

BACILLUS COLI INFECTIONS

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by

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BACILLUS COLI INFECTIONS.

Introduction.

Bacillus Coli infections considering their frequency, seriousness, and lasting sequelae must be regarded as a most important type of disease process. They are unique in the kind of symptoms they produce, in the diagnostic problems they present, and in the difficulties which must be overcome by anyone approaching them. There can be few conditions which make a more widespread appeal since they are by no means uncommon in every class of European practice.

My attention was first drawn to the great importance and prevalence of these infections a few years ago, when it was possible to compare the type of cases met with in a practice almost exclusively devoted to uncivilised and partly civilised Natives, to those found among Europeans and Natives living under European conditions.

It was noteworthy that on coming back to work among Europeans one was in intimate association with a group of conditions which previously one regarded as of rare occurrence and which now proved most formidable in the acute state, and one of the commonest of the chronic diseases. In treating a large number of Natives, I found that appendicitis is exceedingly uncommon and that they are seldom afflicted with gastric and duodenal ulcers, cholecystitis, pyelonephritis, pernicious anaemia, hyperpiesis, and non-specific

infective arthritis.

I was thus led to study their diet and mode of living and to compare the incidence of Bacillus Coli infections in them with their less fortunate neighbours - the Europeans. I shall present a survey of the relation between diet, the care of the bowels, and B. Coli infections. The results of this study are recorded not because I am convinced that the findings will apply to a much larger series of cases, but in order that they may be tested by others with similarly available data.

Secondly, I will emphasize the importance of Bacillus Coli infections and present the subject in such a way as to bring to notice each type of infection:- acute or sub-acute general infections, local, secondary or terminal infections, depending on the lesions set up by the organisms when disseminated throughout the body after entry therein through the blood stream or lymphatics.

We know that this infection is not rare, but it still receives less space in the text books than is given to disorders that are seldom met with and do much less harm. I believe that the time will soon come when it will be necessary to recognise this clinical entity as of importance equal to that of tuberculosis or syphilis in our investigation of a disease process.

The early history of the disease is uncertain but the organism was discovered by Escherich in 1885. Continued

and extended bacteriological observations have now resulted in the recognition of an important group of organisms called the Bacillus Coli group, which is as large, and as complex, as the streptococcus group; and whose various members differ just as widely in pathogenicity as those of the latter group. The Bacillus Coli may be found in some abnormal situations, as in the urinary bladder, in persons who enjoy good health. The organism has become, as it were saprophytic there. Such a state of things must at least be regarded as one having potential pathogenic effects.

Bacteriology.

(a) Morphology. The Bacillus Coli Communis is a short rod with rounded ends, 2 u. to 4 u. long; and about 0.5 u. broad. Larger forms up to 8 u. or 10 u. are not infrequent. It is feebly motile, non-sporing, non-capsulated and capable of growth at 37°C. It possesses, on an average, three or four peritrichous flagellae which are shorter and straighter than those of the typhoid bacilli. It is Gram-Negative. It stains somewhat faintly with watery dyes, but is readily demonstrated with carbolfuchsin (1 of Ziehl-Nielsen stain in 20 of water).

(b) Cultural Characters. The Bacillus Coli is aërobic and facultatively anaërobic and grows readily on the ordinary culture media from 20°C. to 42°C. In gelatin plates the colonies are visible in twenty-four to forty-eight hours. The gelatin is not liquefied. On a gelatin streak a copious,

white, shiny, smooth growth develops, the margins of which are irregular and crenated. Milk is a good culture medium and is curdled in twenty-four hours to seventy-two hours and acid is formed. On fresh acid potato it forms a straw yellow or brownish yellow moist, thick growth. On agar and on blood serum a thick, moist, shiny, greyish layer forms.

It is an active fermenter of many carbohydrates, alcohols, and glucosides, e.g. glucose, lactose, mannitol, raffinose and dulcitol but not of adonitol, inulin and inosite.

Monias¹ in an examination of seventy-five strains has classed them into two divisions:- (a) strains that produce indol and creatin and (b) those without these qualities. A study of 200 cultures led Hill, Seidman, Stadnichenko and Ellis² to classify them into four groups.

The thermal death point of the organism is 60°C with an exposure of ten minutes. It will grow freely in an acid medium, and in media containing as much as 0.15% carbolic acid. It can produce agglutin in the blood of infected human beings.

Habits.

In a newly born infant the meconium is sterile but organisms appear in small numbers within the first twenty-four hours. During the first few days the organisms most frequently found are staphylococcus albus, streptococcus faecalis, and members of the Bacillus Coli group. The

bacillus bifidus, a short, slender, Gram-positive bacillus appears with the first sample of meconium free faeces and there is a rapid increase in these organisms and a diminution in the coliform and other organisms. According to Cruickshank³ so long as breast feeding is the only means of nourishment the bacterial flora of the infant's faeces is predominantly of the Bacillus bifidus type, whereas the flora of infants who are artificially fed shows greater complexity and the predominant organisms are of coliform type. The faeces of breast-fed infants are always distinctly acid in reaction, whereas the stools of the artificially fed children are alkaline or neutral; it having been established that bacillus bifidus and related organisms of bacillus acidophilus type can survive exposure to highly acid fluids which destroy coliform organisms. After the period of breast feeding the child is quickly introduced to a variety of foodstuffs, and during adolescence, and adult life many kinds of proteins and carbohydrates are ingested and among many other types the Bacillus Coli group is found as a constant inhabitant of the intestinal tract. It is plentiful at and about the ileocaecal valve. It is saprophytic, helping in the digestion of cellulose, and acting on the waste products of digestion as well as completing the putrefaction of proteins. As a result of its activities such substances as phenol, phenylpropionic and phenylacetic acids, indol and skatol are produced. Many of these products are given off in the faeces, while others

are absorbed in part and excreted subsequently in the urine. In this latter connection especial interest attaches to the phenol, indol and skatol. Phenol after absorption is combined with sulphuric acid, to form an ethereal sulphate or phenolsulphoric acid, and in this form is found in the urine. So also with cresol. The indol and skatol are also absorbed and are then oxidised to indoxyl and skatoxyl, and are then combined with sulphuric acid and excreted in the urine in the form of potassium - indoxyl sulphate and potassium skatoxyl sulphate. Traces are normally present in the urine and the proof that they arise primarily from putrefaction of the protein material in the large intestine is so conclusive as not to admit of any doubt. They are increased in all conditions associated with excessive putrefaction and the amount to which they occur in the urine is, therefore, an indication of the extent of the putrefaction in the large intestine. In any investigation concerning the colon function Saxon⁴ lays stress on the clinical worth of the test for indican.

The habitat of the Bacillus Coli and the Anatomical pathways by which it gains entry to the human body.

The organism is plentiful at and about the ileo-caecal region and the vitality of this part is our surest safeguard against its attacks. There are certain barriers which prevent its escape. The mucous-membrane is pervaded

with simple tubular glands, (crypts of Lieberk^ohn of the small intestine) lined by columnar epithelium and containing many mucus secreting cells especially in the large intestine. This intact epithelium with its covering of mucus is our first line of defence. Between the glands are scattered nodules of lymphoid tissue which constitute, when they occur singly, the solitary lymph glands of the intestine, and when aggregated together form the patches of Peyer. Lymph corpuscles abound in the meshes of the retiform tissue and at the base of the epithelium cells. In the middle of the villus is a lymphatic vessel. The mucous-membrane is richly supplied with blood by a network of blood capillaries and the venous return is by way of the superior and inferior mesenteric veins and thence to the portal veins, thereby attacking the liver. A large proportion of the organisms reaching the liver are killed. If the dose be too heavy to be dealt with by this organ some of the bacilli will reach the systemic circulation, or will infect the liver and invade the gall-bladder. If only a small number enter the systemic circulation the majority are probably taken up by the kidneys and passed into the urine. With such a blood infection metastatic abscesses may arise in any part of the body. The lymph vessels arise mainly from networks in the mucous and serous coats, so should these barriers fail, infected lymph from the terminal six inches of ileum, the appendix, whose submucous coat consists of large masses of lymph tissue sur-

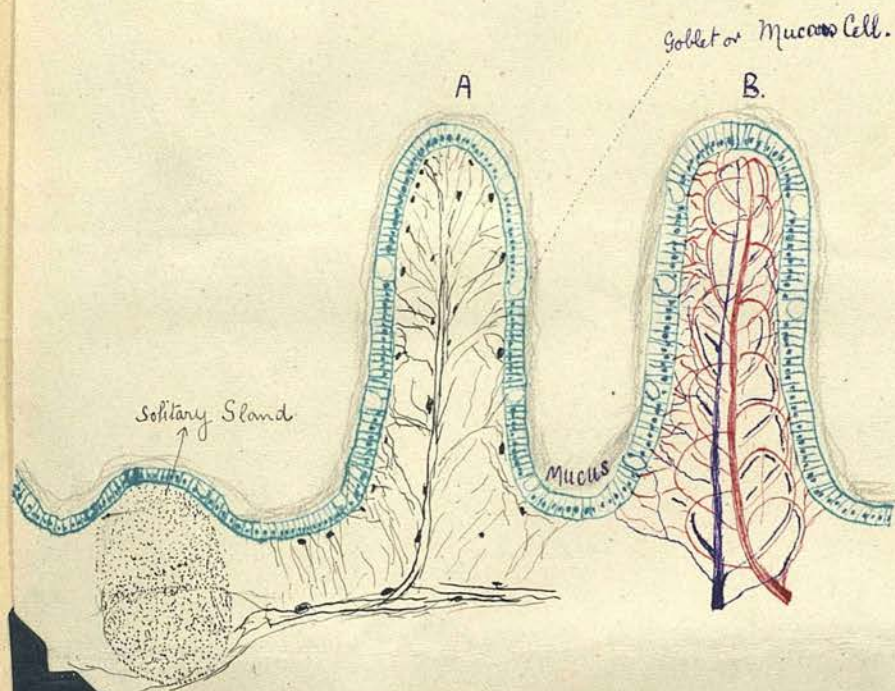


Diagram of. Two villi to demonstrate the point of invasion by the organisms.

A. Villus, showing stratified basilar border, Columnar epithelium, Mucous cells and lymphatic vessels.

B. Villus, showing the Capillary bloodvessels.

N.B. The covering of mucus.

rounded by sinus-like lymph spaces and the caecum, is by vessels which unite to form a group of five or six efferents which pass to the chain of glands dotted along the line of the ileo_colic artery. From the rest of the colon the lymph vessels follow the corresponding blood vessels. The main trunks then pass up in front of the third segment of the duodenum into the glands grouped round the origin of the superior mesenteric artery and from these to the receptaculum chyli. Braithwaite⁵ found that in living animals, even when there is no obvious disease in any of the glands, indigo carmine injected into the wall of the caecum travelled up to the pancreas, and over it into the subpyloric lymph glands. The lymph flow from the ileocaecal region would normally not reach either the duodenum or stomach. Braithwaite is of opinion that "there are in existence reserve sets of lymph channels as well as lymph glands which come into play under unusual pressure of lymph_flow or in the presence of obstruction in the normal channels due to disease." Thus the lymph_flow may be diverted from the superior mesenteric glands to the anterior and posterior pancreatico_duodenal glands. From these glands the flow is to the subpyloric group and thence through the hepatic glands to the coeliac group. Braithwaite also demonstrated that the normal lymph_flow from the great omentum is to the inferior gastric glands and thence to the subpyloric group. The mucous membrane of the duodenum and stomach may thus be the target for infective material not only

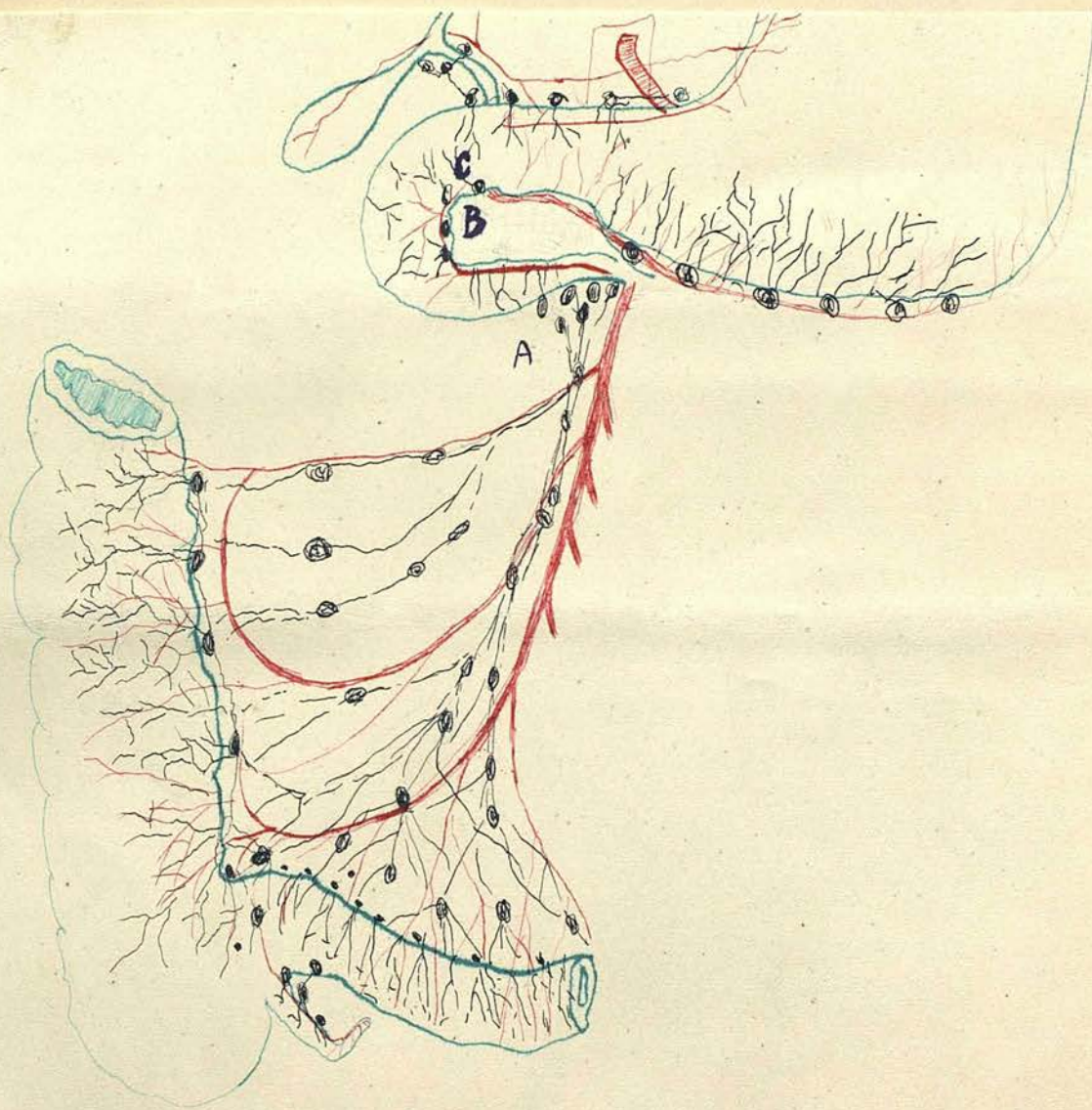


Diagram showing the visceral lymphatic glands and vessels of the ileocaecal region.

N.B. The drainage to the superior mesenteric group (A), the pancreatico-duodenal (B) and (C) the subpyloric set of the hepatic group. The pancreas, stomach, duodenum and gall bladder are targets for infected lymph.

from the ileo-caecal angle but from any part of the abdominal cavity. That pathological conditions of the appendix may be closely associated with the causation of gastric and duodenal ulceration and cholecystitis has long been recognised (Mahnert,⁶ MacCarthy and McGrath,⁷ Paterson,⁸ Burk,⁹ Moynihan,¹⁰ Sherren¹¹.) In spite of a want of unanimity there can, I think, be no doubt that a flow of infected lymph, not only from the ileo-caecal angle but from any part of the abdominal cavity, may be an important aetiological factor in the production of gastric and duodenal ulceration, cholecystitis, especially as Rooke¹² points out that the B. Coli is usually associated with other organisms, notably the streptococcus faecalis, and that it is exceedingly difficult to distinguish the part played by each organism in the production of disease. The Natives unknowingly attend to this natural barrier action by correct diet and in keeping the body, the alimentary canal, and especially the mouth and the colon, as healthy and clean as possible. This demonstrates, in my opinion conclusively, the problem why they enjoy their freedom from appendicitis, gastric and duodenal ulcers, cholecystitis, and diverticulitis, and pancreatic disorders.

Ogilvie¹³ insists that organisms, the result of alimentary infection, reach the blood stream by being absorbed by the gastro-intestinal mucous membrane, chiefly at aggregations of lymphoid tissue. This is an important pathway and would explain the many cases of the sudden onset of symptoms.

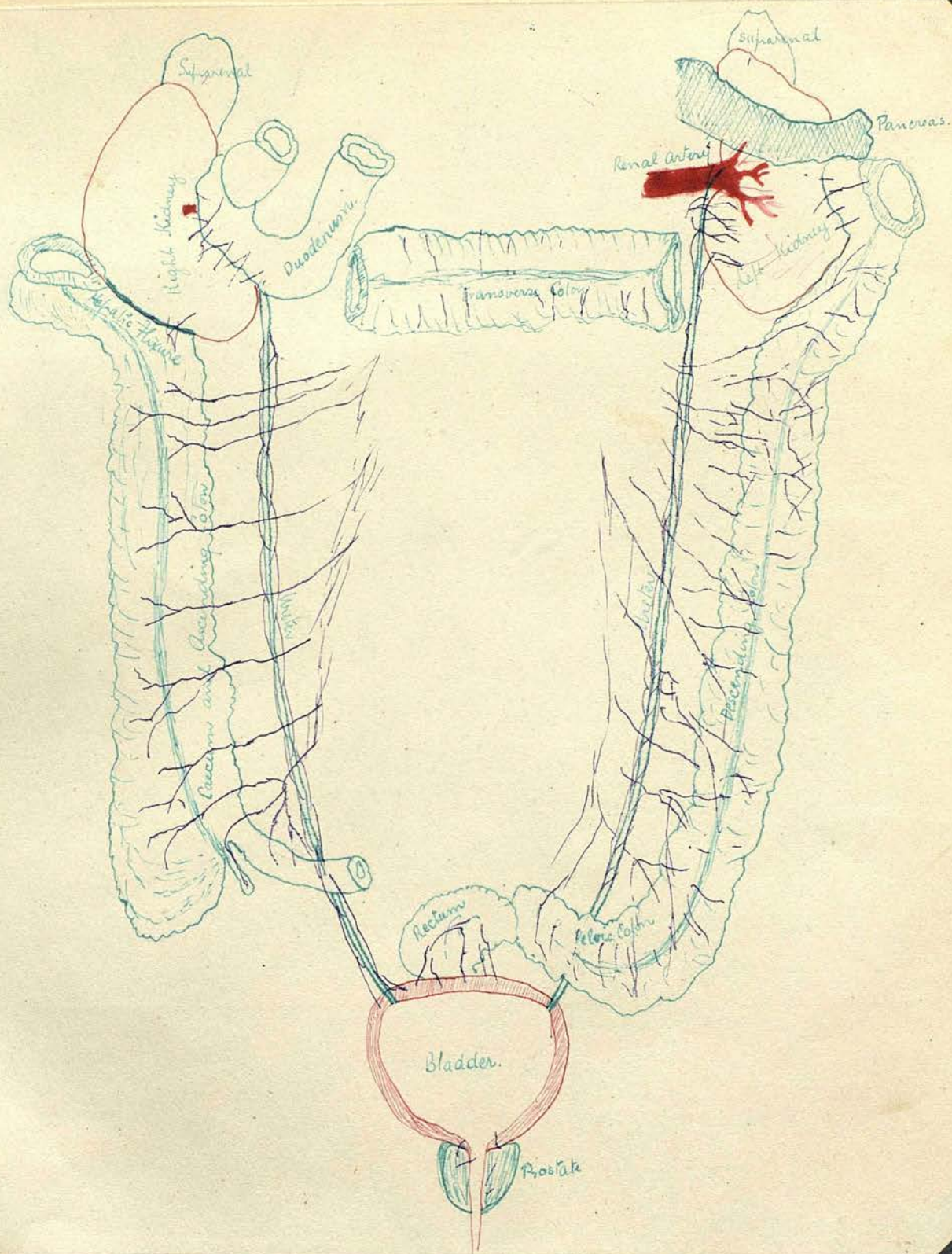


Diagram of Relationship of Intestinal to Urinary Tract. The lymphatics are shown in purple.

The pathway by which the organism leaves the body
is by the urinary tract.

