if one side is reduced and the other left, the patient will have legs of such an unequal length that she becomes more lame than ever. This difficulty may be overcome and the operation of reduction made much easier by the following device: The femur is exposed through an anterior incision, and cut through transversely just below the small trochanter. The upper end of the femur can then easily be brought down, and turned with the head into the new socket. After this has been done, the two ends of the femur will be overlapping by two or three inches. This overlapping part is cut off from the distal portion, and the divided femur united over a bone peg. When the patient has recovered from this operation, she will have the two legs of the same length, and, whether another operation is done or not, she will be quite freed from pain, because on one side the body weight will be transmitted directly on to the femur. In actual practice, the only patient for whom I have done this is now at full work as a factory hand, and has not thought it worth while to have her second hip operated upon."

If it be true, as Hey Groves says, that once the femur has been divided transversely just below the small trochanter the upper end of the femur can easily be brought down and turned with the head into the socket, why not employ this method even in unilateral cases? It would seem to dispose at once of the problem of getting the head low enough to effect reduction, and thus other means of overcoming the obstinate resistance to the descent of the head, such as preliminary traction and division of resisting soft parts, could be dispensed with. The objection that in unilateral cases there would still be inequality in the length of the limbs could be overcome by performing a second operation to shorten the limb on the unaffected side. To me it seems that the suggestion made by Hey Groves possibly puts the whole subject of dealing with the older cases on an entirely new basis.

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BACILLUS COLI INFECTIONS.*

BY

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EVERY clinician who works with children must be well acquainted with *Bacillus coli* infections of the urinary tract because the condition is a common one, especially during the earlier years; but as pyelitis can only be diagnosed with certainty by an examination of the urine it is difficult to form any estimate of the exact frequency of such infections. The symptoms are often misleading, so that the urine is not examined, and in less severe cases the diagnosis must be missed many times for each occasion on which it is correctly made. The unwary and the inexperienced, who have not pyelitis in mind and who neglect to examine the urine of small children, must fail to identify the infection; even the watchful and experienced do not always find the diagnosis easy, for the collection of a satisfactory specimen of urine may take days even under the best conditions in hospital. In dealing with girls a catheter specimen is essential, since there is a great risk of contamination of the urine passed naturally; the difficulty of collecting a sample of the urine of male babies is less, but may require both skill and patience. What is difficult in hospital is but seldom attempted in general practice, and here it is quite exceptional to find that the urine of a small child has been examined.

The typical urine is pale and opalescent, the appearance being unaltered by the addition of acid or alkali; there is at least a trace of albumin present, and under the microscope pus and *B. coli* are seen. But there may be no such gross bacilluria as to produce opalescence, and the quantity of pus may not be great, so that to naked-eye examination the urine appears normal. In such cases a correct diagnosis can only be made by a careful microscopic examination. It is hardly necessary to add that a culture of a fresh specimen of urine is always advisable.

*Read in opening a discussion in the Section of Diseases of Children at the Annual Meeting of the British Medical Association, Winnipeg, 1930.

During recent years the whole subject of urinary infection has been invested with a new interest since Chown and others, working from the pathological aspect, raised important questions of the etiology and pathology of the condition. These questions are of more than academic interest, for, if the pathologists are correct, the clinician must revise his ideas of both etiology and pathology, and will probably have to modify his prognosis and treatment.

Clinical Aspect.

This infection may occur as early as the first week of life; indeed, some cases have recently been labelled congenital. It becomes more common at a later date, and only begins to diminish in frequency after about the eighth year. In the earliest cases boys and girls seem to be almost equally affected, but at the age of 1 year the girls already outnumber the boys, and as the years pass the preponderance of girls increases. These facts are pretty well established clinically, although the more recently published figures suggest that the incidence among boys is not so much less than among girls. Authors differ considerably in their estimates of sex incidence.

The figures from the Birmingham Children's Hospital show: under 2 years, 47 cases; boys 7 (17.5 per cent.), girls 40 (82.5 per cent.); deaths 7 (all girls). From 2 to 12 years, 70 cases; boys 18 (25.7 per cent.), girls 52 (74.3 per cent.); deaths 2. These figures deal with the diagnosed cases—probably the more severe cases which needed hospital treatment; even in these more severe cases the mortality is only 9 in 117, or 7.7 per cent.

Chown has made interesting suggestions to explain the disproportionate number of girls. He says that the diagnosis of pyelitis, and its inherent suggestion of an ascending infection, renders girls more often suspect, so that their urine is more often examined than that of boys in whom the condition is not expected. Further, since a girl's urine is liable to contamination from infections of the vulva, etc., a number of spurious cases of pyelitis are added to the real ones, and so the number of cases occurring among girls increases, while in boys whose urine is unexamined the condition is missed. It is hardly likely that such mistakes can have affected my figures much, because the staff of a children's hospital are alive to the fallacies as well as to the facts of urine examination in children, and the urines to be examined are almost invariably catheter specimens, at least in girls.

