a child can be made earlier; (6) the investigation of infertile couples extends over many months.

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"COLIFORM DIARRHOEA" IN ADULT HOSPITAL PATIENTS

BY

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This report contains the results of an investigation of adults' faeces for the presence of those type-specific coliform organisms known to be closely associated with diarrhoea and vomiting in infants. The work was undertaken as an extension of two smaller investigations previously reported by Stevenson (1950, 1952), who described the isolation of *Bact. coli* O111.B4 (D433) from adults.

Most of the published work on type-specific strains of *Bact. coli* concerns their presence in the faeces of infants; their occurrence and effects in the adult have not yet been fully studied. Fourteen cases of diarrhoea in adults from whom *Bact. coli* O111.B4 was isolated were reported by Stevenson (1950), and Kirby, Hall, and Coackley (1950) described enteritis in adult volunteers, caused by drinking milk inoculated with an organism of the same type-specific group. Stevenson (1952) investigated specimens of faeces from more than 1,000 adults and found *Bact. coli* O111.B4 in nine, four of whom had diarrhoea. Further evidence that this coliform can produce intestinal upset in the adult was provided by Ferguson and June (1952), who described a large-scale experiment in which adult males developed enteritis following the ingestion of milk artificially infected with the organism.

The six strains of *Bact. coli* from which antisera were prepared and used in the present investigation have been described by Taylor and Charter (1952) and Charter and Taylor (1952). They are designated at present as follows: *Bact. coli* O111.B4, O55.B5, O26.B6, Canioni, E611, and E990.

Methods and Results

The investigation covered the period October, 1951, to October, 1952. At the outset, O and OB antisera were prepared to *Bact. coli* strains O111.B4, O55.B5, and O26.B6; a "pooled" serum was made, and was checked before use. In March, 1952, the strains *Bact. coli* Canioni, E611, and E990 became available; individual and pooled sera were

also prepared from these strains. Thus three type-specific antisera were available for the first six months and six antisera for the second six months of the investigation.

The faecal specimens, most of which were from cases of diarrhoea, were inoculated on to MacConkey, D.C.A., and Difco "SS" agar plates and into a "selenite F" enrichment broth. The subsequent growth on the MacConkey plate was used to detect type-specific coliform strains by slide agglutination; final identification of the organisms was made by tube-testing for the O and B antigens. The other media were employed to detect the *Salmonella* and *Shigella* groups. Each MacConkey plate was examined by testing the inoculation "well" and five separate colonies with the two pooled sera; positive colonies were checked against individual sera and subcultured for tube agglutination tests.

The figures obtained over the twelve-months period are summarized in Table I. *Shigella* and *Salmonella* results

TABLE I.—Results of Examination of 894 Adult Stools

Total	Type-specific Strains of <i>Bact. coli</i> Isolated						<i>Shigella</i> Isolated	<i>Salmonella</i> Isolated
	O111 B4	O55 B5	O26 B6	E611	E990	Canioni		
15	5	2	8	0	0	0	16	4
1.7%	0.6%	0.2%	0.9%	—	—	—	1.8%	0.4%

TABLE II.—Analysis of Cases

Case No.	Age and Sex	Clinical Notes	Organism Isolated	Type of Case
1	F 20	Nurse in children's wards. Sharp attack of diarrhoea	O55.B5 19/10/51	Sporadic
2	F 64	Senile dementia. Sharp attack of diarrhoea. Death	O26.B6 22/11/51	"
3	F 52	Abdominal adhesions. Diarrhoea	O26.B6 1/1/52	"
4	M 51	Early ulcerative colitis	O26.B6 8/1/52	"
5	M 46	Pleural effusion. Diarrhoea	O26.B6 19/5/52	Ward outbreak
6	M 68	Pulmonary tuberculosis. Diarrhoea	O26.B6 20/5/52	
7	M 50	Acute rheumatism. No diarrhoea	O26.B6 20/5/52	
8	M 67	Pulmonary tuberculosis. Diarrhoea	O26.B6 21/5/52	
9	M 79	Gangrene of leg. Amputation. Good recovery. Diarrhoea and vomiting. Death	O111.B4 27/5/52	Sporadic
10	F 59	Glaucoma. Diabetes. Diarrhoea	O111.B4 29/5/52	Ward outbreak
11	F 73	Senility. Diarrhoea	O111.B4 3/6/52	
12	F 84	Senility. No diarrhoea	O111.B4 8/6/52	
13	F 66	Hypertension. No diarrhoea	O111.B4 8/6/52	
14	F 26	Mitral stenosis. Diarrhoea	O26.B6 10/9/52	Sporadic
15	F 22	Diarrhoea and vomiting for 24 hours	O55.B5 27/10/52	"

have been added to the table for comparison, but no member of these two groups was isolated from any of the cases yielding type-specific coliforms. A brief analysis of the cases is shown in Table II.