A direct communication exists in the case of the right kidney between the lymphatics of the large bowel and those of the right kidney, and the right and left colic lymphatic vessels are often related to the anterior aspect of the corresponding kidney. Walker¹⁴ says "A pathway, not direct, but offering little difficulty to invading organisms, is provided by the lymphatics of the ureteral sheath. Along the path may travel infection, not only from other portions of the genito-urinary tract, but also, on account of the free intercommunication that exists, from neighbouring lymphatic systems such as the large bowel." Many clinical facts point to a lymphatic communication not only between the bowel and the right kidney but also between the bowel and the ureters and between the rectum and the bladder.

The blood stream would appear to be the more common route by which the infectious agent can reach the kidney. The renal artery divides into branches which again subdivide into small arterioles each of which enters the dilated commencement of a uriniferous tubule, within which its capillaries form a glomerulus. The tubule leaves the capsule by a neck and runs a tortuous course before uniting with others to form larger collecting tubes, which pass through the medullary substance of the kidney to open at the apex of a papilla. The organisms having gained a foothold in the interstitial tissue, or in the

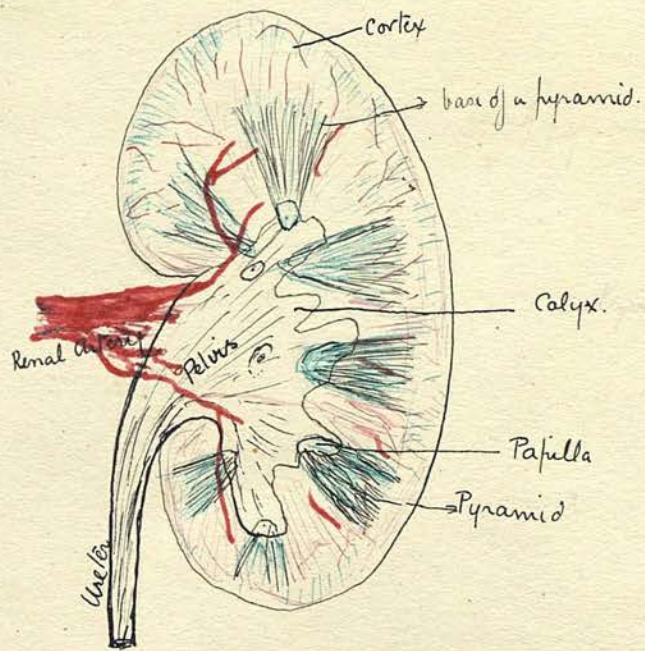


Diagram of Section of the Kidney.
A copy from Cunningham's Text Book of Anatomy.

glomerulus, escape with the inflammatory products into the tubules, drain thence into the pelvis, and so appear in the urine. They may also produce embolism of the small arteries especially those supplying the papilla. The pelvis is apparently very resistant to infection. The vessel which carries the urine from the pelvis of the kidney to the bladder is the ureter - a pale coloured, thick walled duct with a small lumen. The canal is not uniform throughout but is somewhat constricted in (a) the middle of the abdominal portion, (b) the junction of the abdominal and pelvic portion, and (c) again in the pelvic part. Obstruction of the ureter is important in bringing about a dilatation of the pelvis and pressure on the veins, which may result in extravasation of infected blood into the substance of the kidneys, and subsequently diffuse inflammatory changes throughout the kidney. The muscular coat consists of an outer circular and an inner longitudinal layer and outside the muscular coat is a layer of connective tissue in which the blood vessels, lymphatics and nerves ramify before entering the muscular coat. The mucous membrane is composed of areolar tissue and in common with that of the calyces and pelvis of the kidney is lined by transitional epithelium. The inferior end of the ureter is surrounded by a dense plexus of veins which brings the vesical plexus into communication with the hypogastric vein. The upper portion of the ureter receives its blood supply from the renal and internal spermatic arteries, the lower portion is supplied by the superior vesical and middle haemorrhoidal vessels. The

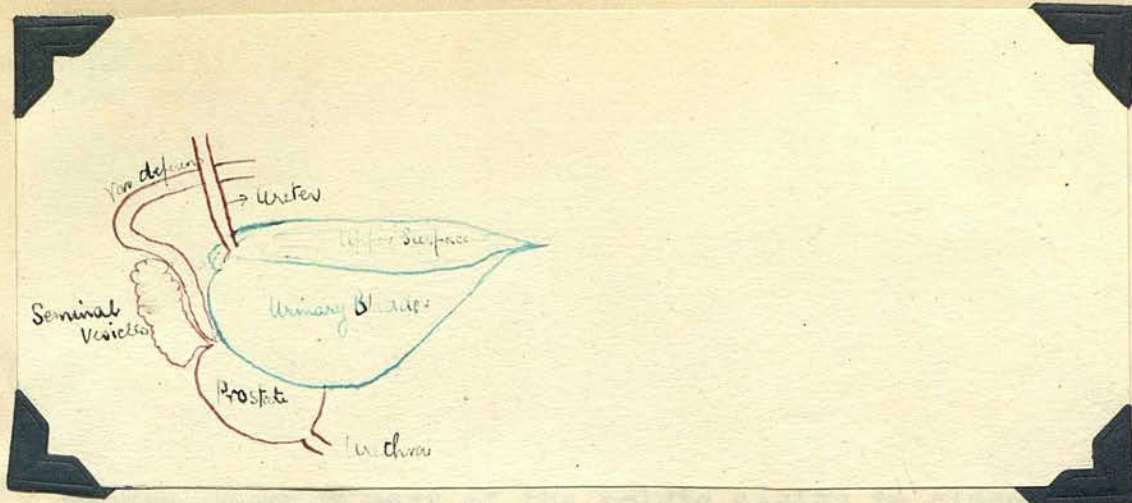


Diagram showing relation of the bladder, prostate and seminal vesicles and ureter.

A copy from Cunningham's Text Book of Anatomy.

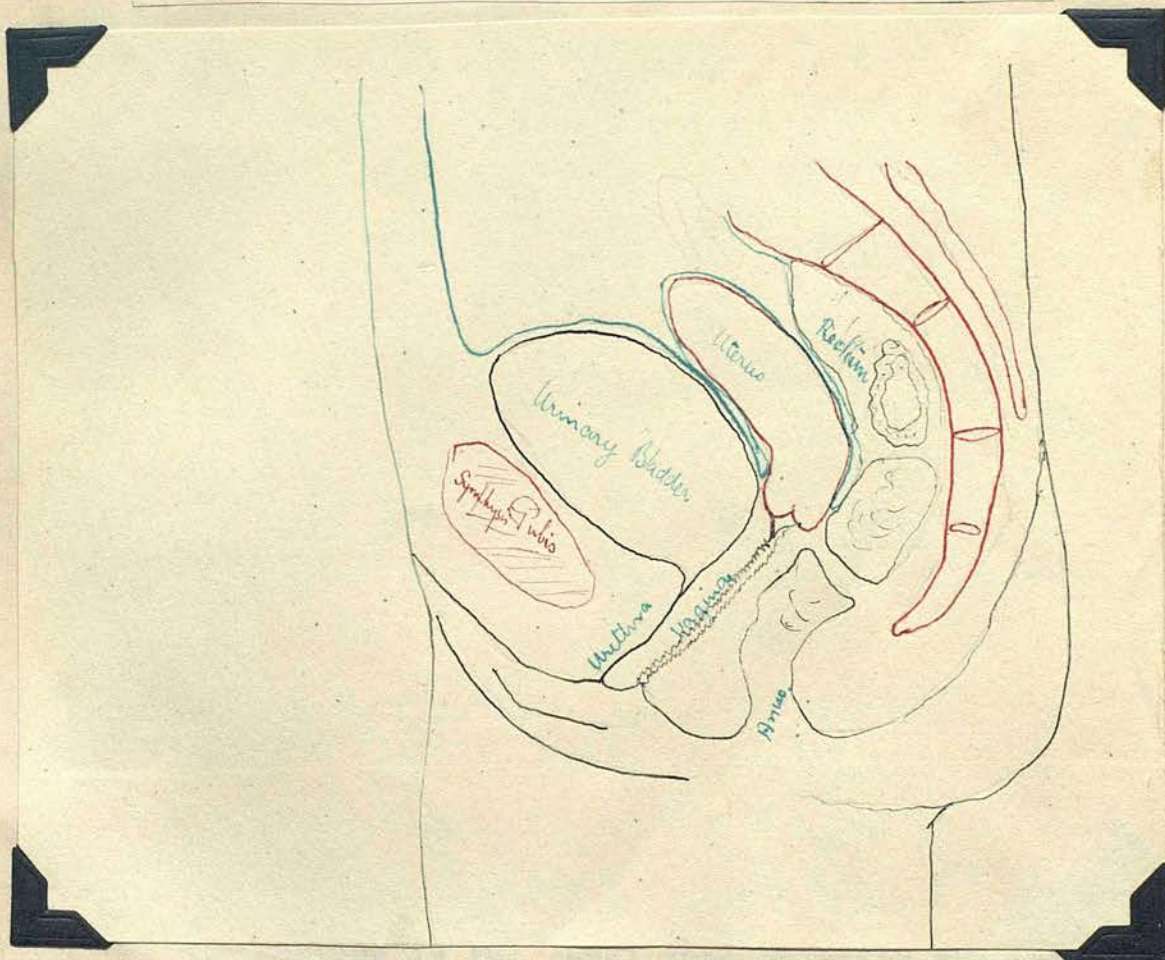


Diagram showing the relations of the female pelvic organs.

A copy from Cunningham's Text Book of Anatomy.

lymph vessels from the abdominal part of each ureter pass to the lumbar and the common iliac and sub-aortic lymph glands. Those of the lower extremity of the ureter anastomose with the lymph vessels of the urinary bladder.

The urinary bladder is a hollow muscular organ situated in the anterior part of the pelvic cavity in close relation to the seminal vesicles, prostate and rectum in the male and the anterior wall of the vagina in the female.

The ureters open into the bladder by two slit-like orifices about an inch apart and about equidistant from the orifice of the urethra which is on a lower and anterior plane.

The triangular area so formed is called the trigone over which the mucous membrane is relatively smooth. The mucose membrane is rugose over the greater part of the bladder but as the organ distends the rugae become unfolded. A smooth ridge is seen to stretch between the ureteral openings. The mucous membrane is lined by a stratified epithelium. The principal fibres of the muscular coat run longitudinally and circularly. The blood supply is from the superior and inferior vesical arteries and the dense plexus of veins pours its blood into the tributaries of the hypogastric vein and communicates below with the pudendal venous flexus. The lymph glands join the iliac group of lymph glands.

The urethra is the canal through which the urine, the semen, and the secretions of the seminal vesicles, the prostate and Cowper's glands are emitted from the body. The seminal vesicles and prostate by virtue of their relationship are

readily infected from the urinary tract and may be the seat of a chronic infection which constantly supplies bacteria to keep up the stock in the bladder. In the whole of its length in the female it is closely bound to the anterior wall of the vagina.

Modes of Infection.

The bacillus coli is indigenous in the bowel and we have seen that there are certain barriers which prevent its escape. The intact epithelium with its covering of mucus is the first of these. The lymphatic nodes of the intestine, the solitary glands, Peyer's Patches and the Appendix are the next and the lymphatic glands along the ileo-colic vessels constitute the final barrier. Why do organisms which are normally present in most parts of the body - as the B. Coli are - become, under certain conditions, pathogenic? The nature of the diet, the habits of the individual particularly as regards the evacuation of the bowels, and the degree of physiological balance of the numerous intestinal ferments would, in combination, appear to be of prime importance in upsetting the normal resistance to our strain of B. Coli, and of allowing an increase in its virulence. Intestinal organisms are usually grouped into two types - proteolytic and saccharolytic. Cruickshank³ tells us that in experiments on monkeys and cats it was found that a high carbohydrate diet, especially milk and lactose, gave a flora rich in B. Bifidus and B. Acidophilus, whereas a high protein diet (meat and eggs) gave a predominance of coliform

organisms and spore bearers. The B. Coli is said to have both saccharolytic and proteolytic activities, but it is present in greater numbers in faeces of the proteolytic type. Cruickshank quotes Cramer as having found that the mucosa of the intestine showed atrophy of the villi in experiments on rats fed on diets deficient in Vitamin A, and that a peculiar condition of the mucous cells was present. As a result of this change bacteria had penetrated between the villi, and were found deep in the crypts of Lieberkühn and even within the mucous cells.

A study of the conditions under which the Natives of this country live would, I feel, help to strengthen this argument. The Natives regard themselves as being constipated if they do not go to stool at least twice a day. Quite commonly the bowels move three or four times in the course of the day. (I am speaking of Natives who do not live under European conditions.) In this connection it is to be noted that in their squatting attitude while at stool they employ the pressure effect of the muscles of the abdominal wall to the best advantage. While it is true that they are exceedingly fond of meat, it is equally true that they very seldom have it in ordinary circumstances. They are not regular meat eaters. The total quantity eaten by the average Native in the course of the year is very much less than that consumed by the average European. (The Cost of Living Commission computed the European portion of the Union of South Africa's rate per capita at 696 lbs per annum, or 1.9 lbs per capita per diem. Three meat meals

a day are common in country hotels. Compare this quantity with the United Kingdom and Germany's one third of a pound and France's one quarter. The standard of cooking of this excessive quantity of meat is not high and among the poorer members of the population the frying-pan is much used.) It is against custom for any Native female to eat eggs at any time or to drink milk during a menstrual period. Men seldom eat eggs, they prefer to sell them. The staple article of diet among all classes of Natives is maize. They usually have mealie-meal porridge every morning, stamped mealies in the middle of the day, and again the porridge at night. Variety is afforded by the addition of brown beans, pumpkins, and by the occasional use of "Kafir corn." Even their bread is made from mealie meal. All this food is very rich in cellulose. Raw milk is seldom drunk but large quantities of sour milk - rendered so by placing fresh milk in calabashes and allowing it to stand for twenty-four hours - are freely taken. A little of the sour milk is always left in the calabash before replenishing it with fresh milk daily. The Natives have one large meal a day, the other meals being of little consequence. Zachary Cope states that "so far as our knowledge goes at present, a predisposition to appendicitis would be lessened by (1) preventing constipation, (2) minimizing the amount of meat taken, (3) increasing the amount of food containing cellulose and (4) diminishing the amount of food taken." He classes cholecystitis along with appendicitis and it is significant that these conditions as well as gastric

and duodenal ulcers, pyelonephritis, pernicious anaemia, hyperplasia and non-specific infective arthritis are not common among Natives. Beyers¹⁵ says "that common conditions met with in Europeans, e.g. gall-stones and peptic ulcer, are in the Bantu conspicuous by their rarity." The same author, reviewing the 18,000 Bantu cases admitted to the Johannesburg Hospital from March 1921 to March 1926 found 80 cases of appendicitis, three each of duodenal ulcer and cholecystitis, 1 each of gastric ulcer and gall-stones, 20 cases of pyelitis, 16 of cystitis and 2 of pyelonephrosis. He adds that "From particulars furnished me during the last six years, only 37 cases of appendicitis occurred among nine boys (Rand mines), i.e. in 13 Native hospitals, with a total of approximately 200,000 in-patients." In dealing with over fifty thousand Natives, I found two cases of gall-stones, seven of appendicitis, one duodenal ulcer and no case of gastric ulcer. Among 18,000 men between the ages of 18 and 40 years examined for work on the gold mines, I did not see an abdominal scar. An examination of the urine for B. Coli among healthy uncivilised Natives showed a few cases in children under the age of ten, and in others of fifty years and over; whereas in those between these ages, the urine failed to reveal evidence of its presence. In Europeans and Natives living under civilised conditions, I found this organism to be present in a relatively higher percentage of cases of all ages. I have seen very few cases of haemorrhoids among

Natives.

Other factors contribute to the invasion of the body by the Bacillus Coli. A lessened resistance or slight injury of the intestinal mucosa is all important. Thomson-Walker¹⁶ has found that drastic purgation, over-distension by the Plombieres treatment, and prolonged radiation without adequate intervals were followed by a bacilluria. The change appears to be a reduction of, or disappearance of, the mucus which covers the interior of the intestine and also damage to the epithelium itself. A bismuth enema has been followed by a disappearance of the bacilluria only to be followed by a reappearance in a few days. The same author finds a great source of danger in operations on the bowel and pelvic organs: he strongly advocates the prophylactic use of urinary antiseptics before and after operations on the bowel, rectum and pelvic organs. The normal appendix is regarded as of vital importance as a protective agent.

Other infections and debilitating conditions of any kind predispose to an infection. Rooke¹² has found the most common season for infection to occur in Europe is from November to March, and a secondary period in July and August. It is not uncommon to meet with several cases in one family. Bottle-fed babies are more susceptible than those which are breast-fed. One attack greatly increases susceptibility. Females appear to be more often attacked than males. Infection usually takes place before the tenth year or between the ages of 20 or 40 years.

Infection may take place by five possible routes:-

- (i) Foreign organisms may enter by the mouth in water, milk, and green vegetables.
- (ii) Ball¹⁷ has shown the importance of the direct route, i.e. by the immediate transference from the bowel to the infected area.
- (iii) By the blood stream. This is the most common path of entry. Through a point of lessened resistance in the intestinal mucosa, the organism gains access to the blood and by it is disseminated to the various tissues and organs of the body.
- (iv) By the lymphatics.
- (v) Per urethram, and (V.B.) through the lumen of the ureter.

Of the various direct routes, however, some doubt exists as to the more likely one in certain cases, such as infection of the urinary tract generally.

Bumpus and Meisser¹⁸ injected 82 rabbits from material obtained from the teeth, tonsils, urine, and blood of patients with pyelonephritis, and in 63 of the animals lesions of the kidneys were found. In investigating the possibility of a blood borne infection from the lower urinary areas to the kidney Sampson¹⁹ states that there is an arterial anastomosis between the bladder and the kidney. Cabot and Crabtree state that "assuming the probable fact that organisms reach the lymphatics about the bladder and over the lower segment of the ureter, the probability of their reaching the blood stream rather than continuing in devious lymphatic channels seems to be overwhelming."

It is possible that the organism may travel by way of the periureteral lymphatics from the appendix and colon to

the kidney area, or by a more direct route from the colon to the right kidney. The ureteral sheath is an important pathway.

Using fresh ureters of still-born infants Bauereisen demonstrates lymphatics in the mucosa and from a series of studies on renal tuberculosis, he concludes that infection is carried first to the lower ureteral segment and then travels towards the kidney in the periureteral lymphatics. Schultz and Easendrath²⁰ believe that infection spreads in the submucous and perivesical lymphatics and then by way of those of the ureter to the submucous lymphatic vessels of the renal pelvis.

The types and sites of B. Coli infection are very numerous depending on the organ or tissue in which the organism lodges after its dissemination throughout the body. Following Paul's²¹ classifications we have:-

I General haemic infections:

- (a) Acute. Septicaemia. Pyaemia.
- (b) Subinfections and intestinal intoxication.

II Local infections:

- (a) Infections of the intestinal tract
- (b) Peritoneal infections.
- (c) Infections of the biliary tract and pancreas.
- (d) Infections of the urinary tract.
- (e) Infections of the genital tract.
- (f) Infection of other tissues and organs.

III. Secondary and terminal infections.

I General haemic infections:

(a) Acute infections: An acute general infection, unless it occurs as a terminal septicaemia, is rare. After entrance to the blood stream, two types of septicaemia may occur:

(i) A Bacillus Coli Septicaemia proper and

(ii) a Septicaemia similar to typhoid fever.

(i) B. Coli Septicaemia proper: There is pyrexia, usually considerable in degree, and most often intermittent in character. Rigors are not uncommon. The patient is usually free from pain and local discomfort; but feels exhausted and very ill. Some degree of general abdominal distension is present. The spleen may be palpable. The pulse is quickened and the pulse tension lowered. A progressive haemolytic anaemia is a striking feature and there is usually a considerable leucocytosis. Joint pains and swellings are common.

Case 1. The following case illustrates this condition:-

E.K. Male aet 34 years.

Except for measles and whooping cough in early childhood, the previous history was a negative one. He enjoyed excellent health and all he could remember in connection with his present illness was a degree of constipation which had existed for about two months. He was taken ill

on 24th February 1929 with fever, lassitude and vomiting. The fever was ushered in by a rigor and the temperature ranged between 103°F and 105°F. There was general abdominal distension with gurgling in the right iliac fossa. He was constipated. The pulse was quickened and easily compressible and the respiration was accelerated. On the fifth day the spleen was palpable. The leucocyte count then was 11,400 with 75% polymorphonuclears. The spinal fluid was normal. The only discoverable focus of infection was a small ulcer on the right tonsil. The diagnosis was in doubt. On the sixth day the right ankle and left knee joint became swollen and tender. The urine was acid and contained a moderate trace of albumen, a few epithelial cells and the Bacillus Coli was grown from it. Blood taken during a rigor demonstrated the presence of this organism. By the seventh day the leucocyte count had risen to 19,800 with 73% polymorphonuclears. The blood showed a progressive and ultimately severe anaemia. There was evidence of valvular disease and pericarditis. Petechiae were found on the abdomen, right arm and right thigh. Tender discoloured areas affecting the terminal phalanges, and which cleared up after a few days only to reappear,

added to his discomfort. Several urine and blood examinations confirmed the presence of Bacillus Coli. The motions which at first were very offensive now became non-offensive and the bowels were well opened every day. For a week the condition progressed with continually high fever, a mounting leucocyte count which on the seventeenth day reached 48,400. Red blood cells were present in the urine. Tachycardia, praecordial pains, faintness, transitory blindness, all associated with a low blood pressure and attacks of nausea after meals, at times accompanied by violent retching added to the patient's distress. There was, at first, a slight loss of flesh but now it became marked. Acute and severe pain developed in the region of the spleen which was enlarged and the friction sounds of perisplenitis could be heard. Cerebral disturbance now became pronounced and he died on the twenty-seventh day of cardiac failure with vomiting, prostration and extreme pallor.