Symptoms.

Cases may be classified as acute, subacute, or chronic. The acute case often commences with a rigor or convulsions and high fever, and general disturbance which may be so severe as to suggest meningitis or pneumonia; the child is obviously ill. Sometimes vomiting or gastrointestinal disturbance is a marked feature. In slightly less abrupt cases headache, backache, and general illness may suggest a typhoid or some similar infection. These acute symptoms are relatively common in the younger children and make the diagnosis particularly difficult and uncertain until the urine has been examined.

In older children the symptoms of pyelitis tend to be less puzzling, and constitutional disturbance is generally less severe. An abrupt onset is still common, but in the majority of these cases there is some local symptom, such as tenderness in the loin, frequency of micturition, or some discomfort in passing urine to point to the correct diagnosis. Still, many cases are obscure at the onset, and where vomiting is a feature the child may present the picture of a profound acidosis when first seen. At times an increased respiration rate may suggest pneumonia. Malnutrition and anaemia may set in rapidly, and occasionally jaundice complicates the diagnosis. Malaise, rather vague aches and pains, and moderate fever may suggest rheumatism, or abdominal discomfort and tenderness may lead to a mistaken diagnosis of appendicitis or abdominal tuberculosis. Indeed, there is scarcely any mistake which cannot be made in regard to these children.

Many of the chronic cases show surprisingly little constitutional disturbance. The patients are, perhaps, restless, imperfectly nourished children, who tend to be nervous;

but they are brought up for consultation on account of symptoms apparently wholly unconnected with the urinary tract, so that as a rule it is only during the search for the cause of their troubles that the infection is discovered. Fever may be absent or very slight in such children, and apart from the general lassitude and malaise with anorexia and some pallor there are no definite symptoms. The subacute cases generally occur among children who show periodic exacerbations of a latent infection, recurrent upsets which may appear with attacks of vomiting simulating cyclical vomiting, or periodic bouts of fever, the cause of which remains obscure until pus and *B. coli* are found in the urine.

Treatment.

The general rule is that patients having acute symptoms do well at all ages under strict treatment, but a certain number of those affected either fail to respond at all or only respond moderately well, and gradually fall into the subacute or chronic groups. In the less acute groups the cure is much more difficult, and treatment has to be more prolonged. In some instances the most painstaking treatment seems to be utterly unavailing, and nothing has the slightest effect upon the urine, for the bacilluria persists unchanged in spite of every form of therapy. Some cases show evidence of renal damage, such as the presence of casts in the urinary deposit, a raised blood urea, or a poor urea concentration test. In such cases the prognosis is not at all good, for sooner or later they develop signs of renal inadequacy or cardio-vascular damage.

There seem to be three important requisites in the successful treatment of all cases; needless to say the earlier the diagnosis is made and correct treatment commenced the better the outlook. The first requisite is rest in bed until the condition of the urine is normal. Children generally relapse if allowed to get up and run about before bacilli are completely abolished from the urine. They may relapse after the urine has become normal, but are certainly less likely to do so if kept at rest until it has become free from bacteria. The second requisite is alkali; this should be given in plentiful doses as sodium bicarbonate or potassium citrate. These drugs are not palatable, and should be made at least tolerable by the addition of syrup and some flavouring agent. The bicarbonate may also be added to drinks, and the citrate given in moderate quantity in home-made lemonade is not objectionable. No degree of alkalization can completely inhibit the growth of *B. coli* in the urine, since the organism will grow in a more alkaline urine than the kidney can excrete. Wright states that *B. coli* grow in urine of pH 9.0, and the most alkaline urine the kidney can excrete has a pH of 8.6. For some years I have been in the habit of maintaining a constantly varying pH of the urine by alternating alkaline and acid medication. The alkalis are given in as large doses as the child will tolerate until the urine is definitely alkaline; then a mixture containing hexamine and acid sodium phosphate is used until the urine becomes acid, at which point alkalis are again exhibited. This treatment has the advantage not only of discouraging the colon bacillus, but also of diminishing other urinary organisms. I do not place any great faith in hexamine, but prolonged usage has given it some reputation and it seldom does harm. The third point in treatment is the flushing of the kidney by a large fluid intake. Fortunately most of the small patients are eager to drink; and this readiness should be used to give as large a quantity of fluid as possible; even a small child should take fifty to sixty ounces of fluid a day, and more can sometimes be given. Various urinary antiseptics are recommended; hexamine, salol, and hexyl-resorcinol are those most commonly taken by the mouth, while the usual lengthy list of antiseptics may be tried locally. Good results seldom follow such measures. Vaccines occasionally seem to be useful, but far more often prove disappointing.

