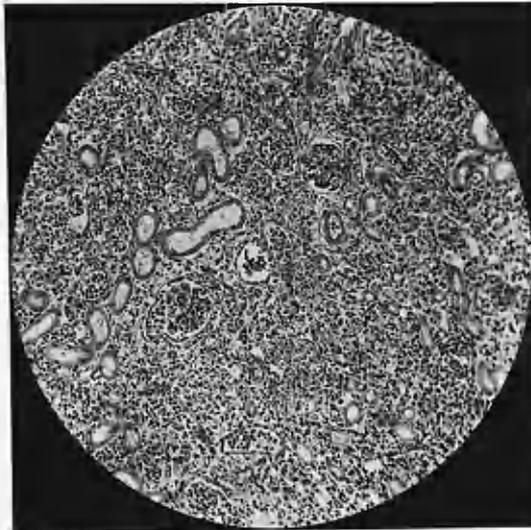


Fig.VI. Female, aged 4½ months. (Chronic Pyelonephritis.)

The cortex of the kidney shows an area of round-celled infiltration of the interstitial tissue.

Haematoxylin and Eosin. x 91.

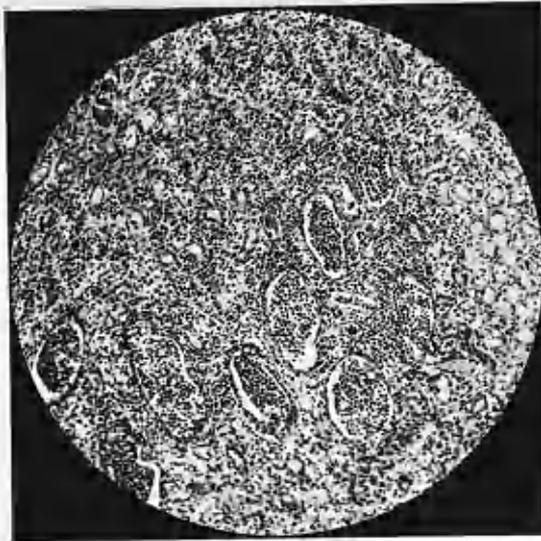


Fig.VII. Female, aged $4\frac{1}{2}$ months. (Chronic Pyelonephritis.)

The medulla of the kidney shows tubules distended with polymorphonuclear cells and surrounding round-celled infiltration.

Haematoxylin and Eosin. x 91.



Fig.VIII. Female, aged 26 weeks. (Chronic Pyelonephritis.)

The pelvis of the kidney shows much round-celled infiltration of the submucous layer.

Haematoxylin and Eosin. x 92.

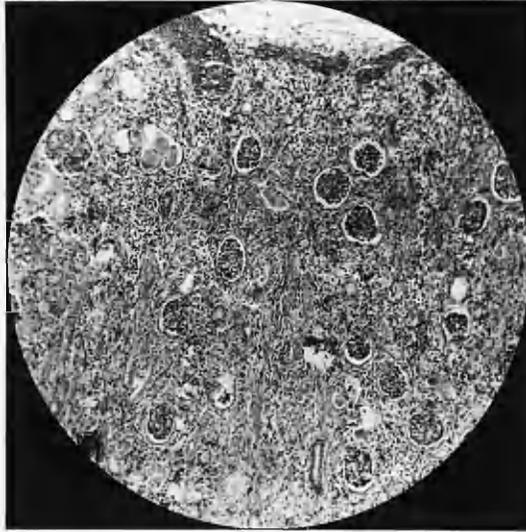


Fig.IX. Female. aged 5 $\frac{1}{2}$ months. (Chronic Pyelonephritis.)

The cortex of the kidney shows a depressed vascular area on the surface. There is slight cellular infiltration of the interstitial tissue immediately under the capsule and some early fibrosis.

Haematoxylin and Eosin. x 67.



Fig.X. Female, aged 1 year. (Acute Pyelonephritis.)

The kidney shows many abscesses. Some of these are wedge-shaped with their apices in the medulla and their bases at the surface of the kidney.

Natural Size.



Fig.XI. Female, aged 8 months. (Miliary Tuberculosis.)

The kidney shows a wedge-shaped caseous area with its apex in the medulla and its base at the surface of the kidney.

Natural Size.

SECTION VIII.

APPENDIX A.

Cases Investigated Histologically.

P.M. No. 115.

10/2/16.

FEMALE, aged 10 months.

Admitted 1/2/16. Died 9/2/16.

CLINICAL NOTES.

The child was admitted with a history of oedema of 2 weeks' duration and diminished urinary output. The urine contained a trace of albumen, pus and coliform organisms. The temperature was 100°F. Eusol was injected into the longitudinal sinus.

P.M. FINDINGS.

Pyelitis; Cystitis; Oedema; Subdural Meningitis
(Pneumococcal).

Kidneys.

Showed congestion of their substance.

Pelves.

Deeply congested, especially the left.

Bladder.

Showed thickened, irregularly congested mucosa and was moderately contracted.

HISTOLOGY.

Kidneys.

The glomeruli showed a slight amount of shedding of the epithelium covering the tufts and lining the capsules. The tubules showed some catarrhal change. There was no cellular infiltration of the interstitial tissue.

Pelves.

The submucous tissue showed a definite round-celled infiltration. A few Gram-negative bacilli and Gram-positive diplococci were noted amongst the epithelial cells lining the pelves.

30/9/16.

MALE, aged 7½ months.

Admitted 15/9/16. Died 29/9/16.

CLINICAL NOTES.

The patient had a history of vomiting and diarrhoea for one week. On 17/9/16 the urine contained a trace of albumen, casts and a few white blood corpuscles. The temperature was 103°F. On 28/9/16 he had a convulsion, early signs of broncho-pneumonia and hyperpyrexia, and the urine contained coliform bacilli.

P.M. FINDINGS.

Cystitis (Coliform); Early Broncho-pneumonia.

Kidneys.

Showed a slight degree of cortical pallor.

Ureters.

Normal.

Bladder.

The mucosa was only very slightly pink.

HISTOLOGY.

Kidneys.

A few of the glomeruli showed some lobulation of the tufts and shedding of the capsular epithelium. The tubules showed some cloudy swelling and slight catarrhal change. The interstitial tissue was normal.

Pelves.

Showed no abnormality.

Bladder.

The submucous lining appeared rather more cellular than normal, and there was slight desquamation of the epithelial lining. No organisms were seen.

23/10/16.

MALE, aged 4 months.

Admitted 11/9/16. Died 20/10/16.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of one week's duration, and the condition improved greatly after one week in hospital. Two weeks before death the temperature rose suddenly to 103°F. and pus cells, casts, coliform bacilli and streptococci then appeared in the urine.

P.M. FINDINGS.

Enteritis (minute ulcers in the lower small intestine);
Pyelitis (left) coliform.

Left Kidney.

Showed no lesion.

Left Pelvis.

Was slightly dilated and contained yellowish grains of urates and some purulent material. Films of this showed mainly mononuclear cells and many coliform bacilli.

Right Kidney.

Was pinker than the left.

Right Pelvis.

Showed no lesion.

HISTOLOGY.

Left Kidney.

A few of the glomeruli showed some lobulation and desquamation of the epithelial cells lining Bowman's capsules. There was also some desquamation of tubular epithelium. The interstitial tissue showed no abnormality.

Left Pelvis.

There was marked round-celled infiltration of the sub-mucous tissue and some desquamation of the epithelial lining. Gram-negative bacilli and Gram-positive cocci were seen lying between the epithelial cells.

Bladder.

There was a small amount of round-celled infiltration of the submucous tissue, and some desquamation of the epithelial cells of the lining. Gram-negative bacilli were seen amongst these cells.

6/5/21.

FEMALE, aged 7 months.

Admitted 25/4/21. Died 5/5/21.

CLINICAL NOTES.

The patient had a history of vomiting and diarrhoea for one week. She was acutely ill and very irritable, and nuchal rigidity was marked. The temperature rose to 105° F. 5 days after admission. The urine contained albumen and pus.

P.M. FINDINGS.

Gastro-enteritis; Eyelitis; Membranous Inflammation of the Oesophagus.

Kidneys.

They were swollen, pale and irregularly congested. The cortex was swollen and marked cloudy swelling with some catarrh was present. Some of the pyramids were deeply congested.

Pelves.

There was congestion of the mucous membrane and pus was seen in the calyces.

HISTOLOGY.

Kidneys.

The glomeruli appeared more cellular than usual and some of the tufts almost filled Bowman's capsules; in others there was desquamation of the cells covering the tuft and lining the capsule. The tubules showed cloudy swelling and some catarrhal change. The interstitial tissue showed no abnormality.

Pelves.

The epithelial lining was thickened. No organisms were seen in the sections.

22/7/21.

MALE, aged 9 weeks.

Admitted 2/6/21. Died 21/7/21.

CLINICAL NOTES.

The child was admitted with a history of convulsions. He had none after admission. He never throve well and during the last week in hospital the weight fell steadily. The temperature rose suddenly to 102°F. two days before death. No organisms were found in the urine during life.

P.M. FINDINGS.

Pyelitis; Patent Ductus Arteriosus.

Right Kidney.

The stellate veins on the surface stood out prominently and the substance of the organ was deeply congested. The cortex was swollen and granular, and there were streaks of haemorrhage in the medulla.

Right Pelvis.

The mucous membrane was congested and pus was found in the calyces.

Left Kidney.

Appeared rather pale.

Left Pelvis.

Showed no abnormality.

HISTOLOGY.

Right Kidney.

The glomeruli appeared more vascular than normal and almost completely filled Bowman's capsules. Numerous Gram-negative diplococci were seen in many of the glomeruli and in some of the vessels. The convoluted tubules showed marked cloudy swelling and some catarrhal change. The interstitial tissue appeared normal.

Right Pelvis.

There was some desquamation of the epithelial lining and a few Gram-negative diplococci were seen between the cells.

27/7/21.

MALE, aged 4 weeks.

Admitted 21/7/21. Died 26/7/21.

CLINICAL NOTES.

For one week the child had screamed when he was handled. The temperature was 103⁰F. on admission and the urine contained pus and coliform bacilli. Physical examination was negative. Diarrhoea began after admission and he died in 6 days.

P.M. FINDINGS.

Gastro-enteritis; Pyelitis.

Kidneys.

They were congested and the cortex showed cloudy swelling.

Pelves.

Both showed pyelitis.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and desquamation of the epithelium covering them and lining Bowman's capsules. The convoluted tubules showed marked cloudy swelling. The interstitial tissue showed no abnormality.

Pelves.

The submucous lining showed a slight amount of round-celled infiltration. The epithelium was not included in the sections. No organisms were seen.

P.M. No. 952.

26/8/21.

FEMALE, aged 46 weeks.

Admitted 25/8/21. Died 25/8/21.

CLINICAL NOTES.

Admitted with a history of vomiting and diarrhoea of one day's duration. She was a fairly well nourished child and the temperature was 101.2°F. She died just after admission.

P.M. FINDINGS.

Gastro-enteritis; Broncho-pneumonia; Pyelitis.

Kidneys.

Both showed cloudy swelling.

Pelves.

The mucous membrane was markedly congested and pus was present in the calyces. In films of this, coliform bacilli were seen.

HISTOLOGY.

Kidneys.

The glomeruli appeared more cellular than normal. Marked cloudy swelling was present in the tubules. The interstitial tissue appeared normal.

Pelves.

Showed some desquamation of the epithelial lining. No organisms were seen.

29/8/21.

FEMALE, aged 1 year 3 months.

Admitted 27/8/21. Died 28/8/21.

CLINICAL NOTES.

There was a history of diarrhoea and restlessness for 3 days. She was acutely ill on admission and the temperature was 105°F. The urine contained albumen, casts and white blood corpuscles. The child died 12 hours after admission.

P.M. FINDINGS.

Gastro-enteritis; Nephritis; Left Pyelitis.

Kidneys.

There was congestion of the stellate veins on the surface of the kidney. The substance was very pale and the cortical area was granular and fatty.

Left Pelvis.

Showed a definite pyelitis.

Right Pelvis.

Normal.

HISTOLOGY.

Left Kidney.

The glomeruli showed some shedding of the capsular epithelium. The convoluted tubules showed marked cloudy swelling. The interstitial tissue showed no abnormality.

Left Pelvis.

The submucous tissue appeared normal. No organisms were seen.

12/1/23.

MALE, aged 6 weeks.

Admitted 5/1/23. Died 11/1/23.

CLINICAL NOTES.

The child was admitted with a history of expulsive vomiting and constipation for 4 weeks. He was a small, emaciated child and the temperature was 101^oF. The urine contained pus and coliform bacilli on admission. The child died 6 days later.

P.M. FINDINGS.

Pyloric Stenosis; Pyelitis.

Kidneys.

In the substance of the left a few small yellowish areas could just be detected (uric acid infarctions).

Pelves.

Both showed some congestion.

Bladder.

Appeared healthy.

HISTOLOGY.

Kidneys.

Many of the glomeruli appeared more cellular than normal and there was some desquamation of the epithelial cells covering the tufts and lining the capsules. The tubules showed cloudy swelling and some catarrhal change and there were collections of uric acid in some of those in the cortex and medulla. The interstitial tissue showed no change.

Pelves.

There was some round-celled infiltration of the sub-mucous layer. The epithelium showed no abnormality but a few Gram-negative bacilli were seen between the cells.

3/2/23.

FEMALE, aged 9 months.

Admitted 11/1/23. Died 2/2/23.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of 8 weeks' duration. Broncho-pneumonia began just after admission and the urine contained albumen, epithelial casts, pus and organisms. The child died 3 weeks later.

P.M. FINDINGS.

Gastro-enteritis; Pyelitis; Broncho-pneumonia.

Kidneys.

Both showed acute congestion.

Pelves.

Both showed acute congestion.

Bladder.

Showed no congestion but contained turbid, purulent urine.

HISTOLOGY.

Kidneys.

Many of the glomeruli almost filled Bowman's capsules and there was some shedding of the epithelium covering the tufts and lining the capsules. The tubules showed catarrhal change and contained some uric acid infarctions in the cortex and medulla. The interstitial tissue appeared normal.