(ii) The septicaemia resembling typhoid and paratyphoid fevers is very important from the many points of similarity to these fevers which it presents.

The onset of the fever is usually insidious with

chilliness, lassitude, loss of appetite and the presence of muscular pains. The tongue is slightly furred, the mouth dry, and the bowels usually constipated. The temperature reaches the 102°F. to 104°F. level in a few days and remains elevated for a fortnight when it falls by lysis. Severe frontal headache and thirst are the chief complaints. The pulse is moderately full but easily compressible and moderately quickened. The abdomen is slightly tumid with gurgling in the right iliac fossa. Circular spots of pale pink colour and from 2 to 4 mm. in diameter, disappearing on pressure, are seen about the end of the first week. Their usual situation is on the abdomen, the flanks, the sides of the chest and back. Arthalgic pains are in some cases very troublesome. The urine which is highly coloured and concentrated contains the Bacillus Coli and Coleman and Hastings²² have noted that agglutinins against the organisms are demonstrable in the blood serum of the patients. Intestinal haemorrhage and perforation do not occur as no ulceration in the intestine takes place.

Another group of cases is characterised by the following clinical features: headache, joint pains, particularly in the limbs, sacral and sacro-iliac regions, sore throat, and slight bronchial catarrh. A mild pleurisy, without effusion is often present. The tongue is foul. The temperature is not usually above 100°F. The pulse is slow and of poor volume. Constipation is usually present and vomit-

ing is rare. In many cases there is a striking absence of both physical signs and focal symptoms, so that, unless the existence of the disease is borne in mind, and the urine is examined carefully, the patient is thought to be suffering from influenza. Relapses are very common.

Case 2. The following case is helpful in illustrating the first of these conditions:-

It is that of a woman D.F., aet 28 years., who, when first seen, had been ill for five days. She had been constipated, was always tired and suffered from severe headaches at times for a considerable period. She now complained of vague abdominal pains, anorexia and sleeplessness. The temperature was 104.2°F , headache was very pronounced and there was marked constipation. The pulse rate was 92 per minute and the pulse was full and easily compressible. The abdomen was tumid with loud gurgling in the right iliac and hypogastric regions. The Widal reaction and that for the paratyphoids were negative on three occasions. The white blood count was 6,200 with a preponderance of lymphocytes. This state continued for four days by which time the bowels were well opened. The temperature now was 100°F . to 102°F . and on the eighth day of the illness rose spots were seen. A blood culture for B. Coli was positive and the organisms were

present in the urine. On the tenth day of the illness the temperature was below 100°F , the headache had practically gone and the patient, though weak and very thin, began to recover. The headache had dominated all other symptoms.

Case 3. A man, J.F., aet 24 years, had three months previously been inoculated with T.A.B. vaccine. He became ill on 4th March 1928 and the onset of his illness was ushered in by headache and pains, which at first were generalised and later became confined to the lumbar region. In five days the temperature reached a level of 102.6°F . where it remained, with daily oscillations of about $\frac{1}{2}^{\circ}\text{F}$. to 1°F , for fifteen days. The symptoms consisted of anorexia, meteorism, and diffuse abdominal pains and tenderness. Rose spots were present and the spleen was enlarged. The course of the disease was mild, the only complication being a mild otitis which soon resolved. A blood culture for B. Coli was positive.

Case 4. A man, R.B., aet 25 years, who had previously enjoyed good health fell ill on 30th October 1928 with headache, slight fever, but severe joint pains. The knee joints, the left elbow and left ankle were the seat of severe arthralgia, but with no effusion. At first a diagnosis of rheumatic fever was made

but 135 grains of salicylate of soda a day for forty-eight hours produced no amelioration. The temperature of intermittent type reached 102°F. and the perspiration which at times was profuse had an offensive acrid odour. The urine contained no flakes, it was cloudy like a general haze. On swinging the glass so as to circulate the fluid it had a peculiar and characteristic shimmering appearance not unlike drifting cigarette smoke. It had a peculiar stale-fish odour to which the patient objected. On allowing a specimen to stand it became cloudy but there was no deposit, a jelly-like mass floated near the bottom. There was a small amount of albumin. Microscopically, there were a few cells from the urinary tract, and a few leucocytes, and, on culture, there was a pure growth of Bacillus Coli. A blood culture for this organism was negative. Widal reaction was negative. There was progressive loss of flesh and the leucocyte count on the seventh and tenth day of illness was 18,200 and 19,100 respectively, with a percentage of 70 and 67 polymorphonuclears. On the eighteenth day the temperature became normal, the joint pains now began to lessen in severity and the general condition of the patient improved sufficiently to enable him after a time to return to work.

After being at work for thirteen days the pains

began to return and when seen the temperature was 102.2^oF. The original condition repeated itself with sore throat and slight bronchial catarrh in addition. The urinary findings were the same, the knee joints became very painful and there was much muscular wasting. A low protein diet, an autogenous vaccine and careful attention to the bowels helped to clear up the condition and he was fit to be discharged on the twenty-seventh day, the only complication on this second occasion being five small boils which soon resolved.

A large group of cases could be classed as ambulatory in form where febrile disturbance is generally, although not invariably, slight, and the patient continues about during the whole or greater part of the illness. Some such cases end in recovery but they usually run a long course, the patient taking to bed about the end of the second week. Mild and abortive forms also occur in which the fever is insignificant, or after a well-marked onset, ends in a rapid defervescence about the end of the first week.

Pyæmia.

The following case is submitted as being one illustrative of this state:-

It is that of a woman, M.M., aged thirty-five, who

for the preceding year and a half had been losing weight and strength and had suffered from digestive disturbances, causing diarrhoea, attended by much nausea and vomiting. She gave a history of always having been frail, and with frequent illnesses affecting the gastro-intestinal tract. At an early age the bowels ceased to act spontaneously and drugs gradually lost their effects until an evacuation could only be procured by means of an enema. Over long periods she had neglected the action of the bowels so that latterly one action a week had become her habit. She was taken suddenly ill on 29th November 1924 with a rigor, severe frontal headache, anorexia. The tongue was foul and there was troublesome vomiting and severe and persistent lumbar and lumbosacral pain. It was more marked on the left side and radiated into the buttock and upper thigh. The temperature was 104.6°F . and kept at a high level for eight days with daily oscillations of $.5^{\circ}\text{F}$. to 1°F . It then came to a lower level, 101°F . to 102.6°F . The pulse was full and soft. The abdomen was flaccid and the spleen palpable. It was with the greatest difficulty that the bowels were made to act. The stools were very offensive. The urine was strongly acid and became offensive after standing, on microscopic examina-

tion, it was found to be teeming with Bacillus Coli, and there was a mere trace of albumin. The temperature came lower and there was an improvement in the clinical picture when on the sixteenth day the temperature began to mount. A leucocyte count on the eighth day was 10,300 and now it reached 15,000 with a preponderance of polymorphonuclears. An abscess developed over the right tibia and this was opened on the nineteenth day. The urine contained colon bacilli on each occasion and a blood culture resulted in the growth of the organism. The spinal fluid was normal. The appetite at this stage was fair and water was freely taken. The temperature now was 100°F. to 101°F. but the pulse and respiration rates were quickened and the pulse soft and weak. The patient now became weaker and very emaciated, her early attacks of nausea returned, a troublesome diarrhoea followed and later ascites. A whitlow on the right index finger and later a small subcutaneous abscess over the left groin added to her distress. The blood showed a marked anaemia. Faintness, transitory blindness, and extreme weakness became manifest on the thirty-sixth day and she died of toxæmia on the forty-second day of her illness.

(b) Subinfections and Auto-intoxication: The general symptoms associated with the chronic passage of B. Coli through the blood into the organs and the continued absorption of the products of activity of the colon groups of organisms which is favoured by continued constipation, and increased intestinal putrefaction, associated with stasis occurring in the caecum and ascending colon, include headache, mental and physical fatigue, vertigo, anorexia, depression and drowsiness, with a subnormal temperature and enfeebled circulation. The patient loses weight, the muscles degenerate, the skin becomes thin, wrinkled and pigmented and there is an excessive secretion of sweat. As a result of loss of fat and muscular tone, there is a tendency to ptosis of the viscera. Changes in the joints of the nature of arthritis deformans, and chronic mastitis with cystic degeneration of the breasts have been attributed to it. The most prominent local symptoms are a feeling of abdominal distension with pain and borborygmi after taking food. As a rule the bowels act only after aperient medicines, the motions are offensive and contain an excess of mucus.

There is no doubt that migraine, neurasthenia, insanity, eclampsia, epilepsy, asthma, nephritis, diabetes, painful pelvic disorders, cirrhosis of the liver, Graves' disease, hyperpiesis, and to some extent pernicious anaemia may be greatly aggravated by this state of affairs. The presence of indican in excessive amount is some evidence of excessive intestinal

putrefaction but according to Brown and Evans²³ a rise in the proportion of the total sulphates which are excreted in ethereal combination is better evidence of intestinal intoxication than a well-marked indican reaction.

Further complications include fibrositis, lumbago, stiffness of the neck muscles and fibrositis of the sacro-iliac ligaments. Non-infective specific arthritis and stiffness of the joints are common and in the worst cases there is extensive osteoarthritis and partial or complete crippling of the patient.

II Local Infections with Bacillus Coli:

(a) Intestinal Infection: Under this heading are included those inflammatory conditions of the intestinal wall which follows:-

(i) whenever through some intestinal disturbance such as stasis, the virulence of one or more of the usually saprophytic strains is increased,

(ii) by a lowering of resistance of the intact epithelium of the intestine with its covering of mucus by physical or chemical changes or by the presence of infection by another microbe, or

(iii) whenever the infecting strain of B. Coli has absolute pathogenic properties.

Further, the following conditions may account for the fact that these organisms may become pathogenic.

1. Diminished Resistance of the Individual:

(a) General: Exposure to great and prolonged heat or cold, malnutrition from underfeeding, improper feeding, and perhaps deficiency of vitamins A and B.

(b) Local:

- (i) Diminished acidity of the gastric juice;
- (ii) Irritation of the bowel by chemical "poisons" in food or made locally, e.g. tryptophane and other protein degradation products;
- (iii) Reduction in the numbers of beneficent intestinal microbes;
- (iv) Stunting and atrophy of the intestinal villi due to under-feeding with fat-soluble A;
- (v) Increased formation of harmful acids by B. Coli and B. Welchii, leading to increased peristalsis and diarrhoea, and an inflammatory condition in the bowel wall.

2. Increased resistance of the organisms by "mass" action, by passage through another individual or by symbiosis.

From one or more of these factors acute or chronic enteritis, enterocolitis, acute catarrhal and ulcerative colitis may ensue.

Acute catarrhal enteritis occurs most frequently as a result of food poisoning. Gaertner's bacillus is closely associated with epidemic food poisoning and may be quoted as an example of the infecting strain of B. Coli with absolute pathogenic properties.

The Bacillus Coli is amongst those which have been isolated in various epidemics of epidemic diarrhoea in children where as a rule the mucous membrane of the stomach and intestines is in a condition of "mucous catarrh". There may also be areas of congestion, with here and there small petechial haemorrhages. The lymphoid tissue of the alimentary canal is often swollen, and in severe and protracted

cases the solitary follicles in the colon and lower ileum may exhibit superficial ulceration. Other organs, such as the liver and kidneys show fatty or parenchymatous degeneration, whilst the lungs are often congested and oedematous with, in protracted cases, patches of bronchopneumonia in the lower lobes. The putrid odour of the stools in the severe bowel disturbances due to B. Coli is almost diagnostic of the infecting agent. R.C. Jewesbury and L.S. Dudgeon²⁴ report a case of acute Bacillus Coli infection of the gastrointestinal tract in a new-born baby. The mother was infected with a certain strain of B. Coli which had produced two attacks of acute fever, and her urine contained a large amount of pus and numerous bacilli; the lochia was similarly affected. In their opinion, the baby became infected at birth by swallowing the urine or lochia. This was supported by the fact that the illness commenced about three days after birth. Thick mucus was passed by the bowel, and mucus was vomited. The organism was present in the bowel for many weeks, and in the vomit eighteen weeks from the onset. Bacilluria due to the same organism was present also. The illness though very severe did not prove fatal.

The commonest organism to cause appendicitis is the Bacillus Coli. Obstruction to the lumen of the appendix from any cause produces stagnation of its contents, and provides the necessary conditions for bacterial invasion when a procession of events from catarrhal appendicitis to

an empyema or local or general gangrene with a possible perforation at any stage leading either to a localised appendicular abscess containing quantities of very foul faecal smelling pus or to generalised peritonitis.

Diverticulitis: This is commonest in the sigmoid colon. If the entire colon is affected there is a gradual increase in the frequency of the diverticula from right to left. It is more common in men than in women and since constipation is more common in women this would seem to show that it is not an important factor in the causation of diverticulitis. It is usually seen in persons over forty years of age. According to Spriggs²⁵ there are three main stages in the progress of the disease:

- (i) The pre-diverticular state)
- (ii) The stage of formed diverticula) Diverticulosis.
- (iii) The stage of inflamed diverticula, or
diverticulitis.

and he thinks that aperients are one cause and that abnormally liquid faeces lying in the sigmoid flexure may, by bacterial or chemical damage, have to do with the frequency of the disease in that part of the gut. The slight inflammatory changes cause relaxation of the bowel wall, so that internal pressure produces small herniae of the mucous membrane through the weakened muscle. Starting in the mucous membrane the inflammatory process involves the coat of the gut including the peritoneal coat and spreads to the surrounding parts; especially to the bladder in men, but also, at times to the

small intestine or abdominal wall, and in women, to the uterus and ovary. In late stages, small, or sometimes larger, abscesses form in the inflamed or septic area. Obstructive symptoms due to the presence of an inflamed and oedematous mucosa or to fibrous constriction of the bowel wall may supervene. In chronic inflammation, or peridiverticulitis, thickening may give rise to stenosis or to the formation of a mass which simulates new growth. Actual cancer, moreover, may be associated with diverticulitis, being here, as elsewhere, probably related to the effects of chronic irritation.

Pericolic suppuration and local peritonitis complicating intestinal conditions are all of them associated with B. Coli infection and in many cases with this alone.

The association of chronic appendicitis, most commonly brought about by the Bacillus Coli, with both acute and chronic gastric and duodenal ulcer is too common to be a coincidence, and the greatly diminished tendency to relapse, especially of acute ulcers, following removal of the appendix without interfering with the ulcer, shows that the appendicitis is the primary condition. Furthermore, by means of the lymphatics the mucous membrane of the stomach and duodenum may be a target for infective material not only from the ileocaecal angle but from any parts of the abdominal cavity. The association of these ulcers with lesions of the large intestine is a well-recognised fact. It is well to note that one has found appendicitis to be very rare among the South African raw Native, gastric, and duodenal ulcers and

gall bladder affections being still more uncommon.

Ischio-rectal Abscess and abscesses in the region of the rectum and anus are most frequently due to infection spreading from a lesion of the mucous membrane infected with the Bacillus Coli.

Whether as the result of circulatory interference or of trauma, the vitality of any portion of the intestinal canal is impaired, the Bacillus Coli soon attacks it and sets up a chain of events ending in gangrene of the part. Should the strangulation of a coil or portion of intestine be sufficiently severe to obstruct arteries as well as veins, the part becomes gangrenous in less than an hour. A strangulated coil soon loses power to prevent the passage of bacteria and the contents are profoundly toxic. The faecal character of the vomiting associated with the vomiting of acute intestinal obstruction is accounted for by the remarkable speed with which Bacillus Coli and other organisms multiply in the stagnant contents.

(b) Peritoneal Infections: The majority of cases, whether acute or chronic depend more or less directly on the passage of B. Coli from within the alimentary canal owing to change in its walls. The appendix is the most frequent seat of the primary condition. Intestinal obstruction, strangulated hernia, perforating ulcers and wounds of any of the hollow organs or leakage from surgical anastomoses and diverticulitis, may afford the necessary passage for infection. It may

arise from infection of the Fallopian tubes, ovaries, ureters, bladder. The Bacillus Coli is often the cause of pelvic sepsis. Any pus found has the characteristic faecal odour.

(c) Infections of the Biliary Tract and Pancreas:

Gall bladder sepsis may occur by lymphatic spread or by infection from the portal system and is closely associated with B. Coli infection. The organism can grow in bile. In the majority of cases of cholecystitis we are concerned with an intramural streptococcal infection nevertheless on account of its ability to grow in bile, denied to the streptococcus, it is favourably situated to start up a catarrhal process of the mucous membrane.

B. Coli infection plays a part in cholangitis and cholelithiasis. The agglutinated bacteria, precipitate mucus, and cellular debris may form the nucleus of gall stones.

Organisms of the B. Coli group have been obtained during life and on post-mortem from the liver on several occasions in cases of epidemic catarrhal jaundice. It seems probable that the disease is caused by an intestinal infection setting up a duodenitis and ascending catarrh of the bile ducts with resulting obstructive jaundice.

Acute Pancreatitis: Bacteria, especially the B. Coli and streptococci can always be isolated from the inflamed gland. These organisms can activate the zymogens of the pancreatic juice and thus set free trypsin and steapsin,

which are the active agents in the production of the characteristic necrotic and haemorrhagic changes in the pancreas and of the fat necrosis. It would seem that infection is conveyed along the lymphatics which drain from the large bowel and from the duodenum by way of the ducts.

Chronic indurative Pancreatitis: We have seen that the pancreas may be a target for infective material from the ileo-caecal region. Obstruction of the pancreatic duct with damming back and infection of the secretion due in most cases to the lodgment of a gall-stone in the terminal portion of the common bile duct, or an ascending infection from the bowel is a common cause. Catarrh of the stomach and duodenum and the presence of a duodenal ulcer are common antecedents.

Chronic pancreatitis is sometimes attended with the formation of pancreatic calculi. The inflammatory process may affect the interlobular or the interacinous connective tissue, and, in either case, may terminate in cirrhosis with degeneration and destruction of the secreting elements. The condition may involve the whole gland, or only part of it, more often the head, where it is embraced by the duodenum. The affected portion is swollen and is usually harder than normal, and the lobulation is unduly distinct.

(d) Infections of the Urinary Tract: These are the most frequent and most important of the disease processes which the Bacillus Coli may produce. The mere presence

of B. Coli in the urine does not establish an actual urinary tract infection. It may signify one of the following conditions:-

(a) The elimination of the bacilli from the body through the kidneys, without infection either of this organ or of the urinary tract.

(b) The excretion of bacilli (with pus) from an infected kidney or from some focus of infection adjacent to the urinary tract (prostate, urethra, pericolic tissues).

(c) True infection of the urinary tract (nephritis, pyelitis, cystitis, pyelo_cystitis).

(d) Bacilluria.

It is with the true infection of the urinary tract that we are primarily concerned.

In the healthy bowel the intact epithelium and covering of mucus, the masses of lymphoid tissue in the intestinal wall and the appendix and the chain of lymph glands in the neighbourhood act as an efficient barrier against the escape of the organisms to the lymph or blood stream. Diseases of the bowel and chronic intestinal stasis and inflammation of the mucous membrane or of the accessory organs is a familiar source of the escape of the bacteria as well as operations on the bowel and the female pelvic organs, excessive purgation, over_distension of the large bowel by lavage.

The work of Dudgeon, Bawtree and Wordley²⁶ showed that the colon bacillus infecting the urinary tract could be grouped into haemolytic and non_haemolytic strains. The haemolytic group accounted for about 70% of cases in the

male sex and about 30% in the female, although the percentage of haemolytic organisms was higher in women suffering from acute coli fever. With the non-haemolytic group the percentages among men and women were reversed. Further they state that while the haemolytic strain reaches the kidney as a primary blood stream infection, the non-haemolytic strain reaches it by contamination of the external urethra.

In the production of infection of the kidney by means of the colon bacillus Lepper²⁷ found that intravenous injection alone acts by producing embolism of small arteries, especially those supplying the papilla; the lesions are localised and much less severe in character than those produced by the extravasation of infected blood into the tissues such as occurs after obstruction of the ureter. Obstruction of the ureter is important in bringing about a dilatation of the pelvis and pressure on the veins, which may result in extravasation of infected blood into the substance of the kidneys and subsequently diffuse inflammatory changes throughout the kidney.