The chronic case and the recurrent case present special difficulties in treatment; and it is still an open question how far one ought to go in attempting to eradicate the infection. McKann, writing in the *American Journal of Diseases of Children*, points out that 20 per cent. of

children with chronic pyuria show some abnormality of the urinary tract. The most common deviations from the normal are dilatation of the ureters or kidney pelves, and kinking or doubling of the ureter on one or both sides. He suggests that these abnormalities have a special relationship to urinary infection, such that the abnormality either predisposes the tract to infection, or that a fortuitous infection persists because of the abnormality. Bigler, in 153 consecutive post-mortem examinations of children in which particular attention was paid to the urinary tract, found no less than 13 per cent. of abnormalities. Curiously enough the commonest abnormality was ureteral narrowing or obstruction, which occurred in 11 cases. In this series of 20 cases only four patients died as a result of urinary tract infection, and as the eldest of these was only 6 weeks old congenital abnormalities can hardly be said to have played a large part in predisposing to urinary infection in this series. On the other hand, there is no definite evidence here for or against the suggestion that abnormalities favour the persistence of acquired infections. In the present state of our knowledge, then, it is essential that every effort should be made to discover any abnormality of the urinary tract in any case of chronic or subacute pyelitis, in order that the abnormality may be corrected if possible or the prognosis modified accordingly.

A child with recurring attacks of pyuria who has a double dilated ureter and kidney pelvis can only be regarded as most seriously ill. On the other hand, a single hydronephrosis with a double ureter, provided that the sound kidney is functioning normally, can be treated surgically with a reasonably good hope of a definite cure. It is therefore advisable to have a cystogram taken in all chronic cases, and to make a cystoscopic examination in such as are unsatisfactory or doubtful as well as in the definitely abnormal. Pyuria is often associated with bowel infections and occasionally with a chronically inflamed appendix. These conditions should receive appropriate treatment.

Pathology of the Condition.

Interesting pathological studies have been published by Chown and by Wilson and Schloss, their papers being the result of post-mortem examination of children with urinary tract infections. Chown's paper was based on material collected at Johns Hopkins Hospital for the years 1911 to 1924, and deals with 29 cases. Wilson and Schloss took twelve years to collect the 49 cases on which they base their paper. These details are of some importance, since we are not told the number of clinical cases which produced the pathological material. The conclusions reached in both papers are similar—namely, that pyelitis is a misnomer; that pyuria is due to an interstitial suppurative nephritis, and that careful examination of the kidney pelvis generally fails to show any evidence of pyelitis.

The types of cases studied by these authors are identical, and are instances of severe septicaemic conditions. In Wilson and Schloss's paper there are no fewer than 7 cases of meningitis; 14 of pneumonia, 3 with empyema, 2 with otitis media; 11 of acute infective enteritis; and many of the cases combine one or more of the above conditions. These cases are obviously general blood infections of the most severe nature. It is doubtful if the *B. coli* which appeared in the urine was the original invading organism, and indeed it seems probable that this organism was a secondary invader if it ever reached the blood stream. The same may be said of those somewhat uncommon and most curious cases of pyelitis associated with jaundice reported by Gorter and Lignac.

Helmholz has done some extremely interesting experimental work with rabbits. He finds that spontaneous *B. coli* infection of the urinary tract occurs in these animals; that the bladder is primarily infected, and hence there may be an extension of the infection producing a pyelitis or pyelonephritis. On the other hand, if colon bacilli are injected into the blood an entirely different pathological picture appears, for under these conditions kidney abscesses may result, the bacilli being found equally distributed through both ureters and the bladder. He finds that the bladder is never infected unless the ureters

are infected; the ureters are never free from *B. coli* if the bladder is infected. In the spontaneous infections, by tying off the bladder and ureters separately, Helmholtz has shown that the bladder is often infected, while one or both ureters are free from infection, and that although pyelitis and pyelonephritis may appear, kidney abscesses do not occur in the spontaneous infection.

It seems worth while to turn from the consideration of children to review briefly *B. coli* urinary infections in adults. After puberty such infections are far less common than in childhood, and a marked disproportion exists between the sexes. In men, apart from calculus, prostatic abnormalities, and urethral stricture, *B. coli* infections of the bladder or ureters are rare. In women, on the other hand, the *B. coli* infection is by no means uncommon. The associated conditions are pregnancy, gynaecological operations, the trauma of the honeymoon, and long periods of retention such as may occur on long car or railway journeys.