Pelves.

There was slight round-celled infiltration of the sub-mucous layer and some thickening and desquamation of the epithelial lining. A few Gram-negative diplococci were seen between the epithelial cells.

26/9/24.

FEMALE, aged 6 $\frac{1}{2}$ months.

Admitted 5/9/24. Died 25/9/24.

CLINICAL NOTES.

Admitted with a history of vomiting and anorexia for 5 days. On admission physical examination was negative, but the urine contained pus and coliform bacilli. Treatment had no effect and the child died 3 weeks later.

P.M. FINDINGS.

Pyelitis.

Kidneys.

Both were very pale and the cortical portions were swollen. The pyramids were acutely congested.

Pelves.

Were congested and slightly dilated; they were covered by a thin milky exudate.

Ureters.

Slightly dilated.

Bladder.

Normal.

HISTOLOGY.

Kidneys.

The glomeruli showed increased cellularity, most of them completely filling Bowman's capsules. A few showed some lobulation of the tufts and desquamation of the cells covering the tuft and lining the capsules. The tubules showed cloudy swelling and some catarrhal change. The interstitial tissue showed no abnormality.

Pelves.

The submucous tissue showed a slight degree of round-celled infiltration, and there was some desquamation of the epithelial lining.

No organisms were seen.

P.M. No. 2325.

2/11/27.

FEMALE, aged 5 weeks.

Admitted 25/10/27. Died 1/11/27.

CLINICAL NOTES.

The patient had a history of constipation and vomiting for 4 days; 4 days after admission the temperature rose to 104°F., pus and coliform bacilli appeared in the urine and right-sided otitis media was noted.

P.M. FINDINGS.

Pyloric Stenosis; Cystitis; Otitis Media (right).

Kidneys.

Showed cloudy swelling.

Pelves.

Normal.

Bladder.

There was well marked acute congestion of the lining.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and shedding of the cells covering them and lining the capsules. The tubules showed cloudy swelling and some desquamation of epithelium; many of them both in the cortex and medulla contained uric acid deposits.

Pelves.

There was marked round-celled infiltration of the sub-mucous lining and there was desquamation of the epithelial lining and some thickening in places.

Bladder.

There were many dilated blood-vessels just beneath the epithelial lining which was desquamating. Red blood corpuscles were seen lying in the tissues outside the vessels. No organisms were seen.

10/11/27.

FEMALE, aged 4½ months.

Admitted 2/11/27. Died 9/11/27.

CLINICAL NOTES.

The patient had had a cough for 10 days and diarrhoea for 4 days. On admission the temperature was 103°F. After 5 days, definite signs of pneumonia were made out. The urine contained pus and coliform bacilli.

P.M. FINDINGS.

Broncho-pneumonia; Cystitis.

Kidneys.

Showed cloudy swelling.

Pelves.

Normal.

Bladder.

Showed injection of the lining especially at the base, and also some catarrhal change.

HISTOLOGY.

Kidneys.

The glomeruli appeared congested. The tubules showed cloudy swelling and catarrhal change. The interstitial tissue showed no abnormality.

Pelves.

Not shown in the sections.

Bladder.

There was some desquamation of the epithelial lining and Gram-negative bacilli were seen lying amongst the cells.

18/12/28.

FEMALE, aged 1 year 8 months.

Admitted 4/12/28. Died 17/12/28.

CLINICAL NOTES.

The child was admitted with the signs and symptoms of a cerebral tumour. One week before death she developed retention of urine and had to be catheterised. The urine contained pus and coliform bacilli. The temperature was 101° F. on admission and rose to 104° F. on the last day.

P.M. FINDINGS.

Glio-sarcoma of Cerebellum; Cystitis.

Kidneys.

Both appeared normal.

Pelves.

They were not congested.

Ureters.

They were not congested.

Bladder.

The mucosa was markedly congested and thrown into folds.

HISTOLOGY.

Kidneys.

The glomeruli showed some shedding of the epithelial cells covering the tufts and lining the capsules. The tubules showed marked cloudy swelling and some catarrhal change. There was no change in the interstitial tissue.

Pelves.

There was some round-celled infiltration of the submucous tissue and shedding of the epithelial lining.

Ureters.

They showed no abnormality.

Bladder.

There were many dilated vessels in the submucous layer and round-celled infiltration. The epithelium was thickened and desquamating. No organisms were seen.

16/2/29.

FEMALE, aged 8 weeks.

Admitted 15/1/29. Died 14/2/29.

CLINICAL NOTES.

The child was operated on for pyloric stenosis on 17/1/29, and did not thrive well afterwards. The temperature rose to 104°F. 4 weeks later. Pus was then obtained from the left ear and pus, streptococci and coliform bacilli from the urine. On 13/2/29 the child developed diphtheria. A haemolytic streptococcus was found on blood culture on 14/2/29.

P.M. FINDINGS.

Diphtheria (laryngeal and tracheal); Pyloric Stenosis (operation); Suppurative Otitis Media.

Kidneys.

Both showed cloudy swelling.

Pelves.

Both appeared healthy.

Ureters.

Both appeared healthy.

Bladder.

Appeared healthy.

HISTOLOGY.

Kidneys.

The glomeruli appeared more cellular and vascular than normal. The tubules showed cloudy swelling and some catarrhal change. The interstitial tissue appeared normal. Serial sections were cut throughout one block and no areas of cellular infiltration were found.

Pelves.

There was slight desquamation of the epithelial lining. A number of Gram-negative bacilli and a few Gram-positive diplococci and short-chained streptococci were seen amongst the epithelial cells.

Bladder.

The findings were the same as those in the pelves.

4/5/29.

FEMALE, aged 11 months.

Admitted 25/3/29. Died 3/5/29.

CLINICAL NOTES.

The child had been pale and anaemic since birth. Vomiting and diarrhoea began 2 months previous to admission. The temperature rose to 104°F. on the second day and both ears contained pus. Ten days after admission the urine contained pus and coliform bacilli. The temperature was intermittent for 4 weeks.

P.M. FINDINGS.

Acute Cystitis; Congenital Cystic Liver; Otitis Media.

Kidneys.

Both were markedly pale.

Pelves.

Both appeared healthy.

Ureters.

Both appeared healthy.

Bladder.

The mucosa in the region of the trigone showed distinct thickening and congestion.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and shedding of the epithelium covering the tufts and lining the capsules. The convoluted tubules showed cloudy swelling and some catarrhal change. The interstitial tissue showed no change.

Pelves.

The submucous lining of the left showed much round-celled infiltration but the right showed no change.

Bladder.

There was marked round-celled infiltration of the submucous lining. There were also many plasma cells and eosinophils. There was some congestion of the vessels of the submucosa and the epithelial lining was thickened and desquamating. No organisms were noted.

14/9/29.

MALE, aged 4 weeks.

Admitted 10/9/29. Died 13/9/29.

CLINICAL NOTES.

Admitted with the physical signs of pyloric stenosis, and operated on 12/9/29. The urine contained no pus on admission. The temperature rose just after the operation to 105°F. and the child died the next day.

P.M. FINDINGS.

Pyloric Stenosis; Acute Pyelitis; Acute Cystitis.

Kidneys.

No lesion was noted.

Pelves.

Congested and the lumen filled with mucopurulent material. On making films of this, pus and coliform bacilli were seen.

Bladder.

The lining was congested and purulent urine was present. Films of this showed pus cells and coliform bacilli.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and desquamation of the cells lining the capsules. The tubules showed cloudy swelling and a few at the tip of one papilla contained polymorphonuclear cells. The blood vessels were markedly congested. There was no cellular infiltration of the interstitial tissue.

Pelves.

In the submucous tissue there was round- and plasma-celled infiltration. Some of the blood vessels there contained many polymorphonuclear cells. The epithelial lining was desquamating and masses of polymorphonuclear and epithelial cells were seen lying in the lumen (Fig. I).

Ureters.

Showed similar changes to those in the pelves.

Bladder.

A few Gram-negative bacilli were seen amongst the cells in the lumina of the pelves and bladder.

21/4/30.

MALE, aged 4 months.

Admitted 14/3/30. Died 21/4/30.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of 2 weeks' duration. The temperature rose occasionally to 101⁰F. Pus and coliform bacilli appeared in the urine 3 weeks after admission and were present for 17 days.

P.M. FINDINGS.

Gastro-enteritis; Acute Cystitis.

Kidneys.

Both showed cloudy swelling.

Pelves.

Both appeared healthy.

Ureters.

Both appeared healthy.

Bladder.

There was much irregular congestion in the trigone region.

HISTOLOGY.

Kidneys.

A few of the glomeruli showed some shedding of the epithelium covering the tufts and lining the capsules. The convoluted tubules showed marked cloudy swelling.

Pelves.

Both appeared healthy.

Bladder.

In the submucous lining there was much round-celled infiltration and congestion of the vessels. Gram-negative bacilli and Gram-positive cocci were seen amongst the lining epithelial cells which showed some thickening and desquamation.

21/4/17.

FEMALE, aged 6½ months.

Admitted 2/4/17. Died 20/4/17.

CLINICAL NOTES.

Admitted with a history of persistent vomiting of 2 months' duration. She had several convulsions 8 days after admission and on the tenth day the temperature, which had been normal, suddenly rose to 101.4° F. and pus cells and coliform bacilli then appeared in the urine.

P.M. FINDINGS.

Marasmus; Slight Hypertrophy of the Pylorus; Colitis; Cystitis (mixed); Pustular Dermatitis; Very Early Broncho-pneumonia with Asphyxial Haemorrhages.

Kidneys.

Rather congested.

Pelves.

Normal.

Ureters.

Normal.

Bladder.

Congestion of the trigone region, and a slight congestion of the rest of the lining.

HISTOLOGY.

Kidneys.

The glomeruli were congested and many of them showed some lobulation of the tufts and desquamation of the epithelium covering the tufts and lining the capsules. The convoluted tubules were the seat of cloudy swelling. In the interstitial tissue of the cortex there was a patch of round-celled infiltration and slight increase of fibrous tissue around three glomeruli.

Pelves.

The epithelium was thickened and desquamating and a few red blood corpuscles were seen between the epithelial cells.

Bladder.

There was a round- and plasma-celled infiltration of the submucous lining, desquamation of epithelium and many Gram-negative bacilli between the epithelial cells.

5/8/22.

FEMALE, aged 11 weeks.

Admitted 12/7/22. Died 4/8/22.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of 3 days' duration. The temperature rose to 103°F. on the third day in hospital and 4 days later granular casts, pus and coliform bacilli were noted in the urine. She developed broncho-pneumonia a few days before death which occurred 2 weeks after pyuria began.

P.M. FINDINGS.

Gastro-enteritis; Pyelonephritis; Broncho-pneumonia.

Right Kidney.

Showed acute congestion of the cortex and medulla.

Right Pelvis.

Contained pus.

Left Kidney.

Was pale with small points of congestion in the cortex.

Left Pelvis.

Showed no abnormality.

Ureters.

Appeared healthy.

Bladder.

Showed no abnormality.

HISTOLOGY.

Kidneys.

Some of the glomeruli showed lobulation of the tufts and shedding of their covering cells and those lining the capsules. A few polymorphonuclear cells were seen in some glomeruli. The tubules showed some catarrhal change. There were bands of congestion extending through the cortex and medulla, and in one section there was a small area of round-celled infiltration of the interstitial tissue in the medulla.

Pelves.

There was slight round-celled infiltration of the sub-mucous layer and some shedding of the lining epithelium. A few Gram-negative organisms were seen between the epithelial cells.

19/10/22.

FEMALE, aged 3 weeks.

Admitted 13/10/22. Died 19/10/22.

CLINICAL HISTORY.

Admitted with a history of vomiting and diarrhoea for one week. Physical examination was negative, but the urine contained albumen, pus and coliform bacilli. The temperature rose from normal to 102°F. 2 days before death. The child failed rapidly after admission.

P.M. FINDINGS.

Gastro-enteritis; Pyelonephritis.

Kidneys.

The substance of both was congested.

Pelves.

Both showed congestion.

Bladder.

Appeared healthy.

HISTOLOGY.

Kidneys.

Some of the glomeruli showed lobulation of the tufts and shedding of the cells covering them and lining the capsules. The convoluted tubules showed some cloudy swelling. In the interstitial tissue of the cortex and medulla a few foci of round-celled infiltration were noted.

Pelves.

The submucous tissue showed round-celled infiltration, and the epithelial layer was thickened and desquamating. A few Gram-negative bacilli were seen lying between the epithelial cells.

10/9/19.

FEMALE, aged 8½ months.

Admitted 25/8/19. Died 9/9/19.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of 3 days' duration. This cleared up a few days after admission but 10 days later pus and coliform bacilli were recovered from the urine. Both kidneys were then palpable and the temperature rose to 103°F. The child died 6 days after the onset of pyuria.

P.M. FINDINGS.

Acute Unilateral Pyelonephritis (left); Broncho-pneumonia.

Right Kidney.

No abnormality was noted.

Left Kidney.

Was much enlarged and congested. It was firm and swollen but no definite abscesses were noted on naked-eye examination.

Left Pelvis.

Was much congested and reddened. Pus was expressed from the pyramids and in films of this material abundant coliform bacilli were found.

Bladder.

The mucosa was thickened, reddened and oedematous.

HISTOLOGY.

Kidneys.

Sections of the right kidney showed no abnormality. In sections of the left kidney the glomeruli showed some desquamation of the epithelial cells lining Bowman's capsules and some contained polymorphonuclear cells. The tubules showed catarrhal change and many were distended with polymorphonuclear cells. In the interstitial tissue there were many foci of polymorphonuclear infiltration in the cortex and medulla. There was also some perivascular round-celled infiltration. Many Gram-negative bacilli and a few Gram-positive cocci were seen amongst the polymorphonuclears in the tubules and interstitial tissue.

Pelvis.

This was not shown in the section.

3/1/22.

MALE, aged 4 months.

Admitted 21/12/22. Died 31/12/22.

CLINICAL NOTES.