Having crossed the natural barrier, the organisms can reach the kidney and urinary tract:-

- (i) by the blood stream,
- (ii) by way of the lymphatics,
- (iii) by direct contact of the urinary passages with infective lesions of the neighbouring structures.
Further
- (iv) it is argued that the organism gets there by direct contiguity through the urethra and
- (v) again that it is brought to the renal pelvis through the ureter.

Let us commence by raising the question whether the colon bacillus is normally in the urine? Beeler and Helmholtz³² found that the urine is sterile in 50% of normal patients. Only 30% was sterile in patients with parenteral infection.

(i) There is no doubt that the commonest course for infection to travel is by the blood stream. Helmholtz working with Milliken, Bowers and Beeler^{28,29,30} was able to produce infection in the kidney and pelvis by intravenous injection. Even when organisms of the coccus group were injected they obtained a colon bacilluria. Bumpus and Meisser³¹ were able to produce abscesses of the renal cortex by injecting intravenously streptococci obtained from carious teeth. This proves almost conclusively that the organisms are carried by the blood stream to the kidneys and there set up lesions. There is abundant experimental evidence to the effect that bacteria may pass through the normal kidney and appear in the urine without the slightest clinical evidence of renal injury, and there is, therefore, sound basis for the statement that, in addition to the mere presence of the bacteria, an additional or predisposing cause is necessary. These causes are mainly obstructive in character, since any condition interfering with the normal drainage from the renal pelvis increases the susceptibility to that kidney to infection as the experiments above quoted prove. The more common underlying causes are hydronephrosis, nephroptosis, ureteral calculus, stricture, or a blood clot

in the ureter, or external pressure upon the ureter due to a pregnant uterus, or to a pelvic new growth or to an inflammatory mass. Chronic ureteral obstruction from any cause is an equally potent factor. These are the local resistance-reducing causes which permit the bacteria to gain a foothold. Of equal if not greater importance is the subject of focal infection. There is abundant experimental and clinical evidence of the ability of bacteria in stagnant colons to irritate and perpetuate renal infections. The susceptibility of the kidney to infection may likewise be increased by general systemic infection as the result of toxic influences.

Helmholtz and Milliken³³ have carried out experiments in which cultures taken from the tonsils, ears and carious teeth have been injected intravenously in animals. Abscesses in the cortex of the kidney and pyuria resulted, but the organisms obtained from the urine were not those injected. Whereas streptococci and staphylococci were injected colon bacilli were cultured from the urine. To quote directly from their paper "It would seem, however, as the result of our experiments that the growth of the colon bacillus in the urinary tract is the result of a favourable medium produced by the lowering of the resistance of the individual rather than by a specific tendency on the part of the streptococci or staphylococci to localise in the kidney and prepare the soil for the colon bacillus."

(ii) The infecting organism may choose the lymphatic

path and the transperitoneal route is dependent on the lymphatic channels which are in close communication with the right kidney and the large bowel. The lymphatic connection between the appendix and large bowel on the one hand, and the periureteral lymphatics on the other hand make it possible for infection to reach the kidney along the lymphatics network between the muscular coats of the ureter. Franke³⁴ was able by means of injection to show a direct connection between these vessels.

(iii) Ball¹⁷ lays great stress on the third mode of infection by direct contact of the urinary passages with infective lesions of the neighbouring structures.

(iv) Per urethram: The short female urethra, with its proximity to the anus has been considered as the route by which the bladder is infected.

In some instances it is clear that invasion takes place directly through the urethra. The cystitis which still occasionally follows the use of the catheter illustrates this; and the greater frequency of B. Coli cystitis in little girls rather than in little boys has been adduced in favour of this route. Beeler and Helmholtz³² have shown that the colon bacillus is not a normal inhabitant of the urethra. In normal patients the organisms isolated were staphylococci and diphtheroid bacilli. In children less than two years of age with extra urinary infections, cultures from the urethra showed the colon group of bacilli in one third of the cases. These cases were concurred with by Schwartz³⁵.

(v) The fifth route of infection by ascension from the bladder through the lumen of the ureter has many advocates. Keyes³⁶ calls attention to the fact that in acute ascending inflammations such as are seen post-operatively, post-mortem examination fails to show any evidence of ascending lymphatic infection along the course of the ureter. Helmholtz³⁷ also states that in two-thirds of the cases, after intracystic injection there was no periureteral inflammation. Parietal peripelvic inflammation and pus in the pelvis of the kidney were the only pathological findings. David³⁸ showed that without periureteral and peripelvic inflammation pyelitis can occur "by infection ascending through the lumen of the ureter".

Experimentally it was shown by Helmholtz and Bower²⁸ and Helmholtz³⁹ that cultures of ureteral urine were sterile in seventeen out of twenty-one rabbits, and in only one of the remaining four did both ureters have innumerable colon bacilli. All twenty-one were injected intravenously and all had colon bacilli in the urine catheterised from the bladder. The deduction they arrived at is "involvement of the bladder is primary and upper tract infection is brought about by ascending infection from the bladder".

That this is true in the child was proved by Hinman⁴⁰ who has shown that in his series 50% had infection of the bladder without involvement of the upper tract. David³⁸ has shown that B. Coli may be found in the urinary bladder

one month after a culture has been instilled into the bladder with no evidence of infection in any part of the urinary tract. Infection appeared if there was any obstruction or injury in the course of the ureter and Hanner⁴¹ believes that cystitis proceeds to renal lesions since he found a focus of infection and ureteral stricture in every case in which the kidney was involved. He quotes Schrieber "in 13% of cases there are lesions which conform to our idea of stricture, i.e. a thickening of the ureteral wall sufficient to cause a dilatation of the tract above it." There must be sufficient obstruction to cause stasis in the ureter. The static decomposing urine becomes easily infected and pyelitis supervenes. Eisendrath and Schultz⁴² present evidence that infection can travel upward with partial obstruction. It has been further shown in many series of cases by Kretchmer⁴³, Thomas and Birdsall⁴⁴, Beer⁴⁵, Lowsley and Butterfield⁴⁶, Smith⁴⁷, Helmholtz⁴⁸, and many others, that renal lesions have been associated with congenital malformations in the kidneys, ureters, or bladder, i.e. organic changes such as hydronephrosis, hydroureter, calculi and tumours.

If there be no obstruction or abnormality above the bladder, can infected urine from the bladder enter the ureters? Satani⁴⁹ and Gruber⁵⁰ showed that the intravesical portion of the ureter acts as a true valve and there is no reflux into the ureters. Kretchmer⁵¹, Helmholtz and Kretchmer⁵²

Kretchmer⁵³, showed that the urine did regurgitate into the ureters under normal conditions in three out of ten children. McKahn⁵⁴ showed that in 20% of children with pyuria there is a reflux of opaque solution into the ureters. "Whether the pyuria is the cause or the result of the reflux has not yet been determined".

The infecting organisms having gained a foothold in the interstitial tissue of the kidney produce an acute inflammatory lesion, Chown⁵⁵ states a suppurative nephritis, characterised by oedema, an outpouring of polymorphonuclear, and to a less extent, mononuclear cells with degeneration of the neighbouring parenchymatous tissue and varying degree of necrosis. The areas of infiltration are often adjacent to small blood vessels. As the disease advances or becomes more severe, the lesions grow larger and contain more polymorphonuclear cells, until, in the severest forms, frank abscess formation is evident. Necrosis and liquefaction are, however, not prominent findings. The organisms and inflammatory products escape into the tubules, drain thence into the pelvis and so appear in the urine. Although the term "pyelitis" is in common usage, it seems that the term "pyelonephritis" may be more properly employed, in that all evidence is contrary to the conception that pyogenic infection may be exclusively limited to the mucosa of the renal pelvis. Pyelitis did not appear as a sole lesion in a single instance in a series of thirty-eight autopsies

collected by Wilson and Schloss^{56,57}. Two cases had involvement of the renal pelvis and both had associated with them a marked inflammation of the interstitial tissue. When the pelvis is affected, microscopically it is seen to be thickened and the submucosa infiltrated. It appears that in mild cases the kidney drains and goes on to complete healing. In the more severe cases there are more extensive and more numerous lesions, with insufficient drainage. The gross appearance of the kidney in this disease varies according to the stage at which the patient dies. In the earliest cases the kidney, both externally and on section, may appear normal or slightly congested. The pelvis is normal. At a later stage the kidney is found swollen and congested. The degree of swelling is extremely variable and may be scarcely noticeable, certainly not clinically appreciable. The outer surface usually shows small, greyish white or yellowish white, flat or slightly depressed areas surrounded by a zone of haemorrhage. The cut surface bears similar lesions both in the cortex and in the medulla, with some linear ones stretching through the pyramids. The pelvis is usually normal, though sometimes it has appeared congested or the seat of petechiae. In the next stage abscesses are found in the substance and on the surface. Finally in the chronic cases, there is a somewhat swollen kidney with a slight adherent capsule, and with necrotic and suppurative foci as in the previous cases. There are certain cases which run

their course without foci becoming visible to the naked eye. In these the kidney is usually swollen, soft and congested, and on section the surface is greyish and slimy.

Aetiology: Bacillus Coli infection of the kidney is a frequent complication of typhus and smallpox, typhoid fever, measles, rubella, scarlet fever and diphtheria. It is met with in children as well as in adults. In general it is more common in females than in males. Its age incidence depends on the determining cause. Thus, it is common in female infants and here sex must be considered as a probable aetiological factor and plays its part in all likelihood, by offering an additional route of infection in girls. It seems very doubtful if infection can ascend through the urethra in male infants. Further, the pathological picture presented in both sexes is usually a definitely interstitial one, suggesting a blood stream infection. In the absence of positive proof it seems reasonable to believe that the route is by way of the blood stream in boys, and in a similar number of cases in girls. In the remaining bilateral cases in girls the assumption of an ascending infection by way of the urethra appears justifiable, and certainly some of the cases of cystitis uncomplicated by a lesion higher in the urinary tract probably originate in this way.

It is common in males at a later age, associated with enlarged prostate and cystitis. It is not an uncommon complication of pregnancy, occurring especially in the fifth month of gestation.

To explain the more frequent occurrence of right-sided lesions, the theory of direct lymphatic extension from the caecum has been invoked by Franke⁵⁸. In point of fact, in infancy, the left kidney is much more closely connected to the colon than is the right. Very frequently only the lower pole of the right kidney is in contact with the large intestine, or there may be no connection whatever. The lower half of the kidney is not more frequently involved in the disease than is the upper. Further the pelvis itself is rarely in direct relation with the colon. There is, however, a difference between the anatomical relationship of the two kidneys, which may be of importance. The right is overlapped by the liver, which may even reach down and cover the renal vessels and pelvis. In the course of acute infections it is a common occurrence to find the liver greatly enlarged. With the patient lying flat, on his back this might well bring pressure to bear on the right kidney with some consequent stasis and lowering of resistance. Helmholtz and Field⁵⁹ have recently demonstrated that complete occlusion of the renal vein for as short a time as three minutes so alters the kidney permeability as to permit bacteria to pass through in a very short space of time. The liver further keeps the kidney at a lower level than the left and this would offer a greater opportunity for ureteral kinking on the right.

According to Rorke⁶⁰ the most common season for infection to occur in the Northern Hemisphere is from November to March

and a secondary period in July and August. These correspond with the period of respiratory infection and of intestinal disturbance. Rosving⁶¹, Wildbody⁶², and Scholl⁶³ describe cases of pyelonephritis with the colon bacillus as the infecting agent following attempts at coition, especially in newly married women and it is the contention of these observers that the urinary infection gains entrance through small wounds of the hymen and that the infection is carried at least part of its way by the blood stream. Fatigue, worry and exposure to cold and wet are occasional predisposing causes.

B. Coli Infection of the Urinary Tract in Adults: In true infection of the urinary tract the cases met with may be conveniently described as falling under three heads:-

1. Acute: In the majority of these cases the infection appears to arise in the kidney; some are undoubtedly vesical in origin; in not a few it is uncertain where the infection starts.

Prodromal Symptoms: There is usually a period of four or five days or a week before the acute symptoms develop, during which the patient feels ill, but these symptoms are not sufficient for him to seek medical advice. At this stage there is some loss of appetite, a little headache, want of energy, irritability and the patient is hypersensitive to changes in the surrounding temperature. Almost always there is some bowel trouble. If the patient is inclined to constipation

the bowels are more difficult to move; flatulent distension, in patients subject to it, is more pronounced and distressing; patients prone to irritability of the bowel have an attack of diarrhoea. There may also be a little irritability of the bladder and increased frequency of micturition although the urine still remains clear.

Symptoms: The acute symptoms come on suddenly. The patient has a sudden desire to pass water, sometimes so urgent that there is an involuntary escape. This is followed by intense bladder irritation and strangury. After a few hours of bladder irritation there is a rigor and the temperature runs up to 103° or 104° F. The rigor may be repeated. The disease is at times quite fulminating in its acuteness, being ushered in by rigors, high fever, delirium and great drowsiness. More often the symptoms are abrupt and severe but not alarming. Kidd says "Strangury combined with fever in a female is always due to pyelitis". The urine which is passed in small quantities at frequent intervals, is high coloured and cloudy and often it has an offensive fishy smell, but the colour and amount of the urine depend upon the degree of pyrexia and the amount of fluid ingested. There may be a fairly frank haematuria. "B. Coli infection is the explanation of a large number of obscure cases of haematuria" (Horder). Evidence of bacilluria, in the



shimmering appearance on swinging the glass so as to circulate the urine, may be present. The amount of pus is very variable - it may be very considerable, or it may be represented only by leucocytes seen on microscopic examination. Like the pus, the bacilli vary greatly in the degree to which they are present in the urine; in some cases they are so abundant as to constitute by far the greater part of the total sediment. The urinary findings are interesting in cases in which temperature oscillations are marked. During the time that the temperature is rising or at its height the urine is of normal specific gravity and a few pus cells are present. If examined at the time of the fall of temperature the urine is found to be more copious with higher specific gravity and the microscopic field is loaded with pus cells. The fall in temperature is explained by discharge of infected urine. In very severe cases a portion of the bladder mucosa may be shed in the form of sloughs, but this is uncommon. The urine usually shows albumin - at least, in traces. It is intensely acid in reaction, though occasionally it may be neutral to litmus. Subsequent bacteriological examination of the urine shows an abundant growth of *Bacillus Coli*.

Flatulent distension of the bowel is a frequent and distressing symptom, and during the course of the attack

this is accompanied by obstinate constipation. The tongue is generally covered by a creamy fur, and anorexia is common and the mental state tends to depression. Some cases run an aprexial course.

Some symptoms may now develop which show where the main stress of the infection is likely to be focussed.

There is pain in the loin on one side, situated in the kidney region both in front and behind. According to Ryle⁶⁴ pain does not exist in pyelonephritis per se. Its presence is due to obstruction and pressure on the muscularis of the ureter. It may be vague at first and felt in the abdomen or the back, but it becomes localized as a dull, heavy, aching pain in one loin. In addition there may be an attack of severe pain along the line of the ureter, amounting to renal colic. The pain here is a localizing symptom of extreme value and shows that a descending ureteritis is present in addition to the kidney lesion. In those cases in which the bladder is from the first markedly affected, symptoms of dysuria are present - frequency, pain and strangury.

On palpation of the abdomen there is tenderness of one loin. Tenderness may be present even when pain is absent. There is also some rigidity of the abdominal muscles on the affected side. The kidney is not enlarged in the early stage of the illness and may not

be enlarged at any time. Enlargement of the kidney indicates pyelonephritis or pyonephrosis. In the early state of enlargement of the kidney the enlargement is due to inflammation of the kidney substance. Later, obstruction of the pelvic outlet may be super-added to this, and a pyonephrosis may develop. The time at which a pyelonephritis becomes a pyonephrosis is not easy to diagnose, but in the pyonephrosis the temperature, instead of running continually high, takes on a swinging character, the pain and tenderness are greater and the enlargement and rigidity are likely to be more pronounced. The urine may become clear, and this is an important diagnostic sign. Later, the escape of a quantity of pus with relief of pain and subsiding symptoms, is characteristic of pyonephrosis. But the urine may have been clear throughout; and this together with a swelling in the loin and symptoms of infection, points to an infection of the renal cortex, with perirenal inflammation and probably abscess. The blood usually shows leucocytosis; polymorphonuclear neutrophils are in greatest numbers. B. Coli may also be isolated from the blood especially when rigors occur.

The course of the disease varies much. Slight attacks lasting from ten to fourteen or twenty-one days are common. Prompt recognition of its nature,

leading to appropriate treatment, usually results in defervescence and the disappearance of pus and bacilli from the urine in seven to fourteen days. But some of the cases last many weeks. It is fair to say that according to Horder⁶⁵ this is not seldom due to failure to diagnose the condition, or to employ efficient measures of treatment.

Relapses are very common and they occur usually when the patient gets up or begins to move about the house. Of complications, prostatitis is perhaps the one most often seen, epididymitis occurs less often and urethritis may occur. Epididymitis may be the first symptom of disease.

2. Recurrent cases: A not uncommon type of case is that in which symptoms of acute or of sub-acute infection occur at intervals over a number of years, the condition of the patient and of the urine being natural during the attacks. Recurring haematuria is sometimes due to this condition. The probable source of these re-infections in any individual is the colon. In some there is a persistent infection of the renal pelvis or bladder which flares up into an acute attack. The attack is excited by cold and damp, anxiety, unsuitable food, alcohol, periods of constipation or attacks of diarrhoea, tonsillitis and other causes. Between the attacks there may be little, excepting a slight ir-

ritability of the bladder, to draw attention to the urinary tract, but in these cases many signs of chronic toxæmia may exist. In the male subject some of these cases are due to an infected seminal vesicle which from time to time re-infects the prostatic urethra and bladder.

3. Chronic cases: These are either:-

(a) the sequelae of the acute attacks that have never completely resolved, or

(b) they arise insidiously, or

(c) they follow instrumental procedures or operations upon the urinary tract, or

(d) they complicate mechanical defects such as stricture and enlarged prostate, or

(e) they occur as secondary infections in cases of renal or vesical calculus or of tuberculosis.

A chronic cystitis persisting in spite of long continued bladder washing and courses of urinary antiseptics, alkalies and vaccine, is a very troublesome condition. There may be some local condition in the bladder which will explain the persistence of the infection; or the prostate and seminal vesicles may be the seat of a chronic infection which constantly supplies bacteria to keep up the stock in the bladder. But these being excluded, the cause of the chronic cystitis is most frequently a chronic infection of the kidney. In one hundred cases of B. Coli urinary infection examined by Thomson-Walker⁶⁶ in forty-two

there was bladder infection, but both kidney urines were sterile. Among fifty-eight cases, thirty had one kidney and twenty-eight had both kidneys involved.

The Symptoms in the chronic cases vary greatly. In one group it is the general toxic state that is the main feature - a sallow complexion, loss of tone, a low blood pressure, colon dyspepsia, headache and back-ache. In another group the local symptoms predominate - increased frequency of micturition, which may be extremely trying, pain during or after the act, and referred pain and discomfort in the vesical region. In a third group there is little or no interference with health, general or local. This corresponds to the chronic condition described by Thomson-Walker⁶⁶ as bacilluria without local symptoms, but with toxæmia. There is either no inflammation or the minimal amount of inflammation of the urinary tract. The urine is cloudy from a bacillary emulsion and on swinging the specimen glass to circulate the urine a peculiar and characteristic shimmering is seen. On standing, the fluid remains cloudy and there is no deposit. The urine has a peculiar stale fish odour. Bacilluria may be present with any of the other types of urinary infection. While there may be no local reaction with bacilluria, symptoms of absorption of toxin may be present. The toxæmia may be acute or chronic. Acute toxæmia may show itself in attacks of pyrexia.

Those suffering from chronic toxæmia complain of headaches, aching of muscles and joints and a lack of energy. The complexion is sallow and muddy - the patient thin and never well. The skin is usually dry and scaly, but sometimes the patient complains of night sweats.

Fibrositis is a common complication; lumbago, stiffness of the neck muscles and fibrositis of the sacroiliac ligaments may also occur. Stiffness of the joints is common and in the worst cases there is extensive osteoarthritis and partial and complete crippling of the patient. In the slighter degrees of toxæmia, the patients are often looked upon as neurasthenics.

The urine in chronic affections shows as much variety as do the symptoms. The characteristic "fishy" odour is rarely absent; the reaction is generally acid, the amount of pus present may be very little or may be considerable but the degree to which the patient is troubled by no means corresponds to the degree of pyuria; mucus is in excess; bacilli are constant and, like the pus, are very variable in quantity. Hæmaturia is uncommon in chronic infections, but is easily induced by instrumental investigation, as are also "flares up" of the chronic state, with the production of rigors, high fever, severe malaise and relative anuria.