Description of Cases

Case 1.—An otherwise healthy nurse aged 20 reported sick with diarrhoea on October 18, 1951. Next day *Bact. coli* O55.B5 was isolated. She had been employed in a paediatric ward in which were cases of gastro-enteritis, none of whom was known to be associated with *Bact. coli* O55.B5. Rectal swabs were taken from all the infants in the ward concerned, and *Bact. coli* O55.B5 was isolated from a male infant aged 5 months who was convalescing from gastro-enteritis associated with *Bact. coli* O111.B4, but who at this point had no gastro-intestinal symptoms. The nurse made an uneventful recovery within a few days; the baby remained symptomless.

Case 2.—A woman aged 64 had been an in-patient for one year and suffered from senile dementia. There

was severe progressive debility, and bronchopneumonia developed a few days before her death on November 23, 1951. The day before death the patient began to have profuse diarrhoea, and *Bact. coli* O26.B6 was isolated from the stools. At necropsy, forty-eight hours after death, moderate congestion of the terminal ileum and transverse colon was found in addition to the pneumonia. Swabs taken from organs and tissues did not produce any type-specific coliforms on culture. Rectal swabs taken from every patient in the wards concerned were also negative.

Case 3.—A woman aged 52 was admitted to hospital on December 28, 1951, with a history of intermittent diarrhoea of several years' duration, apparently dating from appendicectomy some five years previously: there had been an operation for separation of adhesions three years later. *Bact. coli* O26.B6 was isolated in pure culture on January 1, 1952. No type-specific coliform was isolated from any other patient in the ward. After full investigation the case was labelled "nervous diarrhoea." The patient was discharged on February 2, still having two or three soft stools a day, but negative for type-specific coliforms.

Case 4.—A man aged 51 was admitted to hospital on December 4, 1951, with a history of intermittent diarrhoea accompanied by blood and mucus, for a period of eight weeks. On January 8, 1952, *Bact. coli* O26.B6 was isolated from his stools. All other investigations were negative, though sigmoidoscopy suggested early ulcerative colitis. Further examinations of his faeces were negative, and no type-specific coliforms were isolated from any other patient in the ward.

Cases 5, 6, 7, 8.—There seems to be no reasonable doubt that these four cases constitute an outbreak. On May 18, 1952, a specimen of fluid faeces consisting of almost pure blood was received from a patient (Case 5) in a male ward; he had been admitted on May 14 suffering from a pleural effusion. The MacConkey plate showed an almost pure growth of *Bact. coli* O26.B6 on May 19, and rectal swabs were taken immediately from each of the 32 patients in the ward. The following morning two more patients (Cases 6 and 7) were found to have *Bact. coli* O26.B6 in their stools. When the ward staff was notified of these two new cases, information was received that both patients were convalescent and neither had diarrhoea. Case 6, however, developed severe diarrhoea six hours later, with blood and mucus in the stools. No diarrhoea was reported in Case 7. The same day (May 20) another patient (Case 8) developed severe diarrhoea, and twenty-four hours later the MacConkey plate from this patient was found to have a pure growth of *Bact. coli* O26.B6. No other positives were found in this ward, and within 72 hours all diarrhoea had ceased and the four positive cases were negative for the specific coliform.

Case 9.—A man aged 79 was admitted to hospital on February 10, 1952, suffering from gangrene of the left leg. Mid-thigh amputation was performed on April 22. His condition was satisfactory until May 24, when he had slight diarrhoea. This was followed by violent vomiting and diarrhoea twenty-four hours later. On May 27 *Bact. coli* O111.B4 was isolated in pure culture from the faeces. The patient died the following day; permission for necropsy was refused. One point worthy of comment is that a simultaneous case of diarrhoea associated with *Bact. coli* O111.B4 occurred in a child of 9 years in a ward immediately below that where Case 9 was a patient. Rectal swabs from other patients in both wards were negative for type-specific coliforms.