The child had a history of vomiting and constipation for one month. He had 21 convulsions during the 4 days before admission. He was a poorly nourished child and nuchal rigidity was very marked. There was a trace of pus in the urine on admission, but 7 days later a large amount of pus and many organisms were noted.

P.M. FINDINGS.

Abscesses in Kidneys; Pyelitis.

Left Kidney.

Showed a moderate degree of pyonephrosis. Numerous small abscesses were present in the pyramids, in some the whole pyramid was involved up to the surface of the cortex.

Left Pelvis.

The mucous membrane was swollen and congested.

Left Ureter.

The lumen was dilated and the orifice projected slightly into the bladder and was swollen and congested.

Right Kidney.

A small abscess was noted at the apex of one pyramid and the surrounding kidney tissue was intensely congested.

Right Pelvis.

The mucous membrane was swollen and congested.

Bladder.

No cystitis was evident.

HISTOLOGY.

Kidneys.

The glomeruli showed a slight degree of lobulation of the tuft and shedding of the epithelium covering it and lining the capsule. The tubules showed catarrhal change and those in the areas of infiltration were distended with polymorphonuclear cells. In the interstitial tissue of the cortex and medulla there were numerous areas of polymorphonuclear infiltration and there was also great destruction of the kidney substance. Many Gram-negative bacilli and some Gram-positive cocci were seen in the areas of infiltration and amongst the polymorphonuclears in the tubules. In the submucous tissue there was a marked round-celled infiltration. The epithelial cells were desquamating and some polymorphonuclear cells were seen lying between them, as well as many Gram-negative bacilli and a few Gram-positive cocci.

24/1/22.

FEMALE, aged 1 year 4 months.

Admitted 6/1/22. Died 23/1/22.

CLINICAL NOTES.

The child was admitted suffering from tetany. On examination the physical signs of broncho-pneumonia were present. The tetany improved in one week. The temperature rose suddenly on 18/1/22 and for the first time pus cells and organisms were found in the urine.

P.M. FINDINGS.

Abscesses in Kidneys; Double Pyelitis; Broncho-pneumonia.

Kidneys.

Multiple abscesses in cortex and medulla.

Pelves.

Double pyelitis was present.

Ureters.

Dilated.

Bladder.

The mucosa was swollen and congested. The ureterovesical orifices were obstructed by the swollen bladder mucosa, but a probe could be passed into the ureters, showing that no organic stenosis was present.

HISTOLOGY.

Kidneys.

The glomeruli in the affected areas showed some lobulation of the tuft and a few of them contained polymorphonuclear cells. The tubules showed catarrhal change and were greatly distended with polymorphonuclears and desquamated epithelial cells in the areas of infiltration. In the interstitial tissue, particularly in the medulla, were areas of polymorphonuclear infiltration. A few round cells were also seen in those areas. No organisms were seen in any of the sections.

11/3/22.

MALE, aged 3½ months.

Admitted 4/3/22. Died 10/3/22.

CLINICAL NOTES.

The child was admitted with a history of abdominal pain and jaundice of one week's duration, and with cough and dyspnoea for 2 days. On admission he had nuchal rigidity, was irritable and looked acutely ill. Four days later the temperature rose to 105°F. and he died 7 days after admission. The urine contained pus and coliform bacilli all the time in hospital.

P.M. FINDINGS.

Multiple Abscesses in Kidneys.

Kidneys.

Multiple abscesses were present in both, with purulent exudate in the perirenal tissue.

Pelves.

Both appeared healthy.

Bladder.

The lining was slightly congested.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and desquamation of the epithelium covering them and lining the capsules. The tubules showed marked catarrhal change and were distended with polymorphonuclears and desquamated epithelial cells. The interstitial tissue of the cortex and medulla showed great infiltration with polymorphonuclear cells. No organisms were seen.

Pelves.

These were not shown in the sections.

5/6/25.

FEMALE, aged 9 months.

Admitted 1/6/25. Died 4/6/25.

CLINICAL NOTES.

The child was admitted with a history of pallor of 10 days' duration and a cough for 3 days. She was a well nourished child but was pale and acutely ill, with definite tenderness over both kidneys. The temperature was normal. The urine contained pus and coliform bacilli.

P.M. FINDINGS.

Pyelonephritis; Cystitis; Terminal Broncho-pneumonia.

Kidneys.

Many abscesses were scattered throughout the substance. The areas between showed fatty change.

Pelves.

Showed congestion and marked catarrhal change with pus in the lumina.

Bladder.

The mucosa showed irregular patches of hyperaemia and contained purulent urine in films of which many coliform bacilli were seen.

HISTOLOGY.

Kidneys.

The glomeruli showed much lobulation of the tufts and desquamation of the cells covering them and lining the capsules. The tubules showed slight cloudy swelling and catarrhal change. In the interstitial tissue were areas of polymorphonuclear infiltration and in these areas the tubules also contained many polymorphonuclears and desquamated epithelial cells.

Pelves.

These were not properly shown in the sections, but the submucous layer showed no change. No organisms were seen.

12/10/25.

MALE, aged 11 months.

Admitted 9/10/25. Died 11/10/25.

CLINICAL NOTES.

The child was admitted with a history of diarrhoea of 4 days' duration. On admission there was generalised oedema of the body and a septic rash. The urine contained pus and coliform bacilli. The child died 2 days after admission.

P.M. FINDINGS.

Pyelonephritis; Septicaemia.

Kidneys.

Both kidneys, but especially the left, were enlarged and pale. The capsule stripped easily, leaving an irregular surface due to many small cortical abscesses with peripheral zones of congestion. The cut surface was pale and oedematous and studded with numerous abscesses some of which had coalesced to form large pale soft areas.

Pelves.

Both were much congested and the mucosa slightly thickened.

Ureters.

Were not dilated.

Bladder.

The trigone region showed slight injection and catarrhal change.

HISTOLOGY.

Kidneys.

There was slight desquamation of the cells covering the glomerular tufts and lining Bowman's capsules. The tubules showed some catarrhal change and were distended with polymorphonuclear cells and some of these were seen in the walls of the tubules. Areas of infiltration of the interstitial tissue of the cortex and medulla with polymorphonuclears and destruction of kidney tissue were seen. There was also some round-celled infiltration. Clumps of Gram-negative organisms were demonstrated in the centres of the inflammatory areas.

Pelves.

The submucous layer showed slight round-celled infiltration but no organisms were noted.

23/11/25.

MALE, aged 2 months.

Admitted 17/11/25. Died 20/11/25.

CLINICAL NOTES.

The patient had been losing weight since he was 3 weeks old, and had vomited the day before admission. He was very poorly nourished and the temperature was 101°F. Both kidneys were palpable and the urine contained pus and coliform bacilli.

P.M. FINDINGS.

Gastro-enteritis; Pyelonephritis.

Kidneys.

Numerous small abscesses were scattered throughout the cortical portions but none had broken down.

Pelves.

Showed well marked acute pyelitis with much purulent exudate.

Bladder.

Showed slight injection in the region of the trigone.

HISTOLOGY.

Kidneys.

The glomeruli showed some desquamation of the epithelium covering the tuft and lining the capsule, and in a few, polymorphonuclears were seen. The tubules showed catarrhal change and many, in the areas of infiltration, were distended with polymorphonuclears and desquamated epithelial cells. In some places the tubule wall had broken down and the mass of polymorphonuclears within the tubule was continuous with the infiltration surrounding the tubule. In the interstitial tissue of the cortex were numerous areas of polymorphonuclear infiltration. Around some of the tubules and vessels in the cortex there was some round-celled infiltration. Gram-negative organisms were seen in many of the tubules amongst the polymorphonuclear cells, and also in the areas of infiltration.

24/10/27.

FEMALE, aged 45 weeks.

Admitted 9/10/27. Died 23/10/27.

CLINICAL NOTES.

Admitted with a history of vomiting and diarrhoea for 24 hours and having had one convulsion. She was a very poorly nourished child, and the temperature was 102°F. Five days after admission pus cells, casts and coliform bacilli appeared in the urine and there was marked nuchal rigidity. The fever persisted till she died 9 days later.

P.M. FINDINGS.

Pyelonephritis; Gastro-enteritis; Suppurative Otitis Media.

Kidneys.

Several small abscesses were noted, mostly in the cortical regions.

Pelves.

No macroscopic lesion was noted.

Bladder.

Showed slight injection of the lining.

HISTOLOGY.

Kidneys.

Some of the glomeruli showed shedding of the epithelium covering the tuft and lining the capsule. The tubules showed cloudy swelling and some catarrhal change, and contained many polymorphonuclear cells in the affected areas. In some places these cells were seen in the wall of the tubule where it had broken down. In the interstitial tissue of the cortex and medulla there were several areas of polymorphonuclear infiltration and some round cells were also noted in these areas. Many Gram-negative organisms were seen in those areas and also amongst the polymorphonuclear cells in the tubules.

9/5/28.

MALE, aged 6 months.

Admitted 23/4/28. Died 8/5/28.

CLINICAL NOTES.

The child was admitted with a history of diarrhoea and vomiting of one week's duration. On admission the temperature was 105°F. and there was marked nuchal rigidity. The urine contained pus and coliform bacilli and Streptococcus faecalis.

P.M. FINDINGS.

Acute Pyelonephritis with Abscesses in Kidneys; Acute Broncho-pneumonia; Acute Otitis Media.

Kidneys.

Numerous abscesses were present chiefly in the cortical areas immediately under the capsule.

Pelves.

Both were injected and the mucous membrane had a granular appearance.

Ureters.

No lesion was found.

Bladder.

Appeared healthy.

HISTOLOGY.

Kidneys.

A few of the glomeruli contained polymorphonuclears, and showed some lobulation of the tufts and shedding of the epithelium covering them and lining the capsules. The tubules showed marked cloudy swelling and were distended with polymorphonuclears and desquamated epithelial cells. In the interstitial tissue were areas of polymorphonuclear infiltration, mostly in the cortical areas. Clumps of organisms were seen in these areas and a few were also noted in the glomeruli and vessels, most of these Gram-negative bacilli but a few Gram-positive cocci were also present.

Pelves.

They showed no lesions.

22/6/28.

FEMALE, aged 1 year.

Admitted 20/6/28. Died 21/6/28.

CLINICAL NOTES.

The child was admitted with a history of having eaten ice cream 6 days previously. This was followed by pain on micturition, constipation, vomiting and nuchal rigidity. On admission she appeared fairly well nourished and the temperature was 104⁰F. The urine contained sugar, acetone, pus and coliform bacilli. The blood sugar was high. She died 24 hours after admission.

P.M. FINDINGS.

Pyelonephritis; Longitudinal Sinus Thrombosis;
Meningeal Thrombosis.

Kidneys.

Multiple abscesses were present in the cortex and medulla.

Pelves.

No lesion was noted.

Bladder.

No lesion was noted.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and desquamation of the cells covering them and lining the capsules. The tubules were distended with polymorphonuclear cells, and many showed cloudy swelling and some catarrhal change. In the interstitial tissue areas of polymorphonuclear infiltration were present, alongside some of these were areas of round-celled infiltration. Gram-negative bacilli were seen in the tubules amongst the polymorphonuclears.

Pelves.

The submucous tissue showed some round-celled infiltration.

Bladder.

There was a slight perivascular round-celled infiltration of the submucous layer.

21/10/29.

MALE, aged 3 months.

Admitted 14/10/29. Died 20/10/29.

CLINICAL NOTES.

The child was admitted with a history of jaundice for 2½ months. Nine days before admission he began to vomit. He was a poorly nourished child and the urine contained pus and coliform bacilli. The temperature rose to 103°F. 2 days after admission and he died 4 days later.

P.M. FINDINGS.

Acute Broncho-pneumonia; Atresia of Bile Ducts;
Pyelonephritis; Acute Cystitis.

Kidneys.

There was irregular congestion of both kidneys, and small pin-head abscesses were present confined to the cortex and most numerous in the right kidney, where they were surrounded by a zone of congestion. The cortex of the left kidney showed only an occasional small abscess.

Right Pelvis.

Pus was present in the lumen and the lining was markedly congested.

Left Pelvis.

Normal.

Ureters.

Both showed slight congestion.

Bladder.

The mucosa showed catarrhal change and was covered by a layer of purulent material.

HISTOLOGY.Right Kidney.

The glomeruli showed some lobulation of the tufts and desquamation of the epithelium covering them and lining the capsules. Some of the glomeruli contained polymorphonuclear cells. The tubules were distended with desquamated cells and polymorphonuclears, and showed catarrhal change. In the interstitial tissue of the cortex and medulla were areas of polymorphonuclear infiltration. Gram-negative organisms were noted in the inflammatory areas.

Left Kidney.

No areas of infiltration were seen in the interstitial tissue but there was a wedge-shaped area in the cortex where the fibrous tissue was increased.

Right Pelvis.

The submucous tissue showed much round-celled infiltration and there was desquamation of the epithelial lining. Gram-negative organisms were seen amongst the epithelial cells.

Bladder.

Showed no change apart from some desquamation of the epithelial lining.

11/1/30.

MALE, aged 4 weeks.

Admitted 11/1/30. Died 11/1/30.

CLINICAL NOTES.

The child was admitted with a history of wasting for 3 weeks and jaundice for one week. On admission he was very emaciated and the urine contained pus and coliform bacilli. He died shortly after admission.

P.M. FINDINGS.

Acute Pyelonephritis; Acute Cystitis; Toxic Jaundice; Acute Broncho-pneumonia; Acute Gastro-enteritis.

Kidneys.

Both were definitely enlarged and had a lobular surface. There was a diffuse septic nephritis involving all parts. Innumerable pin-point abscesses were present scattered throughout the renal parenchyma, involving both the cortex and medulla.

Pelves.

Both were markedly congested and contained purulent fluid.

Left Ureter.

Was dilated and injected; it ended blindly at the bladder wall.

Right Ureter.

Was slightly dilated and opened into the bladder through a narrow orifice.

Bladder.

Showed well marked cystitis.

HISTOLOGY.

Kidneys.

The glomeruli showed some shedding of the epithelium covering the tufts and lining the capsules. Many of the tubules were distended with polymorphonuclears and desquamated epithelial cells. The interstitial tissue showed areas of polymorphonuclear infiltration, some of these amounting to actual abscess formation. Many Gram-negative bacilli were present in these areas.