B. Coli infection occurring in pregnancy is common. It is closely associated with toxæmia and præclamptic manifestations. In the cystitis of pregnancy and the

puerperium, the colon bacillus is usually one of the infecting organisms. In cases of severe puerperal sepsis, the infection is usually a mixed one, with streptococci. It appears that primigravidae are very prone to B. Coli infection and that the majority of cases are between twenty and thirty years of age and the symptoms usually manifest themselves about the fifth month of gestation. The condition may appear in an acute, subacute or, more commonly, a chronic form. It occasionally brings about a premature termination of pregnancy. This is especially true in connection with recurring attacks, which are relatively common, should there be kidney involvement.

(d) Simple Bacilluria: This term is properly applied to a urine which is loaded with bacilli, but in which there is no pus or, at most, a few leucocytes seen on microscopic examination. It is a state of kidney elimination of bacilli rather than a condition of bacillary infection. It is usually of short duration. The appearance of the urine is characteristic; shimmering when agitated and viewed by transmitted light. It may be met with in children as well as in adults. No lesion exists in the urinary tract in cases of simple bacilluria. The urine has the characteristic "fishy" odour.

Renal and ureteral calculi may result from the bacillus coli together with the shed epithelium acting as a nucleus for the deposition of uratic and phosphatic crystals.

Primary Cystitis still occasionally follows the use of the catheter and is not infrequent in little girls. Cystitis is generally secondary to the renal infection. Cases of cystitis fall into two main groups:-

(a) Those which clear up quickly, either spontaneously or after simple forms of treatment (acute or resolving cystitis) and

(b) Those which become chronic (progressive cystitis).

The paths of bacterial infection in resolving cystitis are not completely understood. In some cases the infection undoubtedly comes from the kidney, in others from the prostate, some per urethram in females and those introduced on catheterization. Chronicity in cystitis is due to a number of conditions. In most cases it is due either to persistent infection from the kidney or to the presence of retained urine in the bladder, on rare occasions to a solitary ulcer of the bladder. Cystitis then, though a distinct clinical entity, is usually secondary to some other lesion of the urinary tract. It should not be treated empirically, the exciting and predisposing causes should be sought by a thorough investigation of the whole of the urinary tract.

The changes in the bladder in acute cystitis are most marked around the ureteral orifices on one or both sides, suggesting the renal origin of the majority of cases, also in the region of the neck, and they affect

chiefly the mucous membrane, which is intensely congested - of a brilliant scarlet when seen with the cystoscope - and may show minute hæmorrhage. Pus and flakes of fibrin adhere to the surface and float in the urine, and shedding of the epithelium may result in the formation of erosions or superficial ulcers. In chronic or progressive cystitis the changes extend throughout the whole thickness of the wall and result in sclerosis, whereby the elasticity of the organ is impaired. The mucous membrane is of a slate or violet colour, is often roughened or villous, and bleeds readily or it may be the seat of ulcers. The state of the muscular coat and the capacity of the organ vary with the condition of which the cystitis is a complication; in some forms of chronic cystitis, the capacity of the organ is reduced to two or three ounces, and any attempt to distend it, by introducing a larger amount of fluid, causes intense suffering. It may be noted that when there is a long-standing obstruction to the outflow of urine, the bundles of muscle fibres may stand out in interlacing columns and the mucous membrane may be herniated between the columns, forming cysts or pouches in which the urine stagnates and decomposes, thus favouring the formation of stone.

Clinical features of Acute cystitis: In many cases spasmodic contraction of the bladder is the dominating feature, the patient complaining of frequent, urgent

and painful micturition. The pain is most marked at the end of the act, and is chiefly referred to the external meatus.

Chronic Cystitis: The symptoms are frequency of micturition, pain at the neck of the bladder, and along the urethra of a burning or scalding character. From time to time there may be rise of temperature, together with backache and aching in the muscles.

The urine has the characteristics described under the section of infections of the urinary tract.

Urethritis: This condition is very rare in infections of the urinary tract with the Bacillus Coli.

Infections of the Urinary Tract by Colon Bacillus in Children: The disease is often a very dramatic one in children, there is a maximum of febrile reaction with lassitude and even stupor and a minimum of serious effect upon the vital organs. It is very common to see a temperature of 105^oF with big intermissions; the child is very ill during the pyrexial stage and comparatively well when the temperature falls. A simple bacilluria, or a cystitis or pyelonephritis, or a combination of these, or a suppurative nephritis may follow infection of a baby's urinary tract with the Bacillus Coli.

Simple Bacilluria: This condition which is often seen in connection with operations on the abdomen, and in any other circumstances in which the general resis-

tance is lowered, as in cases of severe intestinal derangement is similar to that found in adults.

Cystitis: The presence of Colon Bacilli, pus cells, and often blood corpuscles, in an acid urine, increased frequency of micturition, with a varying amount of dysuria, little or no rise of temperature, and no marked appearance of illness or distress make up the clinical picture. It is a common condition, sometimes met with alone, but often along with diarrhoea.

A pyelonephritis, often classed as pyelitis, from Bacillus Coli infection is a common and important disease of infancy and childhood. It may set in during apparent good health, but is more often found in states of debility, or as a complication or sequel of bowel derangements. It may occur at any age but is seen twice as often in babies under two years, as in older children, and it is also usually much more severe in them. It is more common in little girls. Localising symptoms in these cases are so slight that they often remain unrecognised, because though the children are very ill, there may be nothing found to account for their condition, except a small amount of pus and bacteria in the urine. Occasionally there has been some incontinence or undue frequency of micturition for a week or two before the acute symptoms set in, but usually no preliminary local symptoms have been

noticed. The onset is generally sudden, the temperature rising rapidly to 101°F. to 105°F., and assuming a remittent type like that of enteric fever. The patient is drowsy and miserable, sometimes squints, and seems tender all over, refuses food, often breathes quickly and usually vomits. In many cases noticeable shiverings or well-marked rigors take place. Less commonly, the child may alarm the mother from time to time by becoming suddenly pale, stiff and collapsed. In a few of the cases, especially in young babies, convulsions occur which sometimes begin as rigors. A considerable degree of leucocytosis (16,000 to 32,000) is generally present.

Local symptoms are either very trivial or apparently absent. There may, however, be colicky pains, some dysuria, or frequent micturition, tenderness in one or other loin, and occasionally palpable enlargement of one or both kidneys with pain on pressure.

In order to obtain the urine with the pus cells not strained off, the simple plan of allowing the infant to lie for a few hours on a waterproof mackintosh until some urine is passed is all that is needed. The urine, when passed, is opalescent and distinctly acid, and contains a considerable amount of pus and Colon Bacilli; and on standing a deposit is slow to form. The amount of albumin present is very slight. Microscopic ex-

amination of a drop taken from the middle of a specimen of urine - not from the deposit - shows about six to twelve pus cells in a high-power field. Within the first day or even several days of the attack, few or no pus cells may be found, and yet they may be numerous a little later. Should one side only be affected, the pus may from time to time disappear for a day or two, owing to the ureter on that side becoming blocked.

When the disease passes on to the chronic stage, the child becomes wasted, fretful and miserable. It takes food badly and the stools are unhealthy. The extraordinary fretfulness and misery suggest something more than digestive trouble and inquiry elicits the fact that there was some febrile illness, it may be months ago, or perhaps there has been a good deal of irregular fever, which has been attributed to teething, influenza or what not.- Examination of the urine reveals the true state.

Nocturnal enuresis in children is very often due to urinary infection with B. Coli.

Suppurative Nephritis: In a certain proportion of the cases of Bacillus Coli infection, the kidneys become seriously involved, and numerous small pyaemic foci form throughout them. Some of these are haemorrhagic and others necrotic. The temperature chart may be somewhat similar to that of pyelonephritis, but often there is little or no pyrexia, the child being in a

state of collapse. The infected organs may sometimes be found much enlarged and very tender.

(e) Infections of the Genital Tract: A group of symptoms may develop which indicate prostatitis or seminal vesiculitis. There have been bladder irritability, high temperature and changes in the urine, now difficulty of micturition is superadded and retention of urine may suddenly occur, necessitating the passage of a catheter for its relief. Short of complete obstruction there is difficult, frequent, painful micturition with a heavy aching pain in the rectum and perineum, a feeling of fullness in the rectum and pain on defecation. Aching in the testicles is usually present. Rectal examination shows that the prostate is enlarged and very tender and that the seminal vesicles are distended.

Urethritis is only met with as an ascending infection.

Epididymitis: This frequently occurs in association with prostatitis. Orchitis and metastatic abscesses may occur apart from any injury. Abscesses containing B. Coli are not uncommon in recruits who are learning to ride.

In the female, pelvic cellulitis, salpingitis, oöphoritis and other inflammatory lesions are manifestations of the activity of the Colon Bacillus.

(f) Infections of other organs and tissues: Some situations quite remote from the bowel are now and again infected

with B. Coli - the middle ear, the parotid, the meninges, the bronchial tract, pleura, the bones, and joints. Chronic cases are peculiarly liable to staphylococcal skin infections and recurrent attacks of boils are exceedingly common.

III Secondary and Terminal Infections:

The Bacillus Coli readily invades tissues on their death and plays the part of secondary invader in any wasting disease in which intestinal lesions occur. The results of its activity may be sufficient to turn the balance against a patient suffering from typhoid fever. A B. Coli septicæmia, unless it occur as a terminal event, in which form it is not at all uncommon, is rare. When it invades tissues whose vitality is lowered by a disease process it destroys, by its secondary pathogenic activity, any chance the patient may have to live. Many of the patients in whom this terminal infection occurs are so ill at the time the event arrives that it frequently goes undiscovered, partly because their responses to infection are feeble and partly because clinical examination is difficult.

DIAGNOSIS.

Among the many difficulties of diagnosing this disease the chief lies in not suspecting it.

In some patients B. Coli may be present in large numbers in the urinary tract without causing any indication of their presence, whereas a scanty growth may give rise to serious symptoms in other patients. In children the diagnosis is often a matter of great difficulty.

The diagnosis of acute general haemic infections is made from blood culture and the demonstration of specific agglutinins against B. Coli in the blood. The organism is not always demonstrable in the blood and the agglutination reaction is occasionally negative. These facts are not sufficient to prove that the infecting agent is not the B. Coli. As the organism is eliminated by the kidneys its presence can be determined by microscopic examination of the stained deposit and by cultivation. (A polymorphonuclear leucocytosis usually accompanies this infection.) The urine must be collected under sterile conditions by catheterization, the first few ounces being discarded.

In the differential diagnosis I found that the following diseases call for consideration.

(a) Influenza.

This probably gives most difficulty in actual practice. It should be noted that B. Coli infections are very often mistaken for influenza, whereas influenza is rarely mis-

taken for B. Coli infections. The reason for this lies in the fact that the diagnosis of influenza is too often by exclusion. In influenza the onset is generally sudden and the early symptoms are more severe. The temperature reaches its maximum much sooner. The pains in the limbs and the backache are more intense, and the headache, which has a neuralgic character, is frequently supraorbital. Catarrh of the conjunctivae and nose may be present, and perspirations are often marked. Defervescence usually takes place within a few days. A sharp drop of temperature after two or three days with a sudden rebound twelve or twenty-four hours later is very characteristic.

If a supposed influenzal fever persists without definite cause, a critical revision of the diagnosis becomes necessary.

(b) Typhoid and Paratyphoid Fevers.

The onset of the illness is nearly always more gradual, and the evolution of toxic symptoms much more deliberate than in B. Coli infections. The leucocyte count is very helpful, and may prove of great diagnostic assistance before Widal's test is available. The count is low in typhoid (2000-7000) but it is high in B. Coli infections. As soon as a positive Widal's test is obtained (usually about 7th to 10th day), this finding, together with a leucopenia, may be relied upon as decisive in favour of typhoid. A positive blood culture may often be obtained before the agglutination test is available.

I have not been able to get a positive Marris' Atropine test in B. Coli infections.

(c) Rheumatic Fever.

If B. Coli fever begins with arthritis and profuse acid sweats, if the patient is an adolescent, and if the pains are specially referred to the joints, the diagnosis of rheumatic fever is at first natural.

The addition of an erythema makes the simulation all the closer. The failure of salicylates to relieve the pain, (as was found in case No.4) or to relieve the fever, should at once arouse suspicion.

(d) Malaria.

The resemblance is but superficial, owing to the fact that in some cases of B. Coli the fever may be markedly intermittent, and rigors with heavy sweats may occur. The absence of malarial parasites in the blood and the absence of leucopenia are much against a diagnosis of malaria.

(e) Differentiation from acute military tuberculosis, from tuberculous meningitis and from tuberculous peritonitis is often difficult.

Acute military tuberculosis may simulate it in its insidious onset with malaise and headache, its bronchitis and perhaps some splenic enlargement. Dyspnoea and cyanosis and the signs of pleurisy are suggestive of the tubercular condition. There are no agglutinative tests and blood cultures are

negative.

Tuberculous meningitis is differentiated by such symptoms as vomiting, convulsions, and persistence of headache after the first week, or when delirium is established. Stiffness and retraction of the neck, the presence of Kernig's sign, and of retraction of the abdomen or the onset of ocular paralysis is very significant. The irritability and curled up decubitus of meningitis contrasts with the apathy and dorsal decubitus of B. Coli fever. Lumbar puncture will clinch the diagnosis.

Tuberculous peritonitis may resemble this fever. The presence of tuberculous masses in the abdomen, or the development of peritoneal or pleural effusion is significant. In cases with indefinite symptoms and no signs of tubercle elsewhere, negative blood culture and agglutination tests afford assistance.

(f) A mild case of typhus may bear a close resemblance. The Weil-Felix reaction is present, but agglutination tests for B. Coli are negative.

(g) The fever of secondary syphilis is sometimes sufficiently severe to suggest that of B. Coli, especially when accompanied by headache, malaise, and muscular pains. Diagnosis depends on the history or detection of a primary lesion, and possibly presence of a secondary roseolar eruption and on

laboratory tests.

Local Infection of the Intestinal Tract.

It is often extremely difficult to make a correct diagnosis of acute B. Coli infection of the intestinal tract on account of the difficulties of isolating the organism from the blood or urine. The diagnosis must rest in most cases on the symptomatology of the disease. In the severe bowel disturbance due to this agent the stool will have a putrid odour which is almost diagnostic.

In a consideration of cases of chronic colitis, and those the subjects of subinfection and auto-intoxication by B. Coli our criteria for judging accurately of such a condition are lacking. Agglutination is rarely present in chronic cases and is therefore of little use as a guide. Qualitative and quantitative bacteriological investigations beyond yielding presumptive evidence do not take us far. In these cases I would urge that the plan of serially collected specimens of urine, in order to test for indican, be used. Six one ounce bottles are given to the patient who is requested to fill a bottle each time urine is passed throughout a period of twenty-four hours. The contents are then tested for indican. Its presence in excessive amount is evidence of intestinal putrefaction and when looked for in this manner is a reliable guide to diagnosis and treatment.

(ii) Acute Urinary Infections in the Adult.

Failure to make a thorough study of a catheter specimen of the urine accounts for the pitfalls which await one in the form of "acute abdomen," biliary and renal colic, renal tuberculosis, appendicular colic, lumbago, and malaria in B. Coli renal infections. In cases with fever and constitutional disturbance the differential diagnosis is from those diseases which come in their early phases under the category of indeterminate fever and in addition to those already mentioned under the heading of acute general haemic infections. Pyonephrosis is diagnosed by the presence of a tumour. Calculus is recognised by its clinical feature and by X-ray photograph. Perinephric abscess in its early stage is not accompanied by pyuria or frequency of micturition. Cystitis is generally afebrile, and is accurately diagnosed by cystoscopy. Urethritis is recognised by local tenderness, urethral discharge and urethroscopy, and prostatitis by swelling and tenderness on rectal examination.

In many cases one symptom predominates and I will describe the course of the more obscure clinical cases.

Cases with pain as the most prominent symptom may be mistaken for appendicitis but it should not be so mistaken, for the pain is over the kidney, there is tenderness of the affected kidney, and bacilli are present in the urine.

Renal colic may lead to the diagnosis of stone in the renal pelvis or ureter, for the pain of acute pyelitis and ureteritis may be as acute as that of a descending calculus.

The presence of fever and the infection of the urine are sufficient for the diagnosis of descending ureteritis. In case of doubt of secondary infection in a case of calculus an X-ray examination would dispel any doubt.

B. Coli infection is the explanation of a large number of obscure cases of haematuria. Bacteria are found in great quantity in the urine if looked for.

Cases with high fever as the chief symptom are puzzling, especially in children, when vomiting and convulsions may be present. Occasionally the temperature is recurrent and appears after exertion and exposure. The urinary symptoms are either absent or so slight as to be overlooked but a study of the urine will reveal the cause of these attacks.

In more cases than not there is a striking absence both of physical signs and focal symptoms, so that, unless the existence of the disease is borne in mind, and the urine is examined carefully, the patient is thought to be suffering from some indefinite fever which for want of a name is labelled 'influenza.'

On those cases in which the bladder is, from the first, markedly affected, symptoms of dysuria are present, frequency,

pain and strangury and such symptoms draw attention to the nature of the process.

Chronic Urinary Infection.

Accurate localization of the chief focus of infection, and the discovery of the cause of the persistence or recurrence of the infection are of prime importance.

In either sex the chief focus of infection may be in the upper urinary tract, the kidney, pelvis, or ureter, or in the lower urinary tract, the bladder in the female or the bladder, prostate and seminal vesicles in the male.

The symptoms may help and the physical examination carry the diagnosis a step further. Urinary examination may give further help.

In chronic cystitis in the male it is necessary to obtain for examination a specimen of the secretion of the prostate and seminal vesicles by thoroughly washing the bladder and filling it with sterile water. Massage the prostate and vesicles and examine the bladder contents.

Cystoscopy is necessary in order to ascertain whether any condition of the bladder may be responsible. The presence or absence of a stone should be ascertained by radiography.

Urinary Infection in Children.

The diagnosis depends on two things:-

- (1) The presence of pus and colon bacilli in the urine with the severe general symptoms usually present and

- (ii) the absence of any signs of organic disease outside the urinary tract which could account for the symptoms.

The therapeutic test - the disappearance of the fever when the urine has been rendered alkaline - would confirm the diagnosis. It is often mistaken for gastro-intestinal trouble. The extreme misery and restlessness of the patient is very striking, the complexion is pale and the skin hot and dry. The abdomen is a little fuller than normal and the infant seems to be discomforted more than is natural by gentle palpation. That the condition may simulate appendicitis is illustrated by Case No.6.

J.S., aged 6 years, when first seen on 10th January complained of pain in the right side of the abdomen. He had vomited several times, the pulse was quickened and the temperature high. This was on the second day of his illness which began suddenly on 8th January. He had severe headache, was drowsy and the right side of the abdomen was rigid. Appendicitis was suspected, but examination of the urine showed this to be acid with many pus cells and B. Coli. Under potassium citrate treatment the fever rapidly subsided, and all rigidity and pain had almost disappeared by 15th January, when he suddenly became ill again, with much abdominal pain and rigidity now on the left side of the abdomen. Alkalinization of the urine quickly relieved these symptoms and he made an apparently complete recovery.

There are cases in which the renal infection assumes the guise of acute cerebral disease: the child is drowsy or even semi-comatose, there is muco-pus on the cornea, the head slightly retracted, the neck is stiff, there may even be a squint and some slight convulsive twitching of the limbs. Routine examination of the urine and the examination of the cerebro-spinal fluid in cases with cerebral features will clear up the diagnosis in most cases.

When the condition has been allowed to become chronic, marasmus, tubercular meningitis, phthisis, typhoid fever, tubercular pyelitis, gastro-intestinal disturbances may be thought to explain the symptoms. These mistakes can only arise if the urine is not properly examined.

B. Coli Infection during Pregnancy.

The most usual mistake is to regard the case as one of appendicitis. Case No.7, Mrs. F., aged 27, Primigravida, seven months pregnant, complained of pain in the back and appendix area. The pain was of considerable intensity. Pulse 92 per min. Temperature 99.2°F. The tongue was furred and dry, vomiting was frequent and nausea troublesome. Constipation had been the rule for some time previously. There was no distension of the abdomen but the lower area moved less freely than the upper and there was slight rigidity over the right lower abdomen and loin. Rectal examination was negative. A blood count showed a leucocytosis of 15,000 to 20,000. A

retro caecal appendicitis was feared and the abdomen opened. The appendix however was normally situated and the procedure did not relieve her symptoms. In the light of the other symptoms the urine examination was incomplete. It now revealed numerous pus cells and coliform bacilli in the fresh uncentrifuged drop of urine. She was put on appropriate treatment and responded at once.

Threatened Miscarriage or Premature Labour.

The colicky pain often accompanying a renal coliform infection may lead to this error not only in the primary diagnosis, but also in known cases of the disease.