Cases 10, 11, 12, and 13.—This group constitutes another ward outbreak, though less definite than that involving Cases 5, 6, 7, and 8. Case 10, a woman aged 59, was admitted to hospital on May 15, 1952, suffering from glaucoma and diabetes. Diarrhoea developed on May 28 and *Bact. coli* O111.B4 was isolated in pure culture from her stools the following day. Two days later a specimen of faeces was received from another patient in the same ward (Case 11); this patient had had bouts of diarrhoea with blood and mucus on four occasions during the previous

three weeks. *Bact. coli* O111.B4 was isolated from this specimen on June 3 and from subsequent specimens on June 4, 8, and 24, after which date the diarrhoea ceased and the stools became negative. On June 7 rectal swabs were taken from every patient (a total of 32) in the ward concerned, and *Bact. coli* O111.B4 was isolated from two further cases (Nos. 12 and 13). Neither of these patients had diarrhoea, though Case 12 gave a history of having had intermittent diarrhoea some four months previously, when no salmonella, shigella, or type-specific coliforms had been found. The diarrhoea in Case 10 ceased within 72 hours and the stools were thereafter negative.

Case 14.—This woman, aged 26, was admitted to hospital in March, 1952, suffering from mitral stenosis with severe decompensation. On September 6 she began to have loose stools amounting to five or six motions a day, and on September 10 *Bact. coli* O26.B6 was isolated. No blood or mucus was noted in the stools, and no type-specific coliforms were present in specimens of faeces three, four, and five days after the first isolation, the diarrhoea having ceased by this time. No other cases of diarrhoea occurred and no type-specific coliform was isolated from any other patient in the ward concerned.

Case 15.—This patient was a woman aged 22 who was sent to hospital by her family doctor on October 26, 1952, with a diagnosis of acute appendicitis. She had pain in the right iliac fossa, vomiting, and some diarrhoea of 24 hours' duration. On admission it was thought she had bacillary dysentery, so she was isolated and barrier-nursed. The day after admission, *Bact. coli* O55.B5 was isolated in pure culture from a faeces specimen. The patient made an uneventful recovery and was well within a few days, no type-specific coliforms being found after the first isolation. An interesting feature of this case is that her 5-months-old child was in another hospital suffering from gastro-enteritis: no type-specific coliform is known to have been isolated from the child.

Discussion

Among adult hospital patients, small localized outbreaks of diarrhoea of unknown cause, affecting perhaps as many as one-third of the inmates of a ward, are a common experience, as are also sporadic isolated cases which occur from time to time. Frequently the diarrhoea is ascribed to dietary factors of uncertain origin, but from the results of the present investigation we believe that some of these cases are what may be called "coliform diarrhoea"—that is, diarrhoea caused by type-specific strains of *Bact. coli*. There does not at present appear to be any other explanation for the results obtained; the figures suggest that *Bact. coli* O111.B4, O55.B5, and O26.B6 can be the causal agents in a small proportion of cases of adult enteritis. The ward outbreaks affecting the two groups of cases (Nos. 5, 6, 7, and 8, and 10, 11, 12, and 13) provide good evidence for this belief. Here, small groups of patients developed diarrhoea directly related in time of occurrence to the presence of specific coliform organisms isolated in pure culture from the stools. Further evidence is provided by the sporadic cases, especially the two fatal ones (Nos. 2 and 9). These two patients were elderly and were weakened by previous illness; they developed sudden severe diarrhoea, coincident with which *Bact. coli* O26.B6 and O111.B4 respectively were isolated from their stools, and the resulting dehydration and exhaustion were enough to cause death.

It has been suggested in a previous communication (Stevenson, 1950) that these coliform organisms might appear in the stools as the result of the washing-down effect of diarrhoea. That this is untrue is shown by the many hundreds of adult enteritis cases investigated in this series from which no type-specific coliforms were isolated. Smith, quoted by Taylor and Charter (1952), has had similar negative findings in bacillary dysentery of infants. In only two of our positive cases (Nos. 3 and 4), both of whom had prolonged diarrhoea, has a type-specific coliform appeared in the stools as a transitory phenomenon unrelated to any marked exacerbation of intestinal symptoms. Moreover,

three cases (Nos. 7, 12, and 13) excreted type-specific coliforms when no diarrhoea was present, and in Case 6 *Bact. coli* O26.B6 was isolated and identified immediately before any looseness of stools began.

Certain conditions seem to be necessary before type-specific coliforms can exert a pathogenic effect in the intestine. From the cases described, debility and general weakness are evidently important predisposing conditions, but there is evidence of another, unknown, factor. In Cases 1 and 15 there was no history of previous illness, and both patients were young and in relatively good health; nevertheless they developed severe diarrhoea, and type-specific coliforms were isolated in pure culture from each. This other factor may be related to the virulence of the strain concerned. That Cases 1 and 15 developed symptoms could be explained by the particular organisms being highly virulent. As both these patients had enteritis on admission to hospital, they were barrier-nursed, and thus it was not possible to assess the virulence of the organism by observation of a subsequent case-to-case spread. In general, however, the pathogenicity to adults of the type-specific coliforms seems to be of a low order. Thus Cases 7, 12, and 13, despite age and debility, were able to harbour certain of these organisms without developing diarrhoea: the transitory appearance of the organisms in these three patients suggests that there is no true carrier state.