Pelves.

There was some desquamation of the epithelial lining cells and polymorphonuclears were seen amongst them.

Ureters.

Showed much desquamation of epithelium and the lumen was filled with polymorphonuclears and desquamated epithelial cells.

Bladder.

The vessels in the submucous layer showed congestion and there was some shedding of the epithelial cells.

10/2/30.

MALE, aged 25 weeks.

Admitted 3/2/30. Died 9/2/30.

CLINICAL NOTES.

The child was admitted with a history of shaking of the head and vomiting of 3 days' duration. On admission he looked acutely ill, was pale and irritable and had nuchal rigidity. The temperature ranged from 104°F. to 105°F.; both kidneys were palpable and the urine contained pus and coliform bacilli.

P.M. FINDINGS.

Acute Pyelonephritis; Suppurative Otitis Media.

Kidneys.

Much enlarged, especially the left. Both showed many small roundish abscesses in the cortex, projecting from the surface of the kidney. Those in the pyramidal area were more elongated.

Pelves.

Both were congested.

Ureters.

Both were slightly dilated in the upper third and the mucosa was congested.

Bladder.

Showed slight congestion round the ureteral openings.

HISTOLOGY.

Kidneys.

The glomeruli were more cellular than normal and there was some lobulation of the tufts and shedding of their covering epithelium and that lining the capsule. The tubules showed some catarrhal change and were distended with polymorphonuclears and desquamated epithelial cells. In the interstitial tissue of the cortex and medulla there were areas of polymorphonuclear infiltration. Some of these were wedge-shaped with their base along the surface of the kidney. There was also some perivascular round-celled infiltration. Clumps of Gram-negative bacilli were noted in the inflammatory areas.

Pelves.

There was some congestion of the vessels and there were round-celled infiltrations in the submucosa. Gram-negative bacilli were seen between the epithelial lining cells.

Ureters.

Both showed similar changes.

Bladder.

Appeared healthy.

17/3/30.

MALE, aged 11 months.

Admitted 10/3/30. Died 16/3/30.

CLINICAL NOTES.

The child was admitted with a history of convulsions, anorexia, irritability and wasting of 4 days' duration. He was a well nourished child and had marked nuchal rigidity on admission. The temperature was 103°F. and there was tenderness in both flanks. The urine contained pus and coliform bacilli. The blood culture was negative. The child died 6 days after admission.

P.M. FINDINGS.

Acute Pyelonephritis; Cystitis; Acute Otitis Media
(right).

Kidneys.

Numerous cortical abscesses and a few medullary ones were present.

Pelves.

Showed slight congestion.

Bladder.

The vessels in the region of the trigone were congested.

HISTOLOGY.

Kidneys.

Many of the glomeruli showed lobulation of the tufts and shedding of the epithelium covering them and lining the capsules. The tubules showed marked cloudy swelling and were distended with polymorphonuclears and desquamated epithelial cells. In the interstitial tissue were areas of polymorphonuclear infiltration. These were mostly cortical and many of them were wedge-shaped with the base along the surface of the kidney. A few Gram-negative bacilli were present in these areas amongst the polymorphonuclear cells.

Pelves.

No lesions were noted but some Gram-negative bacilli were noted amongst the epithelial cells of the lining.

Ureters and Bladder.

There was some perivascular round-celled infiltration of the submucous lining and a few Gram-negative bacilli amongst the epithelial lining cells.

7/4/30.

MALE, aged 4 months.

Admitted 1/4/30. Died 6/4/30.

CLINICAL NOTES.

The child was admitted with a history of vomiting and irritability of 2 weeks' duration, fever for 4 days and occasional loose, green stools for 2 days. He was well nourished but pale and acutely ill. Slight nuchal rigidity was present. The urine contained pus and coliform organisms.

P.M. FINDINGS.

Acute Pyelo-nephritis; Acute Otitis Media (both).

Kidneys.

Numerous abscesses were present in the cortex, some immediately under the capsule, and a few were seen in the pyramids.

Pelves.

Slight injection of both was present.

Bladder.

Some vessels were injected.

HISTOLOGY.

Kidneys.

The glomeruli showed increased cellularity and in many of them the tuft was lobulated and there was desquamation of the epithelium covering the tuft and lining the capsule. The tubules showed cloudy swelling and many of them contained polymorphonuclear cells. In the interstitial tissue of the cortex there were numerous areas of polymorphonuclear infiltration, and a few of these areas were also seen in the medulla.

Pelves.

In the submucous tissue there was a slight amount of round-celled infiltration, and there was some desquamation of the epithelial lining, and Gram-negative organisms were seen between the cells.

Ureters.

Showed exactly the same changes as the pelves.

Bladder.

Showed very slight desquamation of the epithelial lining.

31/5/30.

MALE, aged 7 weeks.

Admitted 28/5/30. Died 31/5/30.

CLINICAL NOTES.

The child was admitted with a history of vomiting 4 days before admission. He was a small emaciated child and vomited every feed after admission. The temperature was normal. He died after 2 days in hospital.

P.M. FINDINGS.

Acute Pyelonephritis (right).

Right Kidney.

Some perirenal suppuration was noted. There was a large abscess involving practically the whole of the lower pole of the kidney and a small abscess, the size of a hazel nut, was found in the upper pole. Numerous small abscesses were seen throughout the rest of the kidney. Films from the pus showed Staphylococcus aureus.

Right Pelvis.

Showed a slight degree of congestion.

Left Kidney.

Showed no lesion.

Left Pelvis.

Showed no lesion.

Bladder.

Appeared healthy.

HISTOLOGY.

Right Kidney.

The glomeruli showed some lobulation of the tufts and desquamation of the cells covering them and lining the capsules. There were no polymorphonuclear cells in the tubules. Many abscesses were seen in the interstitial tissue with great destruction of the kidney substance. Gram-positive organisms were seen in the abscesses.

Right Pelvis.

Appeared healthy.

27/4/15.

MALE, aged 9 months.

Admitted 5/3/15. Died 26/4/15.

CLINICAL NOTES.

The child was admitted with a history of loss of weight of 2 months' duration. Pus and coliform bacilli appeared in the urine 10 days after admission, and the temperature rose to 101^oF. The child died 6 weeks after pyuria began.

P.M. FINDINGS.

Chronic Pyelonephritis (right); Cystitis; Dilatation of Left Ureter.

Right Kidney.

Showed slight pallor. A minute pale focus with congested peripheral zone was present in the cortex.

Left Kidney.

Appeared healthy.

Pelves.

There was some dilatation of the lumen of the right.

Ureters.

There was dilatation of the left and some hypertrophy but the opening into the bladder was free to a probe.

Bladder.

The mucosa was injected, especially at the left ureter opening.

HISTOLOGY.

Kidneys.

The glomeruli appeared more cellular than normal and many of them almost filled Bowman's capsules. The tubules showed cloudy swelling. In the right kidney there was a small wedge-shaped area, with its base along the surface of the cortex, composed of round-celled infiltration and increase of fibrous tissue. Dilated vessels were seen on the surface of the kidney. No organisms were noted.

Pelves.

These were not present in the sections.

23/8/15.

FEMALE, aged 1 year.

Admitted 19/8/15. Died 22/8/15.

CLINICAL NOTES.

The child was admitted with a history of broncho-pneumonia and gastro-enteritis. She had not seemed well for one month since an attack of measles. The temperature rose from 101°F. to 103°F. and the urine contained tube casts, pus cells and epithelial debris. She died 3 days after admission.

P.M. FINDINGS.

Broncho-pneumonia; Pyelonephritis.

Right Kidney.

Was pale and the cortex was swollen.

Left Kidney.

Showed marked blurring of the markings in the middle portion of the organ with acute congestion and small haemorrhages. There were paler streaks in the cortex suggesting suppurative nephritis. Pure, short coliform bacilli were seen in films from these areas.

Pelvis.

Was not congested.

Left Renal Artery.

Contained white thrombus.

HISTOLOGY.

Right Kidney.

Showed no abnormality apart from cloudy swelling.

Left Kidney.

The glomeruli showed some desquamation of the cells lining Bowman's capsules. The tubules showed cloudy swelling, and many of the collecting ones were distended with polymorphonuclear cells. In the interstitial tissue of the cortex and medulla were many areas of round-celled infiltration and early fibrosis. Many Gram-negative bacilli were seen amongst the polymorphonuclear cells in the tubules and some were also seen in the glomeruli and blood vessels.

Pelvis.

Appeared healthy.

30/6/17.

FEMALE, aged 1 year.

Admitted 15/6/17. Died 30/6/17.

CLINICAL NOTES.

The child was admitted with a history of vomiting, diarrhoea and loss of weight of one month's duration. Pus and coliform bacilli were noted in the urine 5 days after admission and the temperature rose to 103°F.

P.M. FINDINGS.

Marasmus; Septic (coliform) Infection of Urinary Tract.

Left Kidney.

Was dark in colour and slightly congested.

Right Kidney.

Was injected and showed two or three septic foci in the cortex.

Ureters.

Both appeared to be slightly enlarged.

Bladder.

Showed a few haemorrhagic foci in the mucosa.

HISTOLOGY.

Kidneys.

The glomeruli showed increased cellularity and many almost completely filled Bowman's capsules. A few of them contained polymorphonuclear cells. The tubules showed definite catarrhal change. In the interstitial tissue were many scattered patches of round-celled infiltration of the cortex and medulla with increase of fibrous tissue in these areas. Many of them were wedge-shaped with the base of the wedge along the surface of the kidney.

Pelves.

The submucous layer showed much infiltration with round cells. There was desquamation of the epithelial lining cells and some Gram-negative bacilli were seen lying between these cells.

10/8/20.

FEMALE, aged 4½ months.

Admitted 9/8/20. Died 9/8/20.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of 8 weeks' duration and a purpuric rash for 3 weeks. The temperature was 103.4°F. and she died a few hours after admission.

P.M. FINDINGS.

Streptococcal Septicaemia; Abscesses in the Kidneys; Purpura.

Kidneys.

Both were pale and fatty. Several small abscesses were found in the substance especially towards the cortex and under the capsule. Films from these showed streptococci and coliform bacilli.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and shedding of the epithelium covering them and lining the capsules. The tubules showed some catarrhal change and many, especially the collecting ones in the medulla, were distended with polymorphonuclear and desquamated epithelial cells. In the interstitial tissue were many areas of round-celled infiltration and increased fibrous tissue. Some of these were wedge-shaped with the base of the wedge along the surface of the kidney. There were also a few foci where the infiltration was mostly polymorphonuclear. Gram-negative bacilli and Gram-positive cocci were noted in the tubules amongst the polymorphonuclear cells.

Pelves.

The submucous layer showed a slight degree of round-celled infiltration. There was some desquamation of the epithelial lining cells and a few polymorphonuclear cells and bacilli were noted amongst them.

10/11/20.

MALE, aged 7 weeks.

Admitted 1/11/20. Died 9/11/20.

CLINICAL NOTES.

The child was admitted with a history of never having thriven and of having jaundice till one week before admission. He was very pale and the urine contained pus, coliform bacilli and streptococci. The temperature rose to 102°F. after 2 days in hospital, and he died one week later.

P.M. FINDINGS.

Pyelonephritis; Septicaemia.

Kidneys.

Both were enlarged. Numerous small abscesses were scattered through the cortical and medullary portions. The intervening substance was pale and oedematous and showed marked cloudy swelling.

Pelves.

The mucosa was congested.

Bladder.

Appeared healthy but contained a small amount of turbid urine.

The heart's blood was very watery and in films of it streptococci were found.

HISTOLOGY.

Kidneys.

Some of the glomeruli contained polymorphonuclear cells, and many of them almost completely filled Bowman's capsules. The tubules showed catarrhal change and many of them contained polymorphonuclears. In the interstitial tissue there were areas of round-celled infiltration and increased fibrous tissue. There were also many areas of polymorphonuclear infiltration present, representing a more recent infection. Gram-negative bacilli were seen in these areas and also in the tubules.

Pelves.

The mucosa showed some round-celled infiltration.

15/11/20.

MALE, aged 13 weeks.

Admitted 20/10/20. Died 14/11/20.

CLINICAL NOTES.

The child was admitted with a history of vomiting of 6 days' duration. He was a well nourished child but appeared acutely ill, had marked nuchal rigidity and the temperature was 105°F. The right kidney was palpable and the urine contained pus, coliform bacilli and streptococci. Death occurred 4 weeks later.

P.M. FINDINGS.

Pyelonephritis; Gastro-enteritis.

Kidneys.

Both showed irregular congestion. In the cortical areas numerous small bluish patches were noted.

Pelves.

Both showed congestion of the mucosa.

HISTOLOGY.

Kidneys.

The glomeruli showed some desquamation of the epithelial cells covering the tufts and lining the capsules. There was some increase of fibrous tissue surrounding some of the glomeruli. The tubules showed some cloudy swelling. In the interstitial tissue there were bands of increased fibrous tissue running from the cortex to the medulla. In these areas there was much round-celled infiltration.

Pelves.

Both appeared healthy. No organisms were noted.

4/10/21.

FEMALE, aged 7 months.

Admitted 10/8/21. Died 3/10/21.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of 8 days' duration. One month after admission pus, coliform bacilli and streptococci were found in the urine and the temperature rose to 103°F. She lost weight steadily after this and died 4 weeks later.

P.M. FINDINGS.

Gastro-enteritis; Pyelonephritis (left).

Right Kidney.

Appeared healthy.

Left Kidney.

Was enlarged and showed a mottled appearance due to zones of yellowish colour in the cortex and medulla.

Pelvis.

The vessels on the surface of the lumen were very congested.

Ureter.

The vessels on the surface of the lumen were very congested.

Bladder.

Appeared healthy, but contained turbid urine.

HISTOLOGY.

Left Kidney.

The glomeruli appeared more cellular than normal and there was some desquamation of the cells covering the tufts and lining the capsules. The tubules showed some catarrhal change and many were distended with polymorphonuclear cells. In the interstitial tissue there were many areas of increased fibrous tissue running in bands through the cortex and medulla and showing much round-celled infiltration. Many Gram-negative bacilli were seen in the tubules amongst the polymorphonuclears and also in the fibrosed areas.