Case 8. Mrs. G., aged 34, 4th Gv. Six months pregnant. She had had pain in the lumbar region, headache, vomiting and frequency of micturition for two days. The pain was of a spasmodic nature and it was thought that she was about to miscarry. The os was found closed and there was no bleeding. The urine was acid, abundant pus and albumen were present. S.G. 1024. Appropriate treatment was instituted and she was much more comfortable within 48 hours and in 96 hours was free from all symptoms.

Biliary and renal colic, pleurisy and pneumonia, influenza and malaria are all liable to be diagnosed in error.

The other local infections do not require special comment.

Prognosis.

This may be considered under two headings:-

- (i) in infancy and childhood
- (ii) in adults.

Infancy and Childhood.

The prognosis in cases of infection by the B. Coli is on the whole favourable, but treatment is very difficult. In babies it is generally favourable, but in them it must be more guarded than in older children because they may be so weakened by the urinary disease as to succumb rapidly to broncho-pneumonia or some other complication; also because in them the risk of the kidneys becoming infected is much greater. It is not usually difficult to get rid of the constitutional symptoms, but to banish the bacillus from the urine altogether is by no means an easy matter, and it is apt to persist off and on for long periods. Death also sometimes results.

Relapses are common in untreated cases, and also in those treated by antiseptics only.

Prognosis in Adults.

The prognosis as to life is good in haemic infections. When death does occur it is either from collapse following the prolonged vomiting or from acute toxæmia.

Pyæmic cases are attended with a high mortality. The natural course in some urinary cases is to recovery in a few weeks, whereas most cases last much longer. It is fair to

say that this is not seldom due to failure to diagnose the condition, or to employ efficient measures of treatment. A longer interval generally elapses before the urine is free of bacteria. In a proportion of cases the complaint tends to become chronic, and among these are included cases that relapse, for in these the recovery has generally been incomplete. The disease may progress to pyelo-nephritis, suppurative nephritis, pyonephrosis or perinephric abscess. A fatal termination is rare, except when the condition complicates other disease, such as paraplegia, or in elderly persons with obstruction to the outflow of urine. When systemic invasion of B. Coli occurs during the course of infectious diseases the prognosis is bad.

Treatment.

(1) Prophylaxis.

I think it will be allowed that the Bacillus Coli attacks certain people who are at the moment of attack in a state of diminished resistance to that infection.

The general resistance is increased by the avoidance of exposure to cold and wet, an open air life, plenty of congenial exercise and the freedom from fatigue.

The local resistance means an intact intestinal epithelium with its covering of mucus, healthy lymphatic nodes, solitary glands, Peyer's Patches, appendix and lymphatic glands. The Natives are more successful than we are in

keeping up this resistance by keeping the bowel open regularly and by not overtaxing it by dietetic indiscretions. It will hardly be questioned that stagnation of the intestinal contents and the presence of much decomposing meat in the intestines are factors which would favour the growth of the infective organisms. It may be that cellulose-containing foods help to prevent stagnation of the intestinal contents, and they may possibly supply some vitamin which maintains resistance against the organisms. The moral to be deduced from this is that, so far as our knowledge goes at present, a predisposition of Bacillus Coli infections would be lessened (the study of the uncivilized Native bears this out) by :-

- (i) preventing constipation,
- (ii) minimizing the amount of meat eaten, and
- (iii) increasing the amount of food containing cellulose,
- (iv) diminishing the total amount of food taken.

Certain forms of treatment injudiciously carried out lower the state of the local resistance; I refer to drastic purgation, prolonged radiation without adequate intervals, over-distension by the Plombières treatment.

The removal of a healthy appendix removes an important member of the natural barriers which prevent the escape of the Bacillus Coli.

The prophylactic use of urinary antiseptics before and after operations on the pelvic organs, bowel, rectum, and urinary tract should not be neglected.

Pregnant women should be particularly careful with regard to their bowels and general health for Bacillus Coli infection of the urinary tract is a very common cause of fever. It may occur before and after confinement, and especially after gynaecological operations. It is difficult to account for this but I believe that lying on the back after delivery, or operations, is in some way responsible, for I found that if patients are made to lie in the right or left Sim's position for eight or ten hours per day, the tendency to develop fever is very greatly diminished.

An infant's feeding bottle should be thoroughly cleansed before and after each feed. Infants should not be given food which has been exposed or contaminated. It is wise to examine the mother or nurse, for it is not uncommon to find that she is also suffering from a coliform infection which, on being cured, reacts beneficially in a case of infection in the child which had previously proved resistant. Cleanliness of the anal and genito-urinary orifices is extremely important.

11. Treatment of Bacillus Coli Infections.

General Measures.

In all acute cases the patient is kept in bed so as to ensure rest and warmth. The room should be kept at a temperature of 60°F. The mouth should be cleansed after each meal with boroglyceride solution or a weak alkaline carbolic wash. Stools and urine should always be reserved for inspection.

It is important to avoid cold and fatigue. As the bowel is the source of nearly all the infections, attention to it is paramount. The method will consist in the administration of (i) bowel "antiseptics" which, if tried, should be persisted in. Cyllin and kerol or izal oil in M. III capsules thrice daily after food or a cachet containing salol gr. X, hydrarg. cum cret. gr. $\frac{1}{2}$, given with water, between meals twice or three times a day may help. (ii) Treatment of atony of the bowel wall and other causes of chronic constipation. The choice of aperients is of great importance. In acute cases calomel is very useful, gr. V to an adult or grey powder gr. I to a child. In chronic cases, the most helpful form of laxative is of the agar-agar type, liquid paraffin and cascara sagrada supplemented if necessary by a compound aloin pill. A course of high colonic irrigations may be given as a preliminary treatment and is indicated if mucus persists in the stools despite the above measures.

Dietetic Measures.

The diet should be of low protein content. Meat, eggs and raw milk are excluded entirely. Altering the flora of the gut by vegetable foods and B. Acidophilus in milk seems to do good. For the latter a freshly prepared culture in sterile milk of 200,000 bacilli to the cubic centimetre is used. Junket, whey, buttermilk and cream are allowed. The patient is also allowed lightly-cooked green vegetables, raw and cooked fruit, macaroni, boiled rice, salads, jams, marma-

lade, honey, cold fat bacon and ham, and chicken and white game occasionally. Wholemeal bread, maize and 'Kafir corn', oatmeal porridge are recommended. Plenty of barley water or other plain drinks are encouraged, preferably between meals: alcohol is rarely necessary, but it is unwise suddenly to deprive alcoholic patients of all stimulants, and a moderate allowance of brandy or good whisky is by many held to be beneficial in cases of severe prostration with weak pulse, hypostatic congestion of the lungs, delirium and tremor. There is no advantage in giving more than four to six ounces in twenty-four hours, and it should be given in small quantities diluted. In children it is quite unnecessary.

The use of chewing gum will encourage flow of saliva and help to keep the mouth in a healthy state.

111. Special Measures directed to the Urinary Tract.

At the very outset I must lay emphasis on the fact that urinary tract infection is a serious and obstinate matter so far as out-and-out cure is possible in a short time.

Acute cases.

This consists in the administration of diuretics, alkalies and urinary antiseptics. It should be the rule that no instrumental interference be permitted when the disease is in the acute stage, with the exception of cases of retention of urine in the bladder or renal pelvis and in some cases of pregnancy when drainage is indicated.

(a) Diuretics. A minimum of solid food and four or five

pints of fluid in the twenty-four hours are necessary. Water, Malvern water, barley water, lemon drink, Vichy water, weak tea and thin soup go far to allay hunger. If there is vomiting, fluid is given per rectum - half a pint four-hourly.

(b) Alkalies. The freshly passed urine, in most cases, is found to be acid in reaction and the proper treatment is the alkalization of the urine as quickly as possible. The citrate and acetate of potash and bicarbonate of soda are the drugs used. Sodium bicarbonate is more rapid and effective in its action. The advantage of using the two alkaline salts simultaneously lies in the risk of disturbing the gastric digestion by the continued use of large doses of the bicarbonates, whereas potassium citrate is a neutral salt only converted into the carbonate after it reaches the blood. The best plan appears to be to give enough potassium citrate in 20 grain doses every four hours in order to render the urine thoroughly alkaline. Care must be taken that the urine reaction is not kept alkaline by undue continuation with this agent on account of the possibility of setting up an alkaline phosphate cystitis. Phosphates are deposited from the highly alkaline urine on to the tiny ulcers of the mucous membrane of the bladder set up by the passage of previously hyperacid, septic, urine. When improvement has followed the alkaline treatment the infection of the urine will still be present, and if the patient is allowed up, or the treat-

ment discontinued a relapse will very probably take place. Sandal-wood oil is the most reliable antiseptic if the urine is alkaline from the first. The administration of alkalies cures the symptoms since alkaline fluids are less irritating to inflamed surfaces than acids. They have no lethal effects on the bacteria.

Antiseptics. These may do good in two ways: (a) by lessening the infected state of the urine by their action in the intestinal canal. The agents mentioned under heading I, together with kerol and dimol, may help by lessening, for the time being, the number of bacteria that are leaking into the urinary tract from the bowel. A course of salol is sometimes beneficial, alone, or in combination with alkaline treatment. (b) Urinary antiseptics. We do not possess a perfect urinary antiseptic, nor even a very powerful one. Infected urine forms a good culture medium which is continually being reinforced by the blood, pus and organic débris. Any local organic lesion renders treatment much less effective and more difficult to carry out. Early treatment and prolonged treatment are necessary to cope with this infection.

Hexamine. I consider that this drug, properly administered, is undoubtedly effective in combating coliform infections. The action of hexamine as a therapeutic agent depends on its dissociation into formaldehyde and ammonia, and it is claimed that the drug is effective only in an acid urine. It should be noted that it is inert in alkaline urine. It is important that hexamine should be absorbed in the form of hexamine which

is non-irritating and that the splitting into formaldehyde should first take place in the urine. It should not be prescribed with an acid, and if sodium acid phosphate is required to acidify the urine it should be prescribed separately from the hexamine. In order to avoid the action of the acid gastric juice hexamine is best given between meals and well diluted. When there is pus, epithelial cells and mucus, these combine with and fix the formaldehyde and thus lessen the amount in solution. Other factors which affect the antiseptic action of hexamine are the amount excreted, the degree of acidity of the urine, and its dilution by pathological or artificial diuresis. Hexamine decomposes so gradually that very little formaldehyde is set free in the kidney and consequently it is of little value in treating renal conditions. Bladder symptoms subside very rapidly. Some cases of coliform infection clear up very satisfactorily but persistent treatment guided by careful bacteriological tests is necessary. In gall-bladder infection hexamine is also of service. It is well to change the hexamine (gr.v to xv well diluted) for one or other of its derivatives now and again, reverting to the hexamine again later: cystopurin gr.xxx, helmitol gr.xv to xxx.

Caprokol (hexyl-resorcinol) is a combination of hexamine with resorcin and it has a great advantage of being active in urine of either acid or alkaline reaction; but if sodium bicarbonate is given at the same time the urine is deprived of bactericidal powers. I have only tried the drug in a few cases. In one

case there was pronounced improvement where hexamine alone had failed but in the others the results were not encouraging. Dose 2 to 4 capsules, each containing 0.15 grs.tds. Caprokol may be administered in repeated doses for an indefinite period. Continuous administration of large doses causes no injury to the kidney, or irritation to the urinary tract. Caprokol depends largely for its bactericidal properties upon its power to reduce the surface tension of urine. Therefore, in order to obtain optimum results, forcing fluids as commonly employed in the routine treatment of urinary tract infections should not be resorted to, as they raise the surface tension of the urine.

Urinary infections due to the B. Coli group are often very resistant, and may require sixty to ninety days continuous treatment.

Treatment should be continued for at least two weeks after the urine is sterile.

Methylene Blue. Its objection is that it colours the urine but I have found its action quite definite. The subjective symptoms subside very markedly, but the infection persists. Dose: 2 grains three or four times a day.

Aeriflavine: $1\frac{1}{2}$ grains thrice daily. I consider it, in an alkaline urine, to be of splendid promise, and of proved value in several acute cases.

Copaiba - Oil of Sandal-wood. Many cases of cystitis show at once a marked improvement in symptoms and a diminution in the number of organisms. The infection however is not over-

come.

Benzoic acid and Benzoates. Salicylic acid and Salicylates have little effect in getting rid of B. Coli infections.

Boric Acid. It may be given in acute and chronic cases and used as a lotion to wash out the bladder. The combination of boric acid, ammonium benzoate and hexamine is "the most powerful urinary antiseptic I know." Stockman. Novarsurol, a preparation of mercury given in ampoules of 1.2 cc. (1 cc. = 0.1 gram of novarsurol) is primarily a diuretic but it has powerful antiseptic uses. It may be administered both intramuscularly and intravenously. The doses range from 1 to 2 cc., but it is safer to begin with 0.75 cc., or even less in order to determine the patient's tolerance towards mercury.

The use of the new quinoline derivative or 48S is according to Armitage and Gordon⁶⁷ indicated as an antiseptic which is valuable as a genito-urinary irrigant. A concentration of 1 in 20,000 or 1 in 2,000 in normal saline is employed. It should be remembered that the antiseptic is precipitated by concentration of salts such as are met with in normal urine, and in order to avoid this preliminary washing out with normal saline and boric lotion is carried out.

It is also used as an intravenous administration in cases of Septicaemia with a positive blood culture.

In regard to the treatment of infants and children the principles are the same.

In the new-born and in infants a plentiful intake of fluid is most important. If the child refuses to drink freely, water must be given by the rectum, or through a stomach tube, or subcutaneously or even intraperitoneally.

The alkaline treatment is the best for these patients. As a rule, in a patient under two, 60 grains of pot. citrate in the day is enough, and less may suffice; but sometimes the amount has to be raised to 120 grains or more, before the urine becomes alkaline and the temperature drops. If the amount of citrate given is not sufficient to turn the reaction of the urine it has no effect in relieving the symptoms, or in lessening the risk of the disease spreading to the kidneys.

If the kidneys are affected to any extent alkalinisation of the urine and other forms of treatment have no beneficial effect.

In older children two lines of treatment are open as in the adult case. In acute cases I start with the alkaline treatment and follow on with a urinary antiseptic. The urinary antiseptics occasionally succeed in acute cases of a mild type, but, as a rule, they are much less successful than the alkalies. Sometimes in the protracted cases, I find urinary antiseptics and alkaline salts may be given alternately with advantage.

Intravenous Medication.

There has been a limited intravenous use of mercurio-

chrome,⁶⁸ acriflavine, hexamine and arsenobillon and a few good results have been reported.

I have no personal experience of this method of treatment. The subject of intravenous chemotherapy is yet in its infancy.

Chronic Urinary Infections.

A course of the treatment outlined for an acute case is indicated. It is essential to watch the reaction of the urine for it should be kept just faintly acid. Potassium citrate will reduce the acidity and acid phosphate of soda will keep the reaction acid. In addition, salol gr.v. may be given thrice daily if the urine is alkaline or hexamine gr.x, when the urine is acid. Following this, every effort is to be made to build up the patient's resistance by living in pure air, avoiding chill and over-fatigue, a generous and nourishing diet, and by so arranging the diet that the bowels are open regularly without taking purgatives except perhaps liquid paraffin. The successful treatment of such a case depends upon a correct appreciation of the location and extent of the inflammation, and such a diagnosis cannot be made without routine cystoscopy and pyelography and X-ray examination. It may exist in the gastro-intestinal tract as a digestive disturbance or associated with such factors as promote irregular bacterial activity - appendicitis, chronic constipation, etc.

Two important local methods of treatment consist in

washing out the bladder and the renal pelvis.

Bladder Washing. The fluids that may be used are very numerous and include nitrate of silver (1 in 15,000), oxycyanide of mercury (1 in 10,000). Sanquinetti⁶⁹ obtained good results with 0.5% to 2% of collargol. Argyrol (1 in 5000), mercurochrome (1 in 10,000), flavine (1 in 5000), permanganate of potash (1 in 10,000), boracic acid (half saturated), pure collosal argentum, silver iodide or iodoform emulsion may be instilled into the bladder and left after a wash.

J.A.Voss⁷¹ records his observations on B. Coli cystitis and pyelonephritis by bacteriophage therapy. He states that the best place to find a good bacteriophage is in the contents of septic tanks. By employing filtrates from different tanks it is almost always possible to obtain complete lysis of the B. Coli found in the urine. Among 100 cases of chronic cysto-pyelonephritis Voss found only five cases in which B. Coli did not undergo complete lysis in vitro. Before the bacteriophage treatment is begun the patient should be put on an alkaline régime, albuminates being forbidden and carbonates prescribed. When the urine is sufficiently alkaline, 1c.cm. of the bacteriophage should be given subcutaneously and 10c.cm. intravesically for three days in succession; the urine should be kept alkaline for the next three weeks. Of 28 cases which Voss has been able to keep under observation out of 59 treated, 16, or about 60 per cent, were successful. Almost all these 16 patients were chronic cases. The treatment is most likely to be successful in the pyelonephritis of pregnancy, and in

children, whereas it is rarely efficacious in men.

Renal Lavage.

Care must be taken in the selection of cases for certain are unsuitable for this treatment, e.g.:-

- (i) Acute pyelonephritis with high temperature (except some cases of pregnancy). In very severe cases, where the kidney is obviously enlarged and the temperature and recurring rigors show that the inflammatory products are being dammed back in the kidney by a swollen ureter, an important advance in treatment is to pass a ureteral catheter up to the pelvis of the kidney, through a cystoscope, and to leave the catheter there for several days to drain the kidney.
- (ii) Chronic and subacute cases where rigors follow the passage of the ureteral catheter.
- (iii) Cases where there is dilatation of the renal pelvis caused by the presence of a stone, or even simple dilatation of the pelvis.
- (iv) Cases with disease of the prostate, seminal vesicles, prostatic enlargement or urethral stricture, and incurable infection of the lower urinary tract.

The reagents mentioned above are made use of, and the lavage should be thoroughly carried out. The criterion of a cure is the bacteriological examination, not the relief of symptoms.

In children in which the infection has become chronic

no time should be lost in carrying out a complete examination of the urinary tract. By this means, in a number of cases, a definite mechanical cause would be found to account for the chronicity of the infection, and in those cases where no such cause could be found renal lavage should always be tried.

In the rare fulminating cases, with suppurative nephritis, nephrectomy may save the patient's life.

Unless treatment is continued until the urine is free from pus and sterile, relapses are liable to occur. Macroscopic examination is certainly not sufficient, nor do I think we may be content with microscopical examination. Cultural tests are essential.

IV. Operation. Certain advanced cases with dilatation of the renal pelvis require drainage by nephrotomy. The bladder may require drainage by (i) tying in a catheter or by (ii) suprapubic cystotomy. Removal of the prostate and seminal vesicles may be needed in a number of cases.

Treatment of Intestinal Disorders.

Besides the general measures outlined above a very useful adjunct in treatment is to endeavour by means of posture, massage and efficient supports to improve matters if enteroptosis be present. Irrigation of the colon with eusol is helpful in the chronic and subacute forms of infection. The question of operation for piles, for chronic appendicitis and for cholecystitis will also arise for discussion.

Special mention may be made with regard to the treatment

of an early case of diverticulitis. Any source of sepsis that can be reached must be removed. The diet should be simple and regular, with a good deal of fruit and vegetables and a little meat, with half an ounce of paraffin in two ounces of warm milk at bedtime.

Attention to the habit of the bowels is especially important. The patient is told to take plenty of time, giving a little strain every third breath, but never to strain hard. It is better to avoid, if possible, irritation by regular purges and to get the bowels working by the above mentioned measures. The colon is washed out with normal saline every other day, for a time, but at low pressure.

In no case should a diverticulous area be massaged. When diverticulitis is established the lavage is continued for longer and, in some cases, permanently, at regular intervals. By this means a healthier condition of the colon is brought about, and complications may be prevented; the early stages of diverticulitis may be made to subside. Even obstructive symptoms, if they are due to the presence of an inflamed and oedematous mucosa, will yield to conservative treatment. The need for surgical intervention will thus be needed only in neglected cases of diverticulitis or in those in which inflammatory complications have caused fibrous stenosis or have involved the peritoneum or adjacent viscera.

A. Kittinger⁷⁰ in cases of septic peritonitis, pours from 50 to 150 cc. of germ-free cultures of B. Coli and mixed

filtrates into the peritoneum: of 26 cases, all recovered.

Local suppuration will of course be dealt with surgically.

V. Specific Measures.

These should be supplemental to the scheme of therapeutics already outlined.

Serum treatment has been recommended by Dudgeon and by various Italian writers. It seems indicated especially in forms of infection that have not as yet given rise to marked lesions. Secondary localisations do not seem to be susceptible to serotherapeutic treatment alone. I have had no experience of its use.

Vaccines. The vaccine should be autogenous in nature.

In acute cases vaccines should either be deferred until other measures fail, or given in very small doses under strict observation and caution.

If the disease is prolonged and no underlying cause is found to be keeping it going, vaccines are a valuable adjuvant. It is wise to begin with small doses say from 0.5 to 5 million. A careful watch should be kept in the temperature, and, if satisfactory, larger doses of vaccine up to 500 million at 7 to 10 days' intervals, the dose and interval depending on the particular case, are given. If there is a liability to febrile attacks such injections are indicated.