Over the period of the investigation coliform diarrhoea had the same incidence as bacillary dysentery. This, plus the fact that several of the cases in the coliform series had blood and mucus in their stools, suggests that coliform diarrhoea in adult hospital patients may present itself in a manner similar to the shigella infections. There is, however, one main difference between the two types of diarrhoea: dysentery organisms tend to remain in the intestinal tract over a relatively long period, whereas infection with a type-specific coliform is usually transient. In most of the cases in the present series, particular coliforms could be identified only for about 48 hours, after which the stools became negative.

Only two patients in the series had any contact with young children (Cases 1 and 15), and in neither instance was there any definite link of infection so far as can be ascertained. Case 9 had a remotely possible contact with the infected child in a neighbouring ward, but here again the chain of infection is obscure. Contact with infants therefore does not seem to play an important part in the infection of adults with the type-specific coliforms.

Summary

During the examination of 894 faecal specimens from adult hospital patients, type-specific strains of *Bact. coli* were isolated from 15 cases. These strains belonged to O groups 111, 26, and 55; none of the E611, E990, or Canioni strains was found. Twelve of the positive cases had diarrhoea of varying severity; two of these patients died, the associated organisms being *Bact. coli* O26.B6 and O111.B4.

It is suggested that diarrhoea in adult hospital patients can be caused by type-specific strains of *Bact. coli* and that it constitutes a definite syndrome for which the term "coliform diarrhoea" may be used; the predisposing factors are discussed.

We wish to thank Dr. Joan Taylor for supplying cultures of the type-specific strains from which antisera were prepared, and also for confirming the 15 strains isolated during the investigation. Our thanks are also due to Dr. A. D. Briggs, medical superintendent, Stobhill General Hospital, for permission to make use of clinical notes.

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INFECTED URACHAL CYSTS

BY

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The first undisputed report of cyst formation in the urachal relic was contributed by Lawson Tait in 1883. It was, however, the researches of R. C. Begg (1927, 1930) which established the nature of development and anomalies of the urachus on a firm basis. The following facts emerged. The urachus and bladder develop exclusively from the ventral cloaca. The urachus arises by a narrowing of the cranial end of the cloaca and shares with the bladder in its post-natal descent from the umbilicus. In its descent the urachus drags down the adventitia of the obliterated umbilical arteries and, at the same time, its apex becomes broken up, leaving behind its epithelial cells. These epithelial cells may proliferate to form adenomata or, by central degeneration, give rise to cyst formation.

Although containing pus and debris, many cysts are sterile, others grow *Bact. coli*, streptococci, or staphylococci. The route of infection is probably haematogenous in most cases.

Incidence.—In reviews of the literature, Weiser (1906) collected 89 cases and Kantor (1939) a further 38. Since 1936 32 references to the condition have been found in the literature. Yoerg (1942) found only 3 cases in 12,500 admissions to the Brady Urological Institute. The recorded literature gives the impression that anomalies of the urachus are rare, but few experienced surgeons fail to claim one or two cases, and my own experience of four and possibly five cases in a short period strengthens the belief that they are not uncommon. Sex incidence is difficult to establish, but Kantor's analysis suggests an approximately equal incidence. Age incidence in his series varies from 20 months to 69 years.

Classification (Long, 1931).—(1) Those communicating with the bladder. (2) Those communicating with the umbilicus. (3) Those communicating with the bladder and umbilicus. (4) Those communicating with neither. Group 4 cases are most common, and it is easy to understand how these may become group 1 or group 2 as a result of infection.

Diagnosis and Treatment

It is probable that the majority of group 4 cases never come to light unless they become infected; they may give no symptoms and are discovered only at necropsy. The presence of a urachal cyst should always be suspected in any midline abdominal-wall swelling lying between the umbilicus and the symphysis pubis. Differentiation from vitelline cysts is facilitated when it is remembered that the latter are not continued downwards as a sinus towards the symphysis pubis (Yoerg, 1942). Cystoscopy helps in group 1 and group 3 cases, and a patch of bullous oedema in the apex of the bladder may lead to the suspicion of an infected cyst.

The ideal treatment is complete excision of the cyst and tract extraperitoneally. When infected, incision with drainage is often safer. In many cases this is curative, and in any event does not make complete excision at a later date much more difficult. Infection of the peritoneal cavity can generally be well controlled with chemotherapy, and, though undesirable, spillage does not lead to the serious peritonitis of former days. Opening the peritoneum need not be feared if that is necessary for the complete removal of the cyst and its tract.