Pelvis.

There was a slight amount of round-celled infiltration of the submucous layer and there was thickening of the epithelial lining.

12/4/22.

MALE, aged 6 weeks.

Admitted 3/4/22. Died 12/4/22.

CLINICAL NOTES.

The child was admitted with a history of persistent vomiting for 3 weeks. He was a small emaciated child, and the temperature was 101° F. The urine contained pus and organisms. He died 9 days after admission.

P.M. FINDINGS.

Pyelonephritis.

Left Kidney.

The left was larger than the right, due to numerous abscesses in the substance which varied in size and tended to be arranged in small groups with congested margins. Elongated abscesses were also noted in the medulla.

Left Pelvis.

The mucosa was hyperaemic.

Right Kidney.

Was markedly congested but no abscesses were present.

Right Pelvis.

Appeared healthy.

Bladder.

The mucosa appeared healthy. The organ was distended with comparatively clear fluid.

HISTOLOGY.

Kidneys.

Some of the glomeruli contained polymorphonuclears. Albuminous material was present inside the capsules, in many compressing the tufts. The tubules showed some catarrhal change. Around some of the glomeruli were areas of round-celled infiltration of the interstitial tissue with increase of fibrous tissue.

Pelves.

There was slight round-celled infiltration of the sub-mucous layer and some desquamation of the epithelial lining cells. A few Gram-negative bacilli were noted between these cells.

23/10/22.

FEMALE, aged 10 months.

Admitted 9/10/22. Died 23/10/22.

CLINICAL NOTES.

The child was admitted with a history of diarrhoea and vomiting for one week. She was a well nourished child, the temperature was 102°F. and the urine contained pus and coliform bacilli. The blood culture was negative. She died 2 weeks after admission.

P.M. FINDINGS.

Pyelonephritis.

Kidneys.

Both were slightly enlarged and showed congestion of the substance.

Pelves.

Both showed acute congestion.

Ureters.

Both showed acute congestion.

Bladder.

The mucosa was congested.

HISTOLOGY.

Kidneys.

Some of the glomeruli contained polymorphonuclear cells. Many showed lobulation of the tufts and shedding of the epithelium covering them and lining the capsules. The tubules showed cloudy swelling and contained polymorphonuclears in the areas of infiltration which were present in the interstitial tissue. The areas were scattered through the cortex and medulla and showed increased fibrous tissue and round-celled infiltration. A few polymorphonuclear cells were also seen in some of these areas.

Pelves.

The submucous layer appeared normal but there was some shedding of the epithelial lining cells. Gram-negative bacilli and a few Gram-positive cocci were seen amongst these cells.

Bladder.

Both these types of organisms were also seen amongst the epithelial lining cells of the bladder. The epithelium was thickened.

P.M. No. 1214.

2/2/23.

MALE, aged 8 weeks.

Admitted 24/12/22. Died 1/2/23.

CLINICAL NOTES.

The child was admitted with a history of diarrhoea of 7 days' duration. He was a well nourished child and the temperature was 101°F. The urine contained pus and coliform bacilli, but was clear one week before death. The child lost weight while in hospital.

P.M. FINDINGS.

Pyelitis.

Kidneys.

Both showed congestion of the substance.

Pelves.

Both were congested.

HISTOLOGY.

Kidneys.

The glomeruli appeared more cellular than normal and there was some shedding of the epithelium covering the tufts and lining the capsules. The tubules showed cloudy swelling and some catarrhal change. In the interstitial tissue in one section there was an area of round-celled infiltration with increase of fibrous tissue running in a band from the surface of the cortex into the medulla surrounding the glomeruli, vessels and tubules. No organisms were seen.

8/12/22.

FEMALE, aged 1 year.

Admitted 6/12/22. Died 7/12/22.

CLINICAL NOTES.

The child was admitted with a history of broncho-pneumonia 3 months previously and had not thriven well since that time. She vomited 3 days before admission and the temperature was 102°F. The urine contained pus and organisms.

P.M. FINDINGS.

Pyelitis.

Kidneys.

Both were enlarged.

Pelves.

Both were congested.

Ureters.

The upper parts were congested.

Bladder.

Appeared healthy.

HISTOLOGY.

Kidneys.

Many of the glomeruli contained polymorphonuclears, showed lobulation of the tufts and desquamation of the cells covering them and lining the capsules. There was marked cloudy swelling and catarrhal change in the tubules. In the interstitial tissue were many areas of increased fibrous tissue with round-celled infiltration in the cortex and medulla. A few polymorphonuclears were also seen in these areas. A few Gram-negative bacilli were noted in the glomeruli and blood vessels.

Pelves.

The submucous layer showed much round-celled and polymorphonuclear infiltration and the epithelial lining was thickened and desquamating. A few Gram-negative bacilli were seen between the epithelial cells.

30/9/24.

FEMALE, aged 15 months.

Admitted 2/9/24. Died 29/9/24.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea preceded by a convulsion 3 months previously. She was a small emaciated child and was very irritable. One week after admission the temperature rose to 103°F. and pus and coliform bacilli appeared in the urine. She died 3 weeks later.

P.M. FINDINGS.

Pyelonephritis.

Kidneys.

Both, but especially the left, showed much mottling, dark areas of congestion alternating with pale areas of fatty change. Definite abscesses were found in the left kidney only.

Pelves.

Both were acutely congested and the lining showed catarrhal change. There was some dilatation of the calyces.

Bladder.

Showed slight congestion at its base.

HISTOLOGY.

Kidneys.

The glomeruli showed marked lobulation of the tufts and some desquamation of the epithelial cells covering them and lining the capsules. The tubules showed cloudy swelling and some catarrhal change. In the interstitial tissue there were patches of greatly increased fibrous tissue with round-celled infiltration.

Pelves.

The submucous layer showed much round- and plasma-celled infiltration. There was slight desquamation of the epithelial lining cells and a few Gram-negative bacilli were seen lying between these cells.

19/1/25.

FEMALE, aged 5 months.

Admitted 8/1/25. Died 17/1/25.

CLINICAL NOTES.

The child was admitted with a history of vomiting and constipation of 6 weeks' duration. She had several convulsions the day before admission. The left kidney was palpable and the urine contained pus, streptococci and coliform bacilli. The convulsions persisted for 9 days till the child died.

P.M. FINDINGS.

Pyelitis; Cystitis; Broncho-pneumonia; Septicaemia.

Kidneys.

Several pale areas suggestive of abscess formation were present in the cortex.

Pelves.

Both were slightly dilated. The vessels were injected on the surface which was roughened due to catarrh.

Bladder.

The surface of the mucous lining was roughened and vessels were injected. At several places there were small petechial haemorrhages.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and desquamation of the epithelium covering them and lining the capsules. The tubules contained masses of polymorphonuclears and many were greatly distended. The interstitial tissue showed areas of polymorphonuclear infiltration. There were also some areas of fibrosis and round-celled infiltration. Many Gram-negative bacilli and Gram-positive cocci were seen in the areas of acute inflammation and also in the tubules.

Pelves.

The vessels in the submucous layer were greatly congested and there was some desquamation of the lining epithelium, between the cells of which Gram-negative bacilli were noted.

13/5/25.

MALE, aged 3 weeks.

Admitted 4/5/25. Died 11/5/25.

CLINICAL NOTES.

The child was admitted with a history of wasting since birth. Vomiting began 3 days before admission and the stools were green. He was a small emaciated child and the temperature was 102°F. He died 7 days after admission.

P.M. FINDINGS.

Gastro-enteritis; Pyelonephritis; Cystitis;
Hypostatic Pneumonia; Patent Ductus Arteriosus;
Hydronephrosis.

Left Kidney.

Was hydronephrotic with the ureter entering the pelvis at a very sharp angle forming a sort of valve.

Both Kidneys.

Showed abscesses in the substance and under the capsule, but more especially the right.

Pelves.

Both showed pyelitis, especially the right.

Bladder.

The mucosa was injected and thickened. Marked catarrh was present and scrapings from the surface showed numerous pus cells and abundant coliform bacilli in films.

HISTOLOGY.

Kidneys.

Some of the glomeruli contained polymorphonuclears and showed lobulation of the tufts and shedding of the epithelium covering them and lining the capsules. Many of the tubules in the cortex and medulla showed catarrhal change and were distended with polymorphonuclears and desquamated epithelial cells. There were foci of round-celled infiltration in the interstitial tissue and slight increase of fibrous tissue. These areas surrounded the distended tubules. There were also areas of polymorphonuclear infiltration in the interstitial tissue, some of these amounting to actual abscess formation. Clumps of Gram-negative organisms were noted in the tubules and in the acute inflammatory areas in the interstitial tissue.

Pelves.

The vessels in the submucosa were congested and there was an exudate of polymorphonuclears and round cells in this layer. The epithelial lining was thickened and desquamating,

P.M. No. 2043.

18/6/26.

FEMALE, aged 4 months.

Admitted 15/6/26. Died 17/6/26.

CLINICAL NOTES.

The child was admitted with a history of vomiting 3 weeks before admission which cleared up 7 days ago. The bowels had always been constipated. The urine contained pus and coliform bacilli and the left kidney was palpable. The temperature was 103^oF., and she died after 2 days in hospital.

P.M. FINDINGS.

Pyelonephritis.

Kidneys.

Both were pale and scattered throughout the cortical portions were numerous yellowish areas with congested margins which were suggestive of abscess formation.

Pelves.

Both showed congestion.

HISTOLOGY.

Kidneys.

Some of the glomeruli showed desquamation of the epithelial cells covering the tufts and lining the capsules. The tubules showed catarrhal change and many were distended with polymorphonuclear cells. Some of these cells were seen actually in the walls of the tubules. In the interstitial tissue of the cortex and medulla there were patches of round-celled infiltration and increase of fibrous tissue. Some of these areas were wedge-shaped with their base along the surface of the kidney. Some Gram-negative bacilli were seen in the tubules amongst the polymorphonuclear cells.

Pelves.

These were not shown in the sections.

21/7/26.

FEMALE, aged 8 weeks.

Admitted 24/6/26. Died 20/7/26.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea since she was 17 days old, and of vaginal discharge for 11 days. The urine contained pus and coliform bacilli and the temperature was 103°F. Otitis media developed 5 days before death and an abscess on the left knee. Pus from both these sources contained B. paracolon, and these organisms were also recovered on blood culture.

P.M. FINDINGS.

Pyelonephritis; Septicaemia; Otitis Media.

Kidneys.

Both showed yellowish mottling on the capsular surface and yellowish areas in the cortices.

Pelves.

Showed little injection of the mucosa and slight catarrhal change.

Ureters.

Both appeared healthy.

Bladder.

Slight injection and catarrhal change of the mucosa were noted.

HISTOLOGY.

Kidneys.

Some of the glomeruli appeared more cellular than normal and showed some shedding of the cells covering the tufts and lining the capsules. The tubules showed some catarrhal change and many were distended with polymorphonuclear cells. Some of these cells were seen in the walls of the tubules. In the interstitial tissue of the cortex and medulla were many scattered patches of increased fibrous tissue with round-celled infiltration. A few polymorphonuclear cells were also seen in these areas. Many Gram-negative bacilli were seen in the tubules.

Pelves.

The submucous layer showed a marked degree of infiltration with round cells and polymorphonuclears. There was thickening of the epithelial lining and some Gram-negative bacilli were noted between the cells.

5/8/26.

FEMALE, aged 6 months.

Admitted 23/7/26. Died 4/8/26.

CLINICAL NOTES.

The child was admitted with a history of fever and vomiting of 6 weeks' duration. She was a poorly nourished child and was very irritable. The temperature was 102.6°F. and the urine contained pus, coliform bacilli and enterococci. The blood culture was negative.

P.M. FINDINGS.

Pyelonephritis; Cystitis; Acute Otitis Media;
Subdural Suppuration.

Kidneys.

Numerous small abscesses were noted in the cortical and medullary portions.

Pelves.

Both were larger than normal and showed congestion of the mucosa.

Bladder.

The mucosa showed patchy injection and some catarrhal change. The organ was distended.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and desquamation of the epithelial cells covering them and lining the capsules. The tubules showed catarrhal change and many were distended with polymorphonuclear cells. In the interstitial tissue of the cortex and medulla there were areas of round-celled infiltration and increase of fibrous tissue. There were also other areas where the infiltration was composed of polymorphonuclear cells. Many Gram-negative bacilli were seen in these areas and also in the tubules amongst the polymorphonuclears.

Pelves.

Both appeared healthy.

P.M. No. 2143.

13/11/26.

FEMALE, aged 1 year 9 months.

Admitted 3/11/26. Died 13/11/26.

CLINICAL NOTES.

The child was admitted with a history of vomiting and frequency of micturition of one week's duration. She was a well nourished child but appeared acutely ill and had marked nuchal rigidity. The temperature was 105^oF. and the urine contained pus and organisms. She died 10 days after admission.

P.M. FINDINGS.

Pyelonephritis; Cystitis.

Kidneys.

Both showed numerous abscesses in the cortex and medulla.

Pelves.

Both showed a slight degree of congestion and catarrhal change.

Bladder.

The mucosa showed some congestion and catarrhal change in the trigone region and around the ureteral orifices.

HISTOLOGY.

Kidneys.

Some of the glomeruli showed lobulation of the tufts and desquamation of the cells covering them and lining the capsules. The tubules showed some catarrhal change and a few of them contained polymorphonuclears. In the interstitial tissue of the cortex and medulla there were patches of increased fibrous tissue with round-celled infiltration. There were also areas of polymorphonuclear infiltration of the interstitial tissue, some of them amounting to actual abscess formation.

Pelves.

There was much congestion of the vessels in the submucosa. The epithelial lining appeared healthy. No organisms were seen.

4/2/27.

FEMALE, aged 5 months.

Admitted 8/1/27. Died 3/2/27.

CLINICAL NOTES.