The cases in which I have seen the best results have been those in which the vaccine was administered during the de-

cline of an infection with few symptoms, no fever, but infected urine.

In chronic obstinate cases a vaccine is always worth trying but I must add that too much must not be expected from it. The constitutional symptoms are improved but the bacilli seldom disappear from the urine. They are apt to persist, or, to keep coming and going, and in that case all that can be done is to get the general health in as good a state as possible.

Whether or not the patient has been treated by vaccines it is always wise to examine the urine from time to time, after an acute attack has apparently cleared up, to see whether the infecting agent still remains in the urinary tract.

Symptomatic.

The question as to whether it is safe to give morphia for the pain of renal affections will probably arise. Unless the kidney is felt to be enlarged no anxiety need be felt in regard to the renal function. Morphia should be given sparingly for the distension of the bowel is often troublesome, and may be rendered more so, by the free administration of morphia. Saline purgatives are better avoided on account of the flatulent distension of the bowel they produce. If the vomiting is severe, hydrocyanic acid, in an effervescing mixture, gives the best results. Collapse should be treated by camphor dissolved in oil or ether, strychnin hypoder-

mically. Strophanthus and digitalis are of doubtful value. Adrenalin also is of use. Alcohol is strongly advocated by some. Crops of boils call for local treatment, and the appropriate vaccine should the organism be identified. For delirium, sleeplessness and headache the reduction of temperature by sponging or cradling, and the administration of 10 to 15 grains of Dover's powder should be tried. Sometimes trional or chloralamide is effectual. If the haemoglobin be low, iron and arsenic should be given, preferably hypodermically. When cod_liver oil is tolerated it should be taken.

Summary and Conclusions.

- I. Colon bacillus infection is extremely prevalent.
- II. It is peculiar in the diversity of its symptoms and complications and its tendency to become chronic.
- III. Diet and the regular evacuation of the bowels, as exemplified by the Bantu people, are our best prophylactic measures.
- IV. Gross lesions, such as appendicitis, cholecystitis and renal infections, are very common.
- V. Pyelitis as a sole renal lesion seldom, if ever, occurs.
- VI. The common renal lesions is a multiple, focal, suppurative interstitial nephritis, with which is associated occasionally some degree of pyelitis.
- VII. The renal lesion is probably more frequent in

females and when unilateral is more often right-sided.

- Vlll. The most common infection in pregnancy is by the Bacillus Coli.
- lX. It is closely associated with toxæmia and pre-eclamptic manifestations.
- X. Urinary symptoms should never be ignored in pregnancy, and bacteriological examinations of the urine should be carried out if toxæmia is present.
- Xl. Whenever the diagnosis is in doubt the urine should be studied.
- Xll. Prophylaxis is still our best remedy.
- Xlll. Treatment must be thorough and continued for a long period after all signs and symptoms have cleared.
- XlV. It is as necessary for the B. Coli infected patient to have the urine bacteriologically examined from time to time as for the syphilitic to have repeated Wassermann tests.

Case 9.

M.W. F. aged 38. B. Coli Septicaemia.

Previous illnesses. No definite illness. She had headaches at times which she ascribed to constipation from which she suffered a great deal, and at times she felt feverish.

Preliminary Notes. The family history was negative. She weighs 92 pounds, is of sallow complexion and very poor physique. She is a cook.

Onset and type of the illness. The acute stage of her illness began on 2nd July, 1929, through an abrupt onset resembling that of influenza with general pains, headache, and fever, but without evidence of catarrh.

Physical Examination. This was almost negative. The tongue was thickly coated during the whole course of the fever. The abdomen was a little distended, tender at times in the right iliac and right hypochondriac regions, and the liver and spleen were not palpable. No glands were felt. There was no rash. The heart and lungs were normal, except that the heart sounds lacked tone. The pulse rate on the average was 110 per minute during the course of the disease. The blood pressure was 122 mm. systolic 78 mm. diastolic. Respiration was elevated with the rise of temperature, but was otherwise normal, and no bronchial catarrh was present at any time.

Case 9 continued.

Course of the Illness. The course of the temperature was that of an almost regular intermittent fever. The reading was frequently normal or subnormal in the morning, rising as a rule at 5 p.m.; and highest at 7.30 p.m.: and often fell to 100°F or 99°F a few hours later. Sweats of moderate severity and which had a disagreeable odour followed the fever fairly regularly in the evenings, with an occasional feeling of chill just before the rise of temperature. Headache of some severity was complained of throughout the illness. Slight joint pains were felt only in an early stage. After she had been ill for eighteen days she developed an acute otitis media which on paracentesis yielded an offensive discharge from which the B. Coli was grown. The temperature began to subside in the seventh week of illness. The urine was not sterile. She lost eleven pounds in weight. After remaining free from fever for two months during which time she gained four pounds the original clinical picture has repeated itself, and at present she is under treatment for the same condition. In addition to most of the former symptoms there is now marked praecordial discomfort and the heart's action is impaired.

Special Examinations. The urine contained albumin, red blood cells, epithelial cells and a large number of B.

Case 9 continued.

Coli. The Wassermann reaction was negative. Blood culture was negative.

Examination of the blood at present indicates a severe degree of secondary anaemia accompanying a sub-acute infective process. The blood count is as follows:

Haemoglobin	24%
Colour Index	.5
Red Cells per c.mm.	2,740,000
Leucocytes per c.mm.	10,800
Polymorphonuclears	71%
Large Mononuclears	2%
Lymphocytes	26%
Eosinophils	1%
Mast-cells	-

The red cells show a marked degree of achromia, and anisocytosis and polychromasia are evident. On 20th July the patient's serum was negative to the typhoid-paratyphoid group, but positive to the B. Coli in a dilution of 1 in 250. A week later the positive agglutination reaction to this organism had risen to 1 in 800.

Treatment.

Attention to the diet, the care of the bowels, irrigation of the colon with eusol thrice daily at first, the administration of kerol and agar-agar and later on an autogenous vaccine were the methods employed during the first stage of her illness and which are being used now.

Effect of Treatment. Conclusion.

In spite of an undermined constitution and a long history of auto-infection she has responded well to treat-

ment. This is a case which will need thorough supervision for a long time to come.

Case 10.

J.S. F. aged 18 months. B. Coli Infection of the Urinary Tract.

Previous illnesses. The girl had always enjoyed good health.

Preliminary Notes and Onset of the illness. The child had been quite well until 10th October, 1928, when on being dressed in the morning she seemed cold and faint and her colour had a bluish tint. Her temperature was 104°F. but nothing was found to account for it. The mother noticed that the child had shivering attacks on several occasions. Beyond a definite degree of fretfulness, and an obstinate constipation there was nothing else her mother could notice. The fever remained fairly high so on 26th October, 1928, she was brought in from the country for treatment.

Physical Examination. The child was in a drowsy state and when roused was extremely miserable. Her complexion was pale and her skin hot and dry. Her abdomen was fuller than normal with definite tenderness over the front of the abdomen. There was nothing of note in the examination of the circulatory or respiratory systems. The throat was healthy.

Course of the illness. While in the country the temper-

Case 10 continued.

ature had evidently been intermittent. On two occasions when it was taken it was 104°F. and 104.8°F., respectively. The child was miserable, refused food and drank freely.

Special Examination. Examination of the cerebrospinal fluid was negative. The urine was found to be acid, with sufficient pus to make it just turbid. It had a peculiar heavy odour. Leucocytes and colon bacilli were found on microscopic examination.

Treatment.

On 28th October, treatment with potassium citrate was started. The bowels were well opened and were regularly evacuated. The temperature became lower and after a few irregular rises remained normal. After ten days the alkali was replaced by urotropin. This was continued for a further period of ten days when the child was given the alkali for a further period of ten days.

Effect of Treatment. Conclusion.

On the eighth day after treatment the temperature reached normal and remained so. The abdominal pains soon subsided. The urine became sterile on the twentieth day of treatment.

Case XI.

I.M. Male, twenty months of age. He became suddenly

Case XI continued.

ill on 8th April with temperature 103.8°F., a stiff neck, restless and irritable. He vomited three times during the afternoon of that day. Anorexia and diarrhoea followed. The throat was healthy.

The abdomen was distended and the liver easily palpable. A firm immovable tender mass was felt in the right iliac and lumbar region.

The cerebro-spinal fluid was normal. The urine contained much pus but no casts and B. Coli were grown from it.

W.B.C. 32,000 with 75% polymorphonuclears.

A blood culture was sterile.

The distension and diarrhoea persisted and the temperature oscillated between 101°F and 104°F., the respirations became more rapid and he became convulsive, then comatose and died on 10th April.

Case XII.

A.T. F. aged 17 months. B. Coli infection of the Urinary Tract.

Preliminary Notes and Onset. Eight days ago she became ill with fever and occasional vomiting. She screamed out in sleep as though in pain and her mother noticed that every now and then "she went blue." When first seen she was found to be acutely ill, with fever, vomiting and diarrhoea. She was pale, peevish and restless. Her sleep was disturbed and her appetite was lost.

Case XII, continued.

Physical Examination. There was a dirty tongue, distended abdomen and diminished elasticity of the skin. The expression was anxious, wasting marked, the eyes sunken and the face pinched. There was squinting and muscular twitchings. The respirations were quickened and the heart sounds feeble. The throat was healthy.

Special Examination. The white blood count was 9,800 with 62% polymorphs. The urine contained a heavy deposit of pus and B. Coli were grown from it. The cerebro-spinal fluid was negative.

Treatment.

She took 80 grains of potassium citrate in twenty-four hours for two days, and fluids freely per mouth and rectum.

Course of the illness.

The temperature when first seen was 104.2°F. It remained irregularly elevated, rarely above 101°, never over 103°. The tongue became red and moist, the lips scarlet in contrast to the pallor of the face. The fists were clenched, the eyes stared and consciousness was dulled on the third day of treatment. With the disappearance of one heart sound, the corneal reflex lost, and deepening coma, she died on the evening of the third day of treatment and eleventh of her illness.

I was unable to make a post-mortem examination in any of these cases.

Case 13.

J.L. M. aet 6 years. B. Coli infection of Urinary Tract.

Preliminary Notes of Onset of his illness. For seven months he had caused his parents to worry on account of his refusal to take his meals properly, his great nervousness and gradual loss of weight. He had been constipated for a long time.

Physical Examination. He is a pale, pasty-faced, undernourished boy. There was nothing abnormal to note in the mouth, nor did an examination of the pulmonary area reveal any cause to account for his condition. The heart sounds lacked tone. The abdomen was tumid, and there were loud gurgling sounds in the right iliac region which was tender on pressure. There was no rise of temperature and the pulse rate was 90 per minute. His reflexes were exaggerated.

Special examination. Examination of the urine showed it to be acid in reaction, opalescent, with pus cells in a drop of the uncentrifugalised specimen and B. Coli were grown from it.

Treatment and Conclusion.

By care of the bowels and on a diet free of raw milk, eggs and meat and by alkalinisation of the urine the child began to enjoy the society of his companions, ate better and in the first three weeks of treatment put on three and one quarter pounds weight.

Case 13 continued.

The urine was found to be sterile during the fourth week of treatment.

Case 14.

D. McG. F. aged three years. She had enjoyed excellent health until two weeks ago when she began to have green, offensive, curdy stools on the average thrice daily. Previously a sweet-tempered child she now became most disobedient, restless, peevish and was unable to have three hours consecutive sleep. Examination of the body failed to reveal any cause for this change. The urine however was found to be acid and to contain B. Coli. It was turbid from the presence of pus. There was no albumin. Care of the bowels and alkalinisation of the urine led to a general improvement after four days and at the end of twelve days the condition had passed off.

Case 15.

S.G. F. aged 4 years. B. Coli infection of Urinary Tract with Jaundice.

Preliminary Notes and Onset. She had always enjoyed good health until 16th August, 1928, when she became ill with fever and vomiting. Diarrhoea followed and she began to refuse food and to lose weight.

Physical Examination. Seen first on the evening of 18th August, 1928. She appeared to be very ill. She

Case 15 continued.

was pale, pasty-faced, with oedema of both legs, face and back. Her temperature was 103.2°F., pulse 106. The abdomen was distended. She cried on being touched and was tender over the left loin. Her neck was rigid and there was slight retraction of the head and the knee jerks were hyperactive. The throat and mouth did not reveal anything abnormal. On seeing her in daylight next day it was noted that she had a distinctly jaundiced appearance with a greenish tint of the conjunctivae. The liver was enlarged and hard on palpation and the spleen was palpable and hard.

Special Examination.

W.B.C.	32,000
Polymorphs	68%

The spinal fluid was normal. The urine was dark brown. It contained besides bilirubin, albumin, many leucocytes, epithelial cells, some red blood cells and a large number of the B. Coli.

Treatment.

Fluids had at first to be given per rectum and subcutaneously and later it was possible to get her to drink freely. Alkalinisation of the urine produced a rapid fall of temperature and an improvement in the symptoms after eight days. The jaundice began to clear, and on the seventeenth day she appeared well but with a definite pyuria still present in spite of now regular doses of

Case 15 continued.

hexamine. With alternation of alkalies and anti-septics, and an autogenous vaccine, and care of the bowels it took eleven months before the urine was free from the infecting organism.

TABLE I. CASES ILLUSTRATING B. COLI INFECTION OF THE URINARY TRACT IN CHILDREN.

Case.	Sex.	Age.	Previous Health	Localising and General Symptoms.	Urine.	Treatment.	Comment.
16	F.	4 yrs	Good	She had been ill for two weeks, temperature 102°F. Very irritable. Legs kept drawn up. Tongue dry & brown in centre. Constipated & offensive motions. Spleen just reached costal margin. Widal negative.	Acid-opalescent. No albumin. The Urine contained a few coliform bacilli.	Fluid taken freely and Alkalies given for nine days.	Shortly afterwards the temperature fell to normal & she got quite well. There were here no signs of inflammation being set up in the urinary tract. The B.Coli seemed to be simply escaping by the kidney.
17	M.	2 yrs	He had just recovered from measles & broncho-pneumonia	He had spells in which he held his breath & turned blue but did not get rigid. His temperature was 101.6°F. when first seen. He appeared comatose.	An acid urine containing albumin, an enormous number of pus cells & colon bacilli.	Diuresis & Alkaline treatment. Autogenous vaccine. Hexamine.	There was an improvement in the general condition & a fall of temperature after six days. It took three months before the urine was free from pus.
18.	M.	4½ yrs	His mother stated that he often had feverish attacks.	He had been ill for six days with a gradually rising temperature, 102.8° when first seen. He was irritable. There was hyperaesthesia & some looseness of the bowels. His neck was stiff & he was very drowsy. Widal negative. Cerebro-spinal fluid normal.	Albumin, pus & a great many colon bacilli were found in the urine.	General & dietetic treatment. Diuresis. Alkalinisation. Hexamine.	It took a long time to establish a complete cure. The temperature remained high for almost a month, with only a few days of normal temperature. It took a further period of six weeks before the urine was sterile.
19	F.	13 mos.	Until onset she had been quite well.	Her mother stated that two days ago she turned blue & cold & seemed collapsed. There was retention of urine & pain on micturition. Her temperature on the second day of illness was 104.2°F.	A trace of albumin. Few granular casts, a large quantity of pus & B.Coli were found.	Diuresis and Alkalies.	Her condition improved rapidly & she was free of any untoward symptoms on the fifth day & of pyuria on the ninth day.
20	F.	6 yrs	Good.	For a few days she refused food & water. She was nauseated & frequently vomited. She was fretful & there was slight twitching of the limbs. The bowels were constipated. Temperature 101.8°F.	An acid urine a drop of which contained pus cells & B.Coli.	Fluids per rectum, later by mouth. Alkalies. Attention to bowels.	The temperature & other symptoms continued for ten days. A few days later she was troubled with frequency of micturition which continued for six days. Urine sterile during the fifth week.
21	F.	8 yrs	Three years ago double otitis media One year ago Empyema R.	For several days she had been drowsy & had vomited. There was anorexia, distension of the abdomen. Constipation. She was poorly nourished. There were convulsive movements of hands & feet. Temperature 100°-105°F.	Pus & a few red blood cells. Culture of urine resulted in growth of B. Coli.	Fluids, care of bowels. Alkalinisation of urine alternating with Hexamine over a period of twenty-five days.	It was very difficult to establish a complete cure. The temperature reached normal on the eighth day, but two relapses prolonged the illness to eighteen days. It took nine weeks before the urine was free from pus.

TABLE I. (Continued)

Case.	Sex.	Age.	Previous Health	Localising Symptoms	General Symptoms.	Urine.	Treatment.	Comment.
22	F.	18 mos.	Good	None	Sudden onset. Temperature 101° to 105°F. Drowsy, miserable.	Opalescent, acid, considerable amount of pus & colon bacilli.	Administration of fluid, regulation of bowels & Alkalies.	Temperature normal on fifth day. Urine sterile on ninth day.
23	M.	2½ yrs	Rickets	Undue frequency of micturition for four days.	Sudden onset, high temperature, refused food. Peevish.	Acid urine, no albumin. 20 pus cells per field (1/6 objective) & B.coli seen in clumps.	Diuresis - care of bowels - & Alkalinisation of the urine.	Alkalinisation kept up for twelve days, when the urine was found sterile. Symptoms cleared up on fourth day.
24	F.	4½ mos	She had been ill for nine days.	The child was in a marasmic state.	High prolonged fever for nine weeks. The disease was mistaken for tuberculous meningitis.	Pyuria discovered late in disease. B.Coli from free urine.	Fluids per rectum, later through a stomach tube. Alkalinisation then Hexamine & a return to alkalies later.	The urine became sterile five weeks after treatment was started.
25	F.	9 yrs	Diagnosis of phthisis had already been made	Marked cachexia.	Bouts of fever alternating with longer periods of normal temperature.	Large numbers of pus cells and Bacillus Coli.	General treatment, dietetic treatment, care of bowels. Diuresis, alkalies & Hexamine in alternating courses.	The patient left for an inland town eight weeks after treatment had started. Greatly improved.
26	M.	2¾ yrs	Good.	Dysuria.	Shivering and two rigors.	Albumin. Pus cells & B.Coli in a drop of uncentrifugated urine.	Diuresis - alkalies.	The alkalies were continued until the pus cells disappeared from the urine.
27	M.	4 yrs 1 mos	Good.	Tenderness left loin.	From time to time suddenly became pale, stiff and collapsed.	Few pus cells & bacilli in urine.	Diuresis, alkalies.	The tenderness soon disappeared & the child's condition rapidly improved & there has been no recurrence.
28	F.	3½ yrs	Had never thriven	Vaginitis.	High fever coming on suddenly. Squinting, quick respiration, vomiting.	Acid urine a drop of which contained pus cells & B.coli	Diuresis, alkalies.	Local application of protargol soon cleared the vaginitis. The pyrexia & symptoms subsided at the end of six days & the urine lost its organisms after ten days.
29	F.	2½ yrs	She had refused food for four days. Very irritable.	None.	Sudden onset of fever, temp. 103.6F. Vomiting, pains in abdomen.	Acid, opalescent, urine with large numbers of pus cells & bacteria.	Attention to bowels, diuresis alkalies.	Symptoms had subsided on third day & treatment was continued for fourteen days when the urine was sterile.

TABLE I. (Continued)

Case.	Sex.	Age.	Previous Health	Localising and General Symptoms.	Urine.	Treatment.	Comment.
30	F.	8 mos.	She had had a cough for three weeks	Loose green curdy and offensive stools. Vomiting, listlessness. Irritable - no localising signs. T. 98,2°F. W.B.C. 18,000. Rallied quickly, appetite improved. Stools good, but from fifth to seventh day she became restless, Temp. 101° to 103°F. irritable, sleepless. Delirium from then to 20th day, general condition good, temperature normal. On 21st day high fever and frequent stools and death followed in four days.	A few pus cells and B.coli. As the condition advanced the urine became loaded with pus & contained numerous B. Coli.	Fluids taken freely. Alkalinisation of the urine. On 12th day Hexamine was given for ten days. Alkalies were administered again towards the end of the illness.	A postmortem was refused.
31	M.	1½ yrs	Good.	High fever 103.8°F occurred suddenly. The abdomen was distended & tender & there were loud borborygmi. Constipation.	A few pus cells & B. Coli present in urine.	Attention to bowels. Diuresis & alkalinisation of the urine.	He made a quick recovery, the symptoms subsided on fourth day & the urine was sterile on eighth day
32	M.	6 mos.	Good.	High fever & convulsions beginning as rigors. At times the child appeared comatose.	An acid urine containing pus cells and B. Coli.	Fluids per rectum, sub-cutaneously and by stomach tube. Alkalinisation.	The symptoms began to improve during the second day & at the end of five days the temperature was normal
33	M.	3 yrs.	He had had a poor appetite & been irritable for several weeks.	During the course of the afternoon he became feverish. T. 104.2°F. He complained of pain in the abdomen and severe headache.	Urine acid, opalescent, containing B.Coli in a drop of uncentrifuged urine.	Attention to bowels, diuresis, alkalies.	On the third day the serious symptoms began to abate and the urine was sterile on the tenth day.
34	F.	5 yrs	Poor. She had large septic tonsils.	Listlessness & apathy were present for one week when drowsiness was superadded. The neck was stiff & later frequent & uncontrollable vomiting with T. 102.2°F. The external genitals were red & tender.	Urine highly acid, small in amount, pus cells & B.Coli.	Fluids subcutaneously, per rectum & intravenously. Alkalies.	She made a good recovery. The acute symptoms lasted for six days and she was under treatment for fifteen days when the urine lost its infection.
35	F.	6 yrs	Her mother stated she had never thrived. She was badly nourished pale & anaemic, & badly constipated.	Anorexia, nausea, distension and occasional vomiting troubled her for eight days. She now became feverish 102.4°F. Miserable and drowsy. No localising symptoms. W.B.C. 14,200. Spinal fluid normal.	An acid urine containing pus, albumin, cellular casts, red blood cells and B.Coli.	Fluids taken very well. The constipation was difficult to overcome. Alkalinisation of urine.	It took a long time to establish a complete cure. The temperature remained elevated for thirteen days. It took forty-three days before the urine was free from pus.