Further, such infections—provided that the infecting organism is the *B. coli* only—produce but little upset, and are probably frequently missed. The facts of this brief statement seem to point very definitely to an ascending rather than to a blood infection, and support the clinical finding of children's physicians that pyelitis is generally an ascending infection with a correspondingly greater incidence in girls. If these infections (*B. coli*) were blood-borne, then men would be not less susceptible than women, and evidence of disturbance in other organs of the body would be common and not infrequently severe.

Certain figures have been obtained from the Children's Hospital in Birmingham. Starting from the year 1925 117 consecutive and unselected cases of pyelitis were taken with the object of tracing the children, re-examining them, and determining as far as possible their present condition. In this way it is hoped to throw some light on the etiology of the condition.

Age.	No.	Male.	Female.	Average Age.	Acute Cases.	Died.
0 to 2 years ...	47	7	40	1½ years	33	7
2 to 12 years ...	70	18	52	6½ years*	31	2

* The average age among boys was 7½ years.

Of the seven deaths that occurred during the first two years all were in girls. Three were cases of pyelonephritis; one had kidney abscesses; one pneumococcal septicaemia; one infection of a congenital hydronephrosis; and one pyelonephritis and thrombosis of the left renal vein. This death rate (9 in 117 cases) is 7.7 per cent., or 3 per cent. in patients over 2 years of age. It must be remembered that these figures are taken from those ill enough to be admitted to a hospital, which suggests that many milder cases occur which do not need admission, and that therefore this is a higher death rate than the real mortality of all cases of pyelitis. On the other hand, several of the chronic cases showed evidence of nephritis while in hospital—the presence of tube casts in the urine, raised blood urea, or a poor urea concentration capacity. The cases in the above series are being followed up to determine the present condition of the children. It is proposed to examine the urine, the renal function, and the cardio-vascular systems.

Conclusions.

As a clinician I am familiar with a *B. coli* infection of the urine, a condition which is frequent in children, commoner in girls than in boys, appearing in acute, chronic, and recurrent forms, but which is relatively seldom fatal. This condition has been called pyelitis, and although I am not in a position to prove that it is always a pyelitis, I feel that I can prove that it is not always part of a septicaemia or evidence of a nephritis.

It seems that the pathologist has experience only of a selected group of patients out of the many who have *B. coli* infections of the urinary tract—the more severe

cases which are septicaemias, and in which the colon bacillus is seldom if ever the primary infecting organism. It is hardly likely that a severe septicaemic condition in children, with renal infection and possibly abscess formation, could have a mortality as low as 3 per cent. after the age of 2, and it is significant that the collection of 78 post-mortem records took no less than twelve years at two large children's hospitals, whereas, clinically, *B. coli* infections are common.

I am deeply indebted to Dr. A. V. Neale for the work he has done in following up cases and in getting out the original figures for cases of pyelitis at the Children's Hospital, Birmingham.

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BACILLUS COLI INFECTIONS.*

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It is a curious coincidence that just twenty years ago, at the seventy-eighth Annual Meeting of this Association, held in London in 1910, one of the subjects for discussion was "Infections of the urinary tract by *Bacillus coli* in infancy and childhood." Whether it was by accident or by design that the subject of the present discussion, "*B. coli* infections in infancy and childhood," was chosen I do not know, but it will be of interest to compare the views prevalent in 1910 with those current to-day—twenty years after. It is perhaps significant that, whereas in 1910 the discussion was opened by a physician (Dr. Box) and a surgeon (Mr. Pardoe), this year the duty has been entrusted to a physician and a pathologist, which may be interpreted to mean that to-day the pathologist is called upon to take a larger share in the diagnosis than was formerly the case; but there is no doubt that the urological specialist can help very materially by cystoscopic examination and ureteric catheterization in clearing up these occasionally obscure cases.

One of the most commonly recognized diseases of infancy and childhood, which is generally held to be due to, or to be associated with, the *B. coli* in the majority of cases, is pyelitis, and it is a coincidence that Escherich, who discovered and named the *B. coli communis* in 1885, is generally credited with having introduced the concept "pyelitis" as a clinical entity into paediatrics in 1895. This statement is from Chown's paper—"Pyelitis in infancy"—but, as Chown points out, Escherich's cases of pyuria occurred in older girls, from 7 to 9 years of age, and were not cases of the so-called pyelitis of infancy which are held to occur with greatest frequency in children of under 2 years of age. It was Finkelstein who in 1896 drew attention to the condition in infants, and who concluded from his observations that the lesion was a primary pyelitis. From that time onwards the existence of a primary pyelitis has been recognized by clinicians, and has gone unchallenged until recent years. There is no doubt about an infection of the urinary tract of which patho-

*Read in opening a discussion in the Section of Diseases of Children at the Annual Meeting of the British Medical Association, Winnipeg, 1930.