The child was admitted with a history of prolapse of the bladder and pain on micturition of 2 months' duration. She was a well nourished child and did not appear acutely ill, but the temperature rose to 103^oF. 3 days after admission. The left kidney was palpable and the urine contained pus and coliform bacilli.

P.M. FINDINGS.

Cystitis; Pyelonephritis (chronic); Hydronephrosis
(right).

Kidneys.

No abscesses were noted on naked-eye examination.

Pelves.

They were not congested but the right was dilated.

Bladder.

The mucosa was slightly hyperaemic and the seat of catarrhal change. At the neck of the bladder there was a polypoid projection of the mucosa which hung down into the urethra.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and desquamation of the epithelial cells covering them. Many of the tubules in the cortex and medulla contained polymorphonuclear cells. In the interstitial tissue in both the cortical and medullary portions there were scattered patches of round-celled infiltration and early fibrosis. Just under the capsule there were a few subacute abscesses. Gram-negative bacilli were found in these areas and also amongst the polymorphonuclears in the tubules. Serial sections were cut right through an area of round-celled infiltration and no polymorphonuclear area was found associated with it.

Pelves.

There was some round-celled infiltration in the submucous layer and the epithelial lining of the right showed some metaplasia and a few Gram-negative bacilli were seen between the cells.

Bladder.

This organ appeared healthy but some Gram-negative bacilli were seen between the epithelial lining cells.

16/5/27.

FEMALE, aged 10 weeks.

Admitted 17/3/27. Died 15/5/27.

CLINICAL NOTES.

The child was admitted with a history of never having thriven. She had a convulsion the day before admission and the urine contained albumen. The temperature was 103⁰F. After 3 days there was an inflammatory swelling noted at the urinary meatus and an abscess in the right buttock (Staphylococcus aureus). Pus and coliform bacilli were found in the urine 2 weeks later and both kidneys were palpable.

P.M. FINDINGS.

Pyelonephritis; Cystitis; Broncho-pneumonia; Empyema; Acute Otitis Media.

Kidneys.

Some small abscesses were noted in the cortex of the left kidney, but the right appeared healthy.

Pelves.

Both showed acute congestion.

Bladder.

The mucosa showed some injection and catarrhal change.

HISTOLOGY.

Kidneys.

Some of the glomeruli contained polymorphonuclear cells and showed lobulation of the tufts and desquamation of the epithelial cells covering them and lining the capsules. The tubules showed some cloudy swelling and catarrhal change. In the interstitial tissue of the cortex there were some areas of round-celled infiltration and increased fibrous tissue. Some of these areas were wedge-shaped with their base along the surface of the kidney. Gram-positive diplococci were seen in many of the glomeruli, in the blood vessels, tubules and cellular areas of the interstitial tissue.

Pelves and Bladder.

There was slight round-celled infiltration of the submucous layer. Some Gram-positive bacilli and a few polymorphonuclear cells were seen lying between the cells of the epithelial lining.

3/11/27.

FEMALE, aged 26 weeks.

Admitted 9/10/27. Died 2/11/27.

CLINICAL NOTES.

The child was admitted with a history of diarrhoea and vomiting of 6 weeks' duration. She was thin and acutely ill and the temperature was 103°F. The left kidney was palpable and the urine contained pus and coliform bacilli. Right otitis media developed. The fever continued till death 4 weeks later.

P.M. FINDINGS.

Suppurative Pyelonephritis.

Kidneys.

Numerous abscesses were found in the cortical and medullary portions, some of them projecting from the cortex immediately under the capsule.

Pelves.

Both showed some congestion.

Bladder.

The mucosa showed some congestion.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and shedding of the epithelial cells covering them and lining the capsule. The tubules showed cloudy swelling and some catarrhal change and contained polymorphonuclear cells in the areas of round-celled infiltration which were scattered through the interstitial tissue. In these areas there was some fibrosis.

Pelves.

The submucous layer showed much infiltration with round cells, and a few polymorphonuclear cells were also present. The epithelial lining showed desquamation and Gram-negative bacilli were seen amongst the shed cells.

Bladder.

Lesions similar to those in the pelves were noted.

14/9/28.

FEMALE, aged 6½ months.

Admitted 4/9/28. Died 13/9/28.

CLINICAL NOTES.

The child was admitted with a history of drowsiness and vomiting of 3 weeks' duration. The liver and kidneys were palpable and the urine contained pus and coliform bacilli. The temperature was 100°F. and the child had loose stools all the time in hospital. There was a purulent discharge from the nose on the day of death.

P.M. FINDINGS.

Pyelitis; Oedema of the Lungs.

Kidneys.

Both showed cloudy swelling and fatty degeneration.

Pelves.

Both were definitely congested and moderately dilated, but no obstruction was found in the ureters nor was there any hypertrophy of the bladder wall.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and desquamation of the epithelial cells covering them and lining the capsules. The tubules showed catarrhal change and many of the collecting ones were distended with polymorphonuclear cells. In some of the tubules in the medulla there were uric acid deposits. In the interstitial tissue of the cortex there were patches of round-celled infiltration; many of these were situated just under the capsule and there was early fibrosis in these areas. Some of the cellular patches ran in bands through the cortex into the medulla. Many Gram-negative bacilli were seen amongst the polymorphonuclear cells in the tubules, and a few were also noted in the glomeruli and blood vessels.

Pelves.

The submucous layer showed slight round-celled infiltration and there was some desquamation of the lining epithelial cells.

2/11/28.

FEMALE, aged 15 weeks.

Admitted 11/10/28. Died 1/11/28.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of 3 weeks' duration. She was a well nourished child but appeared acutely ill. The temperature was 103°F. and the urine contained pus and coliform bacilli one week after admission. Albumen was noticed on the third day.

P.M. FINDINGS.

Pyelonephritis (right).

Right Kidney.

A few small elongated abscesses were noted in the cortex and medulla.

Left Kidney.

No abscesses were noted.

Pelves.

Both appeared healthy.

Bladder.

There was a small area of congestion in the trigone region.

HISTOLOGY.

Kidneys.

The glomeruli were more cellular than normal, many of them almost completely filling Bowman's capsules. The tubules showed catarrhal change and many of them contained polymorpho-nuclear cells. In the interstitial tissue of the cortex and medulla there were scattered areas of round-celled infiltration and increase of fibrous tissue.

Pelves.

Were not shown in the sections.

Bladder.

There was slight thickening and desquamation of the lining epithelium. No organisms were seen in the sections.

13/11/28.

MALE, aged 6 years 10 months.

Admitted 19/10/28. Died 12/11/28.

CLINICAL NOTES.

The child was admitted with a history of osteomyelitis of the tibia. The temperature was 103°F. and the urine contained albumen (probably due to pus cells). He passed very little urine for 4 days before death which occurred 4 weeks after admission.

P.M. FINDINGS.

Osteomyelitis (operation); Septicaemia (Staphylococcus aureus); Suppurative Pericarditis; Abscesses in Heart Wall; Empyema; Abscesses in Kidneys.

Kidneys.

Both showed numerous cortical abscesses immediately under the capsule. Staphylococcus aureus was found in films and on culture of the material from the abscesses.

HISTOLOGY.

Kidneys.

The glomeruli showed lobulation of the tufts and some shedding of the epithelial cells covering them and lining the capsules. The tubules showed cloudy swelling and some catarrh and many contained polymorphonuclears in the areas of round-celled infiltration which were scattered throughout the interstitial tissue, extending in parts from the cortex into the medulla. On cutting serial sections through one block the area of round cells gradually disappeared into normal tissue. No area of polymorphonuclear infiltration was connected with the round-celled area.

Pelves.

These were not shown in the sections.

17/4/29.

FEMALE, aged 5½ months.

Admitted 13/11/28. Died 16/4/29.

CLINICAL NOTES.

The child was admitted with a history of vomiting and wasting of one week's duration. The temperature rose to 102° F. after 8 weeks in hospital and pus, coliform bacilli and enterococci were then found in the urine. Pyuria continued for 3 months and cleared up one week before death which was due to broncho-pneumonia.

P.M. FINDINGS.

Marasmus; Acute Otitis Media (both); Slight Broncho-pneumonia.

Kidneys.

Both were pale and showed fairly well marked cloudy swelling. In the substance of the left, foetal lobulation was still present but, in addition, numerous small, depressed, rather vascular areas were scattered over the surface of the kidney.

Pelves.

Both appeared healthy.

Bladder.

Appeared healthy.

HISTOLOGY.

Left Kidney.

The glomeruli showed some lobulation of the tufts and shedding of the epithelial cells covering them and lining the capsules. The tubules showed a slight degree of cloudy swelling. There were a number of wedge-shaped areas with their base along the surface of the kidney. These areas were slightly depressed and consisted of fibrotic tissue infiltrated with round cells. The vessels on the surface of these depressions were greatly congested. There were also many areas in the interstitial tissue of the cortex of round-celled infiltration.

Right Kidney.

Appeared healthy.

Pelves.

There was desquamation of the lining epithelial cells in both, and a slight degree of round-celled infiltration of the submucous layer in the left.

Ureters.

Many Gram-negative bacilli, a few Gram-positive cocci and some red blood corpuscles were seen between the epithelial lining cells in both.

Bladder.

There was slight round-celled infiltration of the submucous layer and some desquamation of the epithelial lining cells.

10/5/29.

FEMALE, aged 6 weeks.

Admitted 30/4/29. Died 9/5/29.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea of 3 weeks' duration. Jaundice became marked and increased after admission. Both kidneys were palpable, The urine contained pus and coliform bacilli and the temperature was 103°F. She died 10 days after admission.

P.M. FINDINGS.

Pyelonephritis; Cystitis; Septicaemia; Broncho-pneumonia.

Kidneys.

Both were pale and several small abscesses were found in the cortical areas just beneath the capsule.

Pelves.

Both appeared healthy.

Bladder.

The mucosa was congested and thickened.

Spleen culture showed streptococci.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and shedding of the epithelial cells covering them and lining the capsules. The tubules showed cloudy swelling and many were distended with polymorphonuclear cells; in some, these were seen in the walls of the tubules. In the interstitial tissue of the cortex and medulla were scattered patches of round-celled infiltration and increase of fibrous tissue. Some areas of polymorphonuclear infiltration were also present. Many Gram-negative bacilli and Gram-positive cocci were seen amongst the polymorphonuclears in the tubules and a few in some of the glomeruli.

Pelves.

The submucous layer showed a marked degree of round-celled infiltration and there was some desquamation of the epithelial lining cells. Some Gram-negative bacilli and Gram-positive cocci were seen between the epithelial cells.

Bladder.

This organ showed similar changes to the pelves, but to a less marked degree.

16/11/28.

FEMALE, aged 1 year 5 months.

Admitted 4/10/29. Died 15/11/29.

CLINICAL NOTES.

The child was admitted with a history of fever and pain on micturition of 9 days' duration. The temperature was 104° F. and the urine contained pus, coliform bacilli and enterococci. She was very pale and looked acutely ill. Death occurred 6 weeks after admission.

P.M. FINDINGS.

Pyelonephritis.

Kidneys.

Both were slightly swollen. Scattered through the cortical portions of both were numerous congested areas associated with paler areas, suggestive of an acute inflammatory condition. There was a pea-sized abscess in the upper pole of the left kidney and in films from this there were many pus cells and coliform bacilli.

Pelves and Ureters.

Showed no change.

Bladder.

The mucosa showed marked congestion and some thickening.

HISTOLOGY.

Kidneys.

The glomeruli showed marked lobulation of the tufts and desquamation of the cells covering them and lining the capsules. The tubules showed slight catarrhal change. In the interstitial tissue there were scattered patches of round-celled infiltration and increased fibrous tissue.

Pelves.

The submucous layer showed slight round-celled infiltration and there was some thickening of the lining epithelium.

Bladder.

The submucous layer showed a marked degree of round-celled infiltration and there was thickening of the epithelial lining. No organisms were seen in the sections.

9/12/29.

FEMALE, aged 6 months.

Admitted 26/11/29. Died 8/12/29.

CLINICAL NOTES.

The child was admitted with a history of sudden rise of temperature, frequency of micturition and loss of weight occurring 2 weeks previously. She was a fairly well nourished child but seemed acutely ill. The temperature was 103°F., the left kidney was palpable and the urine contained pus and coliform bacilli. The physical signs of broncho-pneumonia were also noted.

P.M. FINDINGS.

Suppurative Nephritis; Acute Broncho-pneumonia; Acute Otitis Media.

Kidneys.

The left was slightly enlarged. The cortical areas were congested in both and numerous abscesses were present there. The medulla was free in both.

Pelves.

Both showed only slight congestion.

Bladder.

Showed slight injection of the mucosa.

HISTOLOGY.

Kidneys.

The glomeruli showed marked lobulation of the tufts and desquamation of the epithelial cells covering them and lining the capsules. The tubules showed cloudy swelling and some catarrhal change; many contained polymorphonuclear cells. In the interstitial tissue of the cortex definite abscesses were seen. But there were also patches of round-celled infiltration and early fibrosis. Gram-negative bacilli were noted in some of the abscesses.

Pelves.

There was slight round-celled infiltration of the submucous layer and a few polymorphonuclears were seen between the cells of the epithelial lining.

Bladder.

Some thickening and desquamation of the epithelial lining were noted.

24/4/30.

MALE, aged 7½ months.

Admitted 27/1/30. Died 23/4/30.

CLINICAL NOTES.

The child was admitted with a history of drowsiness of 3 days' duration. The urine contained pus and coliform bacilli, and the temperature was 103·8°F. Fever and pyuria persisted for 3 months.

P.M. FINDINGS.

Pyelonephritis; Capillary Bronchitis; ? Encephalitis.

Kidneys.

Normal size. Scarring of the superficial cortex was seen in both, on stripping the capsule which was only slightly adherent. No evidence of recent infection was seen in either kidney substance.

Pelves, Ureters, Bladder.

The mucosa showed slight congestion.

HISTOLOGY.

Kidneys.

Most of the glomeruli showed lobulation of the tufts. The tubules showed practically no change. The areas noted naked-eye on the surface of the kidneys were composed of round-celled infiltration of the interstitial tissue and showed early fibrosis. The areas were wedge-shaped and extended from a depressed base on the surface to form an apex in the medulla.