TABLE II. ILLUSTRATING INFECTION OF THE URINARY TRACT AND THE GENITAL TRACT IN THE ADULT.

Case.	Sex.	Age.	Prodromal Symptoms.	Localising and General Symptoms.	Urine.	Treatment.	Comment.
36	F.	25	Vomiting, This patient was 7½ months pregnant. (Primipara)	Pain in right lumbar region. Rigors rapid pulse. Pain & tenderness in region of right kidney soon became very pronounced.	Pus abundant, no blood, B. Coli in large numbers.	Diuretics, attention to bowels. Alkalies & a fortnight later Hexamine.	The pain passed off in five days & the temperature & pulse rate fell rapidly. The urine remained infected for twenty-two days.
37	F.	32	This patient, Primipara, was 7 months pregnant. Pain all over - mistaken at first for influenza.	Temperature 104F. pulse 130. Vomiting Headache, pain in epigastrium, Frequency of micturition. Severe tenderness over the renal area posteriorly & over the appendix area in the front.	Albumin present Many pus cells & a few red blood corpuscles. B. Coli grown from the urine.	Diuretics, alkalies, attention to bowels	She responded at once to treatment & her urine was sterile at the end of fifteen days.
38	F.	23	Patient was 6½ months pregnant. 3rd Gr. no prodromal symptoms.	Sudden onset, temperature 102.8F. & pulse rate of 122 per minute. Repeated vomiting & severe pain in the loins. She was flushed & restless & complained bitterly of abdominal pain.	The urine contained a haze of albumin, and microscopically pus and coliform organisms	Diuretics & alkalies. Hexamine. Alkalies,	The pulse rate & temperature became normal in six days. By the fourteenth day she was put on Hexamine but the temperature rose to 100°F. & the pulse quickened on the sixteenth day, so she was given alkalies for a further period of ten days by which time the condition had entirely cleared up.
39	M.	57	Frequent micturition & urethral burning.	Sudden onset with severe dull aching pain in the left flank. Temperature 102°F. Leucocytosis 17,000. He was poorly nourished & looked septic. An X Ray film showed a small oval shadow on the left side just outside the tip of the transverse process of the third lumbar vertebra. The cystoscope showed chronic inflammatory changes in the bladder. The ureteral catheter passed the length of each ureter without evidence of obstruction. The urine from the right kidney was clear, that from the left was cloudy & contained pus cells & bacilli. An X Ray with the catheter in place showed that the catheter had passed & dislodged a small stone at the pelvo-uterine junction.	Cloudy urine continuing many pus cells & B. coli and a good trace of albumin.	Diuretics, alkalies. The ureteral catheter was left in place three days.	The temperature came down to normal on the second day & remained so. Removal of the stone was advised & refused.

TABLE II. (continued).

Case.	Sex.	Age.	Prodromal Symptoms.	Localising and General Symptoms	Urine.	Treatment.	Comment.
40	M.	16	Headache	No localising symptoms but high temperature, 103°F to 105°F for four days. Squinting, vomiting, muscular twitchings.	Acid. Few pus cells & blood cells. B. Coli grown from it.	Diuretics. Alkalies & later Hexamine.	The condition remained puzzling until study of the urine revealed an unsuspected bacilluria which lasted twelve days.
41	F.	24	Frequency of micturition.	Bladder irritability, pain, Fever. Retention of urine suddenly supervened.	Urine acid, two or three pus cells per high power field & occasional red cell. Fifth day many pus cells & few red cells. B. coli grown from it.	Diuretics, Diet alkalies then Hexamine, Hexylresorcinol. Alternately alkalies & Hexamine. Autogenous vaccine.	The severe symptoms lasted three weeks with the temperature remaining high and the symptoms continuing. Recurrent exacerbations followed a short afebrile stage. Urine sterile on fifty seventh day.
42	M.	37	Flatulent distension of bowel with constipation.	Severe headache, backache, high temperature, delirium & great drowsiness, constipation.	Acid urine with a heavy sediment of pus, B. coli grown from urine.	The bowels required a lot of attention, colon lavage when much mucus came away, Diet, alkalies, diuretics, Hexamine were needed.	The symptoms subsided after ten days but the urine remained infected for a further twenty five days.
43	M.	43	Loss of appetite, little headache, irritability.	Sudden onset of pain in right loin, rigors, frequent micturition.	Acid urine, trace of albumin, few granular casts, large quantity of pus. Culture B. coli.	Attention to diet & the bowels. Diuretics Pot. Citr. was found nauseating & Sod. Bicarb. was used. Hexamine, cystopurin.	On the ninth day the fever & other symptoms had left & the urine was sterile on the twenty-third day.
44	F.	31	Irritability of the bladder, constipation, malaise.	Sudden onset with frequent desire to pass water. Intense bladder irritation & strangury High fever. The temperature remained high & the symptoms continued for thirty seven days. The right kidney became palpable under observation. W.B.C. 12,800. Acute vomiting and diarrhoea.	Acid urine containing albumin, heavy sediment of pus. B. coli grown from urine.	Attention to diet, the bowels. Diuretics Alkalies & Hexamine in alternation. Autogenous Vaccine. Acriflavine. Hexylresorcinol.	Recurrent exacerbations were a feature A relapse followed the primary infection Nine and half months elapsed before a report on the bacteriological findings of the urine was satisfactory.

TABLE II. (continued).

Case.	Sex.	Age.	Prodromal Symptoms.	Localising and General Symptoms	Urine.	Treatment.	Comment.
45	F.	39	Malaise and anorexia.	High fever, rapid loss of flesh, backache, diarrhoea with much mucus, frequency of micturition, pain and strangury.	Acid, pus trace of albumin, granular, and cell casts. B. coli present.	Diuretics, attention to bowels. Alkalies, Hexamine. Colon lavage with Eusol.	A pronounced secondary anaemia followed this infection. The symptoms subsided at the end of five weeks. Urine sterile on sixty-first day.
46	M.	59	Aching pains in back and rectum.	Bladder irritability & difficulty in micturition. Prostate enlarged and tender. High temperature.	Pyuria, mucus and albumin in acid urine. B. Coli isolated.	Prostatic massage & instillation with collargol, alkalies administered, diuretics. Helmitol & cystopurin. Autogenous vaccine.	The acute symptoms subsided at the end of four weeks, but it was nine months before they completely disappeared and the urine was sterile.
47	M.	61	Difficult, frequent micturition.	High fever, heavy, aching pain in rectum and perineum, pain on defaecation. Prostate large, tender. Seminal vesicles distended.	Epithelial cells, leucocytes, albumin & B. Coli present.	Diet, alkalies, diuretics, acute retention necessitated the passage of a catheter.	The attack lasted twenty three days & though the urine was found sterile frequency of micturition existed for some time.
48	M.	33	Slight headache, nausea.	Sudden severe lumbar pain, both sides, high fever, vomiting.	Urine much pus, no casts. B. Coli grown from it.	He required morphia for the pain. Diuretics, diet, alkalies then Hexyl-resorcinol.	The symptoms subsided and pus and bacilli disappeared from the urine in sixteen days.
49.	M.	41	Malaise, anorexia.	Pain in left loin. Epididymitis (left) high fever. Vomiting. Diarrhoea.	Urine contained many epithelial cells, few leucocytes. Albumin, B. Coli.	Diuretics, alkalies then Hexamine in alternate courses. Autogenous vaccine, diet.	The epididymitis was the first symptom of the disease. The acute stage lasted seventeen days. The urine remained infected. It was sterile on 42nd day. This case improved after the vaccine was started on the 19th day

TABLE II. (Continued.)

Case.	Sex.	Age.	Prodromal Symptoms.	Localising and General Symptoms.	Urine.	Treatment.	Comment.
50	F.	21	None.	Rigors. Frequency of micturition.	Urine pus, blood. culture sterile, urine B.coli.	Diuretics, alkalies, and later Hexamine.	The attack lasted nine days & the urine was sterile on the eighteenth day.
51	F.	36	Nausea and vomiting.	Haematuria & strangury. High fever.	Besides blood, there was a large quantity of pus and on culture B.Coli were found.	Diuretics, alkalies, attention to diet, & the bowels. Sandal wood oil. Hexamine.	The Haematuria began suddenly and continued for two days before the other symptoms followed. It quietened down after four days and in sixteen days the urine was sterile.
52	M.	46	Great drowsiness.	High fever, severe pain in left costo-vertebral angle radiating down to the groin. Vomiting. Headache.	Infected urine, much pus. B.Coli grown from urine.	The pain was so severe as to necessitate the use of small doses of morphia. Diuretics, alkalies, Hexamine, pyridium.	The high fever and infected urine made the diagnosis of stone unlikely & this was confirmed by X.Rays later. The symptoms suddenly subsided in six days and the urine was sterile on the 23rd day.
53	F.	28	Loss of appetite.	Sudden onset with high fever & intense bladder irritability. Pain in right loin.	Acid, high coloured, offensive odour, pyuria and B. coli.	Four pints of water for two days, attention to bowels, diet and alkalisation of urine.	Pot. Citr. was continued for eleven days. On the fifth day the symptoms subsided and on the ninth the urine was sterile.
54	F.	21	Little headache, constipation.	No localising symptoms. Sudden high temperature without other symptoms.	Examination of the urine showed an unsuspected bacilluria.	Diuretics, alkalies, attention to bowels and diet.	This case was one of very short duration the urine being sterile in thirteen days.
54a	M.	37	Want of energy, irritable.	Acute aching pain in right loin radiating to right testicle. High fever, vomiting, diarrhoea.	Acid urine, Leucocytes seen on microscopic examination. Culture revealed B.coli.	Diuretics, diet, alkalies, Hexamine and acriflavine.	The symptoms and pyuria persisted over four weeks. An afebrile state of six days was followed by a relapse of two days. Sixty-five days elapsed before urine was sterile.

TABLE II. (Continued)

Case.	Sex.	Age.	Prodromal Symptoms.	Localising and General Symptoms.	Urine.	Treatment.	Comment.
55	F.	16	Diarrhoea.	Severe headache, slight pain in right side, delirium.	Small amount of pus, no albumin, but B.coli present in a strongly acid urine.	Attention to bowels, diuretics, diet, and alkalies followed by Hexamine gr.X.t.d.s.	The symptoms soon subsided and the urine was free of pus and organisms at the end of twenty five days.
56	F.	18	Increased frequency of micturition.	High fever, anorexia, depressed, constipated.	Blood in an acid offensive urine containing pus and B. coli.	Diuretics, colon lavage with eusol, diet, alkalies started after the patient had been ill fifteen days,	This is a sister of case No.55 and she was ill at the same time. For two weeks she had been regarded as suffering from influenza until the urine was carefully examined. The symptoms subsided and the urine became sterile after eighteen days treatment.
57	M.	31	Irritability of bladder.	High fever and marked haematuria.	B. coli were found in great quantity in the urine.	Diuretics, diet, alkalies, sandalwood oil, later Hexamine, helmitol.	The haematuria was so pronounced as to prove a very puzzling symptom. It persisted for eleven days and the urine was free of organisms in twenty-seven days.
58	M.	27	Flatulent distension of bowels.	Pain in left loin radiating to left testicle and rigidity of muscles on the affected side. Temperature 101°F.	Acid urine, cloudy of offensive odour, very little pus, little albumin, B.coli on culture.	Attention to bowels, diet, diuretics, alkalies, methylene blue, later Hexamine & cystopurin.	The pains and temperature subsided after eight days & the urine was sterile on the twentieth day.

The Treatment outlined for an acute case was carried out in addition to the special.

TABLE III. CASES ILLUSTRATING CASES OF CHRONIC URINARY INFECTION.

	Case.	Age.	Sex.	Organisms found.	Duration of illness.	Complications.	Length of Medication before urine colon bacillus free.	Surgical Treatment	Comment.
A.T.	59	37	M.	B.Coli.	1½ years.	Resistant suprapubic fistula after suprapubic lithotomy and chronic progressive cystitis and diverticulum of bladder.	Urine never free of organisms.	Indwelling catheter and bladder lavage for six weeks at first. Operation to remove diverticulum.	The suprapubic fistula closed at the end of six weeks, but he had difficulty of micturition & it reopened. The treatment was repeated. He seemed unable to empty the bladder. Following the operation to remove the diverticulum an ascending pyelonephritis set in & he died ten days later.
R.L.	60	67	M.	B.Coli & Staphylococcus.	Ten years	Atony of bladder and progressive cystitis - old tubercular disease of spine. Bladder capacity 7 ozs. Residual urine 3 ozs.	Urine never sterile.	Drainage & lavage.	He had had paraplegia earlier in life from the spinal caries & the cystitis dated from that time. His condition after 2½ years treatment had improved.
P.N.	61	⁵⁴ G.N.	F.	B. Coli	Six months	Sequel to an acute attack of pyelonephritis.	9½ months.	Renal lavage.	Cured.
L.W.	62	18	F.	B. Coli.	Nine months	Ureteral calculus which passed into the bladder.	Ten weeks.	Bladder lavage after crushing of the calculus.	Cured.

TABLE III. (Continued.)

Case.	Age.	Sex.	Organisms found,	Duration of illness.	Complications.	Length of Medication before urine colon bacillus free.	Surgical Treatment	Comment.	
J.F.	62a	35	M.	B. Coli	Two years.	Prostatitis and Vesiculitis	4 $\frac{3}{4}$ months	Massage & irrigation of the posterior urethra. Vasotomy.	Cured.
D.G.	63	48	M.	B. Coli	Five years	Sequel to the passage of small calculi five years ago. X Ray of urinary tract negative. Renal pelvis slightly dilated.	Ten months.	Renal lavage.	Cured.
W.C.	64	62	M.	B. Coli & Staphylococci.	18 years.	Sequel to an acute attack of pyelonephritis. X Ray pyelogram, cystoscope are negative.	He has been under treatment for thirteen months and the urine is still infected.	He had had no surgical treatment beyond Bier's congestion.	He exhibits a general non-specific infective arthritis. The joints specially involved are the metacarpocarpal joints of the thumb & the phalangeal, metacarpal & carpal joints of the hands.
R.Me	65	32	F.	B. Coli.	3 years duration	Ureteral stricture.	Eighteen months.	Dilatation of Ureter.	Cured.
J.B.	66	38	F.	B. Coli.	2 $\frac{1}{3}$ years.	Renal ptosis	31 months.	Nephropexy.	Great improvement followed operation.
M.G.	67	24	F.	B. Coli.	1 $\frac{1}{2}$ years.	Ureteral stricture, large pyonephrosis. (R.)	9 months.	Nephrectomy.	Cured.
J.F.	68	46	M.	B. Coli & Staphylococci.	17 years	Urethral stricture-cystitis, double pyonephrosis.	The urine remained infected all the time.	Dilatation of urethra.	He was in a general toxic state & died one month after treatment was instituted.
R.M.	69	38	M.	B. Coli.	8 months	Chronic Prostatitis & Seminal Vesiculitis.	Thirteen months.	Massage, autogenous vaccine, Posterior urethral lavage, Vasotomy.	Symptoms subsided & he was apparently cured.

TABLE III. (Continued.)

	Case.	Age.	Sex.	Organisms found.	Duration of illness.	Complications.	Length of Medication before urine colon bacillus free.	Surgical Treatment	Comment.
D.A.	70	36	F.	B. Coli.	9 months.	Ureteral Stricture with renal ptosis.	43 months.	Ureteral Dilatation & Nephropexy.	Cured.
R.H.	71	57	M.	B. Coli.	Six years	Renal calculi and pyonephrosis.	Death three months after operation, urine still infected.	Nephrectomy.	He became uraemic & died three months after operation.
J.S.	72	28	M.	B. Coli + B. Proteus	6 months.	Epithelioma of Bladder	The urine was never sterile	Electro-coagulation.	Cachexia, toxaemia, & death four months later.
I.B.	73	32	M.	B. Coli	8 years.	Urethral stricture old Bilharziasis of bladder. Progressive Cystitis.	16 months.	Dilatation of Urethra Suprapubic drainage of bladder.	Considerably improved
W.J.	74	28	F.	B. Coli	4 months	Pyonephrosis, severe cystitis.	Six weeks.	Nephrectomy.	A continuous stream of pus kept up a severe cystitis which soon subsided. 3 week after operation urine contained a little pus & albumin.
M. le R.	75	33	F.	B. Coli.	7 months.	Progressive cystitis concealed pyelonephritis	7 months.	Collargol 20% bladder irrigation improved condition considerably, but when renal lesion was discovered lavage of renal pelvis soon caused symptoms to disappear.	The pain & frequency decreased but did not disappear & the urine still contained pus & blood while attention was devoted to the bladder only, A patch of ulceration near the Right Ureteric orifice focussed one's energies on the kidney, with good results. No residual urine, micturition normal.
A.E.	76	59	M.	B. Coli + Staphylococci	five years.	Urethral Stricture following gonorrhoea. Diverticuli of bladder- Vesical calculi, shaggy cystitis, Residual urine 4 ozs.	Eleven months.	Dilatation of Urethra & lithotrity, drainage & lavage of bladder.	
J.W.	77	65	M.	B. Coli	Two years	Urethral stricture following gonorrhoea Atony of Bladder- 'Shaggy' cystitis. Residual urine 30 Ozs.	Urine was never sterile.	Dilatation of Urethra Irrigation of bladder.	Greatly improved.
T.H.	78	55	M.	B. Coli.	3 years	Seminal Vesiculitis	26 weeks	Vasotomy	Cured.
F.E.	79	56	M.	B. Coli.	2 years	Enlarged prostate- progressive cystitis.	7 months	Bladder drainage & lavage, later Prostatectomy.	Cured.

Case 80. A Case of B. Coli Meningitis.

A primipara, M.C. aged 28, had been under observation and treatment for toxæmia of pregnancy - manifested by vomiting, headache, slight oedema and raised blood pressure. She was however delivered of a son at $8\frac{1}{2}$ months. The infant weighed $7\frac{1}{2}$ lbs and appeared to be perfectly healthy and remained so until fifty-six hours old when he started to scream. The screaming lasted for about three hours. The abdomen was distended and there was the frequent passage of stools. Three convulsive attacks, associated with a cephalic cry then set in and were frequently repeated. There was no rigidity of his limbs or neck, no tension of the fontanelle. The convulsions became more frequent, his temperature rose to 104.8°F and he died thirty-four hours after the onset of symptoms. On puncturing over the fontanelle after death a purulent fluid was obtained which yielded a growth of B. Coli. There was no umbilical sepsis. The mother's urine was next examined, and the same organism discovered. It was also present in the cervical canal.

Auto-intoxication.

Case 81.

M.F. 44. Female. She had enjoyed excellent health until at the age of 26 she underwent an operation in London for B. Coli infection of the uterine appendages

Case 81 continued.

and at the same time the appendix was removed. With the exception of occasional headaches, and rather stubborn constipation, she was able to live a very strenuous life in a wild uncivilised part of this country. At the age of 42 she became the subject of an apoplexy of sudden onset. Her blood-pressure systolic, taken at the time was 238 mm.Hg., Wassermann test was negative. There was no general atheromatous condition, nor was any renal disease, or abnormal condition of the blood, or sign of new growth, or inflammatory condition, or evidence of traumatism present to account for this. A catheterised sample of urine revealed an abundant growth of B. Coli suggesting in this case the importance of auto-intoxication. We see this factor at work every day.

Other Organs.

Cases illustrating infection of the intestinal tract, peritoneum, biliary tract and pancreas, other organs and tissues, and of secondary and terminal infections, have been omitted as they are innumerable and devoid of any outstanding feature and, in my opinion, do not require special comment.

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