Pelves.

There was some desquamation of the epithelial lining cells.

Bladder.

Showed slight desquamation of the epithelial lining cells. No organisms were seen.

9/5/30.

FEMALE, aged 10½ months.

Admitted 22/4/30. Died 7/5/30.

CLINICAL NOTES.

The child was admitted with a history of irregular fever of 3 weeks' duration. The urine contained pus and coliform bacilli. She was a fairly well nourished child but appeared acutely ill. The temperature rose to 104°F. after 4 days in hospital and the child died 2 weeks later.

P.M. FINDINGS.

Pyelonephritis; Cystitis; Broncho-pneumonia; Acute Otitis Media.

Right Kidney.

Was somewhat swollen and its substance was extremely pale. Scattered through the cortex and to a lesser extent in the medulla were numerous small abscesses. On stripping the capsule a few depressed, rather vascular areas were found on the superficial surface of the kidney.

Right Pelvis.

The mucosa was slightly injected.

Left Kidney and Pelvis.

Showed similar but less marked lesions.

Bladder.

There was some congestion of the mucosa in the trigone region.

HISTOLOGY.

Kidneys.

The glomeruli showed some lobulation of the tufts and shedding of the epithelial cells covering them and lining the capsules. The tubules showed cloudy swelling. There were depressed areas in the cortex of round-celled infiltration of the interstitial tissue and early fibrosis. These areas were wedge-shaped with their base along the surface of the kidney.

Pelves.

Both appeared healthy.
No organisms were seen in the section.

24/5/30.

FEMALE, aged 17 weeks.

Admitted 30/12/29. Died 23/5/30.

CLINICAL NOTES.

The child was admitted with a history of gastro-enteritis and congenital heart disease. She then developed broncho-pneumonia and pus and coliform bacilli appeared in the urine 5 weeks later. The right kidney was palpable after 13 weeks and the child died 3 weeks later.

P.M. FINDINGS.

Absence of Left Kidney; Pyelonephritis (right);
Atelectasis in Lungs; Acute Broncho-pneumonia; Slight
Acute Enteritis.

Right Kidney.

Much enlarged and at a lower level than normal. Many abscesses were present, especially in the cortex (under the capsule).

Pelvis.

Showed a very little congestion.

Ureter.

Appeared normal.

Bladder.

There was slight injection of the vessels in the region of the trigone.

HISTOLOGY.

Right Kidney.

The glomeruli showed lobulation of the tufts and desquamation of the epithelial cells covering them and lining the capsules. The tubules showed cloudy swelling and were distended with polymorphonuclears and desquamated epithelial cells in the inflammatory areas. In the interstitial tissue of the cortex were areas of polymorphonuclear infiltration, some of them amounting to actual abscess formation. There were also some patches of round-celled infiltration and early fibrosis. No organisms were seen.

Right Pelvis.

Showed no lesion.

14/7/30.

FEMALE, aged 8 months.

Admitted 1/7/30. Died 13/7/30.

CLINICAL NOTES.

The child was admitted with a history of vomiting and diarrhoea 5 days before admission and rapid loss of weight since then. She was a well nourished child and the temperature was 103°F. A trace of albumen was found in the urine 5 days after admission, and the following day pus and coliform bacilli appeared. The child died one week later.

P.M. FINDINGS.

Pyelonephritis; Gastro-enteritis.

Kidneys.

Both showed multiple abscesses. These were situated chiefly in the cortex and were apparent immediately under the capsule on stripping the latter. The surface of the kidneys showed, in addition, scarring indicative of an older inflammatory condition. Small abscesses were also seen in the interpyramidal cortex and also involving the pyramids.

Pelves.

Both showed congestion.

Ureters.

Both showed congestion.

Bladder.

Showed congestion chiefly in the region of the trigone.

HISTOLOGY.

Kidneys.

The glomeruli were more cellular than normal and some showed lobulation of the tufts and desquamation of the cells covering them and lining the capsules. The tubules showed cloudy swelling and many contained polymorphonuclears. In the interstitial tissue there were many areas of polymorphonuclear-celled infiltration. Some were wedge-shaped with their base along the surface of the cortex. There were also some areas of fibrosis with round-celled infiltration, mostly in the cortex. Gram-negative bacilli were seen in many of the tubules amongst the polymorphonuclear cells.

Pelves.

There was some desquamation of the lining epithelium, and a few pus cells and Gram-negative bacilli were seen amongst the epithelial cells.

APPENDIX B.

Cases Investigated for the Presence of
Agglutinins and Complement-Fixing Antibodies
in the Blood.

Case 1.

Elliot, female, aged 34 weeks.

Clinical History.

Admitted on 21/10/29 with a history of diarrhoea for one week. She appeared acutely ill and was drowsy and feverish. The general condition improved very slowly and treatment with sodium bicarbonate and protosil had no effect on the urinary condition. She improved quickly after vaccine treatment. Blood culture was negative on 24/10/29.

Urinary Findings.

The urine contained abundant pus and B. coli communis. The urine was free from pus and organisms on dismissal.

Serological Findings.

(1) Agglutination.

2/11/29. Strongly positive with dilutions of serum 1:20 to 1:1,600.
Weakly positive with dilution 1:3,200.
13/12/29. Positive with dilution 1:400.
22/12/29. " " " 1:160.
13/1/30. " " " 1:80.

(11) Complement
Fixation.
13/12/29.

- (a) untreated complement.
Strongly positive with doses 2 to 20.
Weakly positive with doses 30 to 40.
Antigen control showed zonal fixation of complement.
- (b) treated complement.
Negative result.

Case 2.

Marshall, male, aged 4 months.

Clinical History.

Admitted with a history of irritability for 2 weeks, fever for 4 days and occasional loose stools for 2 days. The child was well nourished but looked pale and acutely ill, and there was slight nuchal rigidity. He became rapidly worse, the temperature rising from 102°F. to 106°F., and died in 5 days.

Urinary Findings.

The urine contained pus and B. paracolon.

Serological Findings.

Agglutination.

Strongly positive with dilutions of serum 1:20 to 1:640.
Weakly positive with dilutions of serum 1:1,280 to 1:2,560.

Case 3.

McCargo, male, aged 11 months.

Clinical History.

Admitted with a history of vomiting and irritability of 4 days' duration. The child appeared well nourished but was pale and acutely ill, and there was marked nuchal rigidity. There was tenderness over both flanks. The temperature was 102.6°F. The condition became rapidly worse and the child died one week after admission. Blood culture was negative.

Urinary Findings.

The urine contained pus and B. MacConkey 71.

Serological Findings.

Agglutination.

Strongly positive with dilutions of serum 1:20 to 1:160.
Weakly positive with dilutions of serum 1:320 to 1:640.

Case 4.

White, male, aged 12 weeks.

Clinical History.

Admitted with a history of a rigor 7 days previously and fever since then. The child was well nourished but looked pale and acutely ill, and there was nuchal rigidity and diarrhoea. There was tenderness of both kidneys. The temperature was 104^oF. The condition became rapidly worse and the child died 9 days after admission. Blood culture was negative.

Urinary Findings.

The urine contained pus and B. paracolon.

Serological Findings.

Agglutination.

Strongly positive with dilutions of serum 1:20 to 1:80.
Weakly positive with dilution of serum 1:160.

Case 5.

Grant, female, aged 8 years.

Clinical History.

Admitted with a history of headache, vomiting, pain in the back and frequency of micturition of 3 days' duration. The child was well nourished but seemed acutely ill. The temperature was 103.2°F. for 3 days, then it fell by crisis to normal.

Urinary Findings.

The urine contained pus and B. coli communis, and was clear in one month after daily injections of 5 c.cs. of protosil into the bladder for one week.

Serological Findings.

Agglutination.

Strongly positive with dilutions of serum 1:20 to 1:160.
Weakly positive with dilution of serum 1:320.

Serum was taken one month later when the urine was clear and the result was the same.

Case 6.

Brennan, female, aged 7 years.

Clinical History.

Admitted with a history of incontinence for one year, and pain in the right side, frequency of micturition and fever for 3 days. The temperature was 104.8°F. and fell by lysis after one week's treatment with sodium bicarbonate.

Urinary Findings.

The urine contained pus and B. coli communis, and was clear after 2 months.

Serological Findings.

Agglutination.

Strongly positive with dilutions of serum 1:20 to 1:80.
Weakly positive with dilution of serum 1:160.

Case 7.

Farrell, female, aged 17 weeks.

Clinical History.

Admitted with a history of vomiting and diarrhoea of 6 days' duration. The child looked acutely ill and was very irritable. Both kidneys were palpable. The temperature was 103.6° F. The condition became steadily worse and the child died in 12 days.

Urinary Findings.

The urine contained pus and B. MacConkey 71.

Serological Findings.

(1) Agglutination.

Strongly positive with dilutions of serum 1:20 to 1:80.
Weakly positive with dilution of serum 1:160.

(11) Complement
Fixation.

Negative results with untreated and treated complement.

Case 8.

Fleming, female, aged 3 years.

Clinical History.

Admitted with a history of chronic pyuria. She was not acutely ill and the temperature was normal.

Urinary Findings.

The urine contained pus and B. coli communis, but was clear in 2 weeks after treatment with sodium bicarbonate.

Serological Findings.

Agglutination.

Strongly positive with dilution of serum 1:20.

Weakly positive with dilutions of serum 1:40 to 1:80.

The same result was obtained when normal serum was used instead of the patient's.

Case 9.

Buchanan, female, aged 4 years.

Clinical History.

Admitted with a history of pain and frequency of micturition of 2 months' duration. She was not acutely ill on admission and the temperature was normal.

Urinary Findings.

The urine contained pus and B. MacConkey 71, and was clear after 2 weeks' treatment with sodium bicarbonate and 3 daily intravenous injections of 2 c.c.s. of 1 per cent. sulphato-violet.

Serological Findings.

(1) Agglutination.

Strongly positive with dilutions of serum 1:20 to 1:40.

(11) Complement
Fixation.

(a) untreated complement.

Strongly positive with doses
2 to 7.

Weakly positive with doses
10 to 20.

(b) treated complement.

Strongly positive with doses
2 to 10.

Weakly positive with doses
15 to 20.

Case 10.

Davidson, female, aged 6 months.

Clinical History.

Pyuria arose during the course of an attack of broncho-pneumonia. The left kidney was palpable and there was frequency of micturition for 2 weeks before death.

Urinary Findings.

The urine contained pus and B. coli communis.

Serological Findings.

(1) Agglutination.

Weakly positive with dilutions of serum 1:20 to 1:40.

(11) Complement Fixation.

Negative results with untreated and treated complement.

Case 11.

McKie, female, aged 14 weeks.

Clinical History.

Pyuria arose during convalescence from broncho-pneumonia. She was a small, emaciated baby. The temperature rose to 101.4°F. and was intermittent for 4 weeks. The right kidney was palpable 13 weeks after pyuria began, and the temperature rose to 104°F.; the child died 3 weeks later.

Urinary Findings.

The urine contained pus and B. coli communis, and did not clear under treatment with sodium bicarbonate and protosil.

Serological Findings.

Agglutination.

Negative results with dilutions of serum 1:20 to 1:160.
The test was repeated with serum taken 3 months after the onset of pyuria.
Positive results with dilutions of serum 1:20 to 1:80.

Case 12.

Brown, male, aged 8 months.

Clinical History.

Admitted with a history of a rigor one week previously, and fever and vomiting since then. On admission the child was well nourished but was acutely ill and the temperature was 103.2°F. and did not fall to normal till after 5 weeks' treatment with sodium bicarbonate.

Urinary Findings.

The urine contained pus and B. coli communis and was not clear after 5 weeks' treatment.

Serological Findings.

(1) Agglutination.

Strongly positive with dilutions of serum 1:20 to 1:160.
Weakly positive with dilutions of serum 1:200 to 1:400.

(11) Complement Fixation.

(a) untreated complement.

Strongly positive with doses 2 to 20.
Weakly positive with doses 30 to 40.

(b) treated complement.

Strongly positive with doses 2 to 40.

Case 13.

McWilliams, female, aged 7 years.

Clinical History.

Admitted with pain in the right side of the back of 2 days' duration, pain on micturition, vomiting and constipation. On admission she did not appear acutely ill. The temperature was 103°F. but this fell in one week by lysis. The general condition cleared up quickly.

Urinary Findings.

The urine contained pus and B. coli communis, but was clear in 5 weeks with no treatment.

Serological Findings.

(1) Agglutination.

Negative result with dilutions of serum 1:20 to 1:160.

(11) Complement
Fixation.

(a) untreated complement.

Strongly positive with doses 2 to 10.

Weakly positive with doses 15 to 20.

(b) treated complement.

Strongly positive with doses 2 to 20.

Weakly positive with doses 30.

Case 14.

Clelland, female, aged 10 months.

Clinical History.

Admitted with a history of vomiting and diarrhoea. She was a well nourished child. The temperature was 103°F. intermittently for 2 weeks. The general condition improved after 2 months' treatment with sodium bicarbonate.

Urinary Findings.

The urine contained pus and B. coli communis and was not clear after 2 months.

Serological Findings.

(1) Agglutination.

Weakly positive result with dilutions of serum 1:20 to 1:40.

(11) Complement Fixation.

(a) untreated complement.

Strongly positive with doses 2.
Weakly " " " 4.

(b) treated complement.

Strongly positive with doses 2.
Weakly " " " 4.

Case 15.

McIntyre, female, aged 7 years.

Clinical History.

Admitted with a history of haematuria, and pain and frequency of micturition at intervals for several months. She was a well nourished child and the temperature was 100.2°F. for 2 days after admission.

Urinary Findings.

The urine contained blood, pus and B. coli communis, and was clear in 10 days without treatment.

Serological Findings.

(1) Agglutination.

Negative results with dilutions of serum 1:20 to 1:160.

(11) Complement
Fixation.

Negative results with untreated and treated complement.

Case 16.

Wallace, female, aged 10 years.

Clinical History.

Admitted with a history of pain and frequency of micturition of 10 days' duration. She did not look acutely ill but there was definite tenderness in the left renal region. The temperature was 102.2°F. on admission but fell by lysis to normal in 5 days after treatment with sodium bicarbonate.

Urinary Findings.

The urine contained pus and B. MacConkey 71, but was clear after 10 daily injections of 5 c.cs. of protosil.

Serological Findings.

(1) Agglutination.

Negative result with dilutions of serum 1:20 to 1:160.

The same result was obtained with serum taken 3 weeks later.

(11) Complement Fixation.

Negative results with untreated and treated complement.

Case 17.

McGavin, female, aged 3 years.

Clinical History.

Admitted with a history of having a rigor and vomiting one week before admission. She appeared a well nourished child and did not seem acutely ill, although the temperature was 105°F. Sodium bicarbonate was given and the temperature fell by lysis to normal in one week.

Urinary Findings.

The urine contained pus and B. MacConkey 71, and was clear after 3 weeks' treatment with sodium bicarbonate and one week of injections of 5 c.cs. of protosil into the bladder.

Serological Findings.

Agglutination.

Negative result with dilutions of serum 1:20 to 1:160.

Case 18.

Paul, female, aged 41 weeks.

Clinical History.

Admitted with a history of vomiting and diarrhoea of 4 days' duration, and convulsions on the day of admission. She appeared a well nourished child, was acutely ill and had well marked nuchal rigidity. The temperature was 103.6° F. but fell to normal in 3 days.

Urinary Findings.

The urine contained pus and B. paracolon, and was almost clear after 4 weeks' treatment with sodium bicarbonate, and one week's treatment with protosil (5 c.cs. daily).

Serological Findings.

Agglutination.

Negative result with dilutions of serum 1:20 to 1:160.

Case 19.

Mann, male, aged one year.

Clinical History.

Pyuria arose during convalescence from broncho-pneumonia. There were no general or local symptoms.

Urinary Findings.

The urine contained pus, B. proteus and enterococci. After 3 weeks' treatment with sodium bicarbonate the urine was free from pus but still contained bacilli.

Serological Findings.

Agglutination.

Negative result with dilutions of serum 1:20 to 1:160.

Case 20.

McBride, female, aged 9 months.

Clinical History.

Admitted with broncho-pneumonia; 5 weeks later she developed vomiting, diarrhoea and fever, the temperature gradually rising to 103.8°F. The fever continued for 5 weeks and fell by lysis.

Urinary Findings.

The urine contained abundant pus and B. paracolon, for 11 months.

Serological Findings.

Agglutination.

Negative with dilutions of serum 1:25 to 1:200.

Case 21.

Brown, female, aged 11 months.

Clinical History.

Admitted with a history of fever, vomiting and pain on micturition for 4 days. She was a well nourished child, but was acutely ill. The temperature was 104.2°F. but fell to normal after 3 days' treatment with sodium bicarbonate.

Urinary Findings.

The urine contained pus and B. coli communis and was clear in 5 weeks.

Serological Findings.

Agglutination.

Negative results with dilutions of serum 1:20 to 1:160.

Case 22.

McKinnon, female, aged 9 months.

Clinical History.

Admitted with a history of listlessness and fever of 5 days' duration. She was a well nourished child but was acutely ill and had well marked nuchal rigidity. The temperature was 103°F. and fell to normal in 2 weeks.

Urinary Findings.

The urine contained pus and B. coli communis, but was clear after 2 weeks' treatment with sodium bicarbonate.

Serological Findings.

Agglutination.

Negative results with dilutions of serum 1:20 to 1:160.

Case 23.

Morrison, female, aged 3 years.

Clinical History.

Admitted with a history of haematuria and pain and frequency of micturition at intervals for one year. On admission the child was well nourished and did not look ill. The temperature was 100.4°F. The general condition improved after cystoscopy, which showed a simple cystitis.

Urinary Findings.

The urine contained blood, pus and B. proteus, and was clear after 5 weeks' treatment with sodium bicarbonate and one week's injections of 5 c.cs. of protosil into the bladder.

Serological Findings.

Agglutination.

Negative results with dilutions of serum 1:20 to 1:160.

Case 24.

MacAllum, female, aged 11 months.

Clinical History.

Admitted with a history of drowsiness, fever, anorexia and attacks of screaming for one week. She was a well nourished child. There was tenderness over both kidneys and the ears were discharging. The temperature was 105°F. and was intermittent in character for 5 weeks.

Urinary Findings.

The urine contained pus and B. lactis aerogenes and was not clear after 5 weeks' treatment with sodium bicarbonate and potassium citrate.

Serological Findings.

Agglutination.

Negative results with dilutions of serum 1:20 to 1:160.

Case 25.

Watt, male, aged 25 weeks.

Clinical History.

Admitted with a history of shaking of the head of 3 days' duration. On admission the child was well nourished but was acutely ill; nuchal rigidity was present and both kidneys were palpable. The temperature was 105.2°F. and was remittent till the child died 10 days later.

Urinary Findings.

The urine contained casts, pus and B. coli communis.

Serological Findings.

Agglutination.

Negative results with dilutions of serum 1:20 to 1:160.

SECTION IX.

REFERENCES.

R E F E R E N C E S .

- Abt, I., Amer. J. Dis. Child., 1926,
XXXII, 507.
- Band, D., Dunlop, D.M. and Dick, I.L., Proc. Roy. Soc. Med.,
1933, XXVI, 217.
- Barash, L., Internat. Clinics., 1929,
ii, 159.
- Blacklock, J.W.S., Tuberculous Disease in
Children: Its Pathology and Bacteri-
ology, 1932, IV, 3, A, p.85.
- _____ (a) Personal Communication,
1933.
- _____ (b) Personal Communication,
1933.
- Blaustein, N., J. Urol., 1926, XV, 363.
- Borrmann-Bremen, Von R., Handbuch der allgemeinen
Pathologie und der Pathologischen
Anatomie des Kindesalters, 1913, ii,
part 1, 747.
- Box, C.R., Lancet, 1908, i, 77.
- Braasch, W.F. and Bumpus, H.C., Jun., J. Urol., 1926, XV,
341.
- Brown, W.L., Proc. Roy. Soc. Med.,
1928-29, XXII, 1127.
- Cabot, H. and Crabtree, E.G. (a) Surg. Gyn. Obst., 1916,
XXIII, 495.
- _____ (b) Boston Med. & Surg. J.,
1916, CLXXIV, 780.

- Cabot, H. and Crabtree, E.G. . J. Amer. Med. Ass., 1917,
LXVIII, 589.
- Campbell, M.F., The Urologic & Cutan.
Review, 1929, XXXIII, 225.
- Chown, B., Arch. Dis. Child., 1927,
ii, 97.
- Cockayne, E.A., Proc. Roy. Soc. Med., 1928,
XXI, 503.
- David, V.C., Surg. Gyn. Obst., 1918,
XXVI, 159.
- Dible, J.H., J. Path. Bact., 1923,
XXIV, 3.
- Dudgeon, L.S., Lancet, 1908, i, 615.
- Dukes, C., Proc. Roy. Soc. Med.,
1928-29, XXII, 1.
- Dunlop, E.M., J. Path. Bact., 1928,
XXXI, 769.
- Eisendrath, D.N. and Kahn, J.V., J. Amer. Med. Ass., 1916,
LXVI, 217.
- _____ and Schultz, O.T., J. Med. Res., 1916-17,
XXXV, 295.
- Escherich, quoted by Trumpp, Jahrb.
f. Kinderh., 1897, XLIV, 268.
- Feilden, F.E., Proc. Roy. Soc. Med.,
1928-29, XXII, 1.
- Findlay, L., Glasgow Med. J., 1922,
XCVII, 28.
- Finkelstein, H., Jahrb. f. Kinderh., 1896,
XLIII, 148.

Freeman, R.G., Arch. Ped., 1924, **XLI**,
171.

Friedenwald, E.B., Ibid., 1910, **XXVII**, 801.

Frontz, W.A., J. Urol., 1932, **XXVII**,
489.

Garrod, A.E., Batten, F.E., Thursfield, H. and Paterson, D.,
Diseases of Children,
1929, p.580.

Göppert, F., Ergeb. d. Inner. Med. u.
Kinderh., 1908, **ii**, 30.

Gorter, E., Rev. franc. de pediat.,
1926, **ii**, 1.

Graham, R.H., Amer. J. Med. Sciences,
1925, **CLXX**, 401.

Gregory, H.H.C., Post-Grad. Med. J., 1929,
IV, 135.

Hamill, P., Proc. Roy. Soc. Med.,
1928-29, **XXII**, 1.

Helmholtz, H.F., Amer. J. Dis. Child.,
1921, **XXII**, 606.

_____ J. Urol., 1922, **VIII**,
301.

_____ Amer. J. Dis. Child.,
1926, **XXXII**, 396.

_____ Brit. J. Child. Dis.,
1929, **XXVI**, 247.

_____ and Beeler, C., Amer. J. Dis. Child.,
1916, **XII**, 345.

_____ Ibid., 1917, **XIV**, 5.

- Helmholtz, H.F. and Beeler, G., J. Urol., 1918, ii, 395.
- _____ and Bowers, M.R., Amer. J. Dis. Child.,
1926, XXXI, 856.
- _____ and Field, R.S., J. Urol., 1926, XV, 351.
- _____ Amer. J. Dis. Child.,
1926, XXXI, 693.
- _____ and Milliken, F., (a) Ibid., 1925, XXIX,
78.
- _____ (b) Ibid., 1925, XXIX,
497.
- Hill, C., Internat. J. Med. Surg.,
1931, XLIV, 26.
- Hinman, F., Amer. J. Dis. Child.,
1919, XVII, 305.
- Holt, L.E., Diseases of Infancy and
Childhood, 1928, (a) p. 516; (b) p.517.
- Hoppe, L.D., Arch. Ped., 1924, XLI,
29.
- Huët, G.J., Jahrb. f. Kinderh.,
1915, LXXXII, 466.
- Hyman, A., Amer. J. Dis. Child.,
1918, XV, 116.
- Jeffreys, W.M., Quart. J. Med., 1910-11,
IV, 267.
- Kaufmann, E., Pathology for Students
and Practitioners, 1929, ii, 1361.
- Kerley, C.G., Arch. Ped., 1909, XXVI,
217.

- Kowitz, H.L., Jahrb. f. Kinderh.
1915, LXXXII, 309.
- Kretschmer, H.L. and Helmholtz, H.F., J. Amer. Med. Ass.,
1920, LXXV, 1303.
- Langer, H. and Soldin, M., . . Zeits. f. Kinderh.,
1919, XIX, 161.
- Leonard, V. and Freirer, W.A., Johns Hopk. Hosp. Bull.,
1927, XLI, 21.
- _____ and Frobisher, J., J. Urol., 1926, XV, 1.
- Lepper, E.H., J. Path. Bact., 1921,
XXIV, 192.
- Levy, S., Zeits. f. Kinderh.,
1928, XLV, 643.
- McCartney, J.E. and Fraser, J., Brit. J. Surg., 1921-22,
IX, 479.
- MacConkey, A., J. Hyg., 1905, V, 333.
- _____ Ibid., 1909, IX, 86.
- Mackey, W.A., Glasgow Med. J., 1931,
CXV, 9.
- Mackie, T.J., Trans. Roy. Soc. South
Africa, 1921, IX, part 4, 315.
- Madsen, T., J. State Med., 1923,
XXXI, 51.
- Mallory, F.B. and Parker, F., Amer. J. Path., 1927,
iii, 91.
- Muschat, M., J. Urol., 1926, XV, 375.
- Nabarro, D., Brit. Med. J., 1930, ii,
414.

Pappenheimer, A.M., Hyman, H.T. and Zenman, F.D.,
 quoted by Helmholtz, H.F.
 and Milliken, F., Amer. J. Dis. Child.,
 1925, XXIX, 497.

Pfaundler, M., Centralb. f. Bakt.
 Parasit. u. Infetstionsk., 1898, XXIII,
 131.

Porter, L. and Fleischner, E.C., Arch. Ped., 1910, XXVII,
 826.

Quinby, W.C., J. Amer. Med. Ass., 1916,
 LXVIII, 591.

Rosenbusch, H., Jahrb. f. Kinderh., 1929,
 CXXV, 127.

Rosenow, E.C., J. Infect. Dis., 1915,
 XVI, 240.

Samson, J.A., Johns Hopk. Hosp. Bull.,
 1903, XIV, 334.

Schlack, H., Jahrb. f. Kinderh., 1927,
 CXVIII, 224.

Schwartz, A.B., Arch. Ped., 1918, XXXV, 1.

Scott, W.J. and Leonard, V., Amer. J. Dis. Child.,
 1926, XXXI, 241.

Shawki, I., J. Egyptian Med. Ass.,
 1930, XIII, 124.

Smith, R.M., Amer. J. Dis. Child.,
 1916, XII, 235.

Stevens, W.E., J. Amer. Med. Ass.,
 1921, LXXVII, 1081.

_____ Ibid., 1923, LXXXI, 1919.

- Sweet, J.E. and Stewart, L.F., Surg. Gyn. Obst., 1914,
XVIII, 460.
- Thiemich, M., Jahrb. f. Kinderh.,
1910, LXXII, 243.
- Thomson, J., Scot. Med. Surg. J.,
1902, XI, 7.
- Thomson, J. and McDonald, S., Quart. J. Med., 1909-10,
iii, 251.
- Thursfield, J.H., Proc. Internat. Assemb.,
Inter-State Post-Grad. Med. Ass.
N. Amer., (1928) 1929, p.205.
- Torres, C., Amer. J. Dis. Child.,
1917, XIV, 365.
- Trumpp, J., Jahrb. f. Kinderh.,
1897, XLIV, 268.
- West, J.P., Arch. Ped., 1909, XXVI,
213.
- Wilkinson, K.D., Brit. Med. J., 1930,
ii, 412.
- Wilson, J.R. and Schloss, O.M., Amer. J. Dis. Child.,
1929, XXXVIII, 227.
- Wood, E.J., Arch. Ped., 1915,
XXXII, 199.
- Wood, E.A., Brit. Med. J., 1932,
ii, 817.
- Young, H.H., J. Urol., 1926, XV, 11.
-