Escherichia coli Serotypes Associated with Urinary Tract Infections in the Western Cape

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SUMMARY

Examination of 3 261 specimens of urine from patients with urinary tract infections led to the isolation of *Escherichia coli* types from 933 samples (28,6%). Serological typing revealed 222 isolates (23,8%) as urinary or as enteropathogenic serotypes. The rest were untypeable. The following urinary types were identified: O 1, O 2, O 4, O 5, O 6, O 7, O 9, O 11, O 18, O 39, O 75, the commonest being O 6, O 4, and O 75. Enteropathogenic types were O 26 - B6, O 55 - B5, O 86 - B7, O 111-B4, O 112 - B11, O 119 - B14, O 124 - B17, O 125 - B15, O 126 - B16, O 127 - B8, O 128 - B12, and O 142 - B. Types O 112 and O 111 were the most prevalent.

The 1973 pattern of urinary *E. coli* infections in the Western Cape differs from that found in other parts of the world. Type O 6 is most prevalent, followed by O 4, and O 75. The last is the most common type north of the equator. Other types were far less frequent.

Cross-reactivity between 14 *Vibrio cholerae* strains and *E. coli* O 39 antiserum was proved, suggesting similarities between the enterotoxins of *V. cholerae* and pathogenic *E. coli* strains.

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The importance of *Escherichia coli* as a causal agent of disease in man is often underestimated. These organisms are the most important single cause of pyelitis and pyelonephritis. Certain serotypes produce epidemic diarrhoea in children, also summer and traveller's diarrhoea. In addition they may produce abscesses in internal organs, septicaemia, endocarditis and meningitis.

The pathogenicity of some *E. coli* types has been slowly recognised over the last 7 decades, and is now understood as a function of the antigenic structure. This has since been studied by Kauffmann[1] and Ewing.[2] Recently James[3] has reviewed the history of enteropathogenic *E. coli* types.

The specific *E. coli* serotype depends upon the presence of three classes of antigen: (*i*) the O-somatic antigens, withstanding heating at 100°C, (*ii*) the K antigens occurring as sheath envelopes or capsules which inhibit O agglutination and which are inactivated by heat at 100°C;

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(*iii*) the H (flagella) antigens which occur irregularly and are broken down by heat.

Serotyping is based on the recognition of ± 150 O antigens. As they may be masked by K antigens, the bacterial suspension has to be heated for one hour in a steam pot, or autoclaved before serotyping is performed. Suitable antisera are commercially available and usually used for the detection of the enteropathogenic *E. coli* types which sometimes cause outbreaks of acute gastroenteritis. So far, information about *E. coli* types isolated from patients with urinary infections is scanty.

Rantz[4] isolated *E. coli* serotypes from a number of stools and urines. He recovered types 2, 4, 6, and 75 from 49,3% of urines. These types were by far the commonest found in urines and comprised 79,6% of strains recovered from adult sources. Rantz's observations were the first to draw attention to *E. coli* types associated with urinary infections.

In 1971 Erwa[5] reported from Khartoum the occurrence of *E. coli* serotypes O 1, O 4, O 7, O 9, O 11, O 18, O 39, O 75, and of the enteropathogenic types O 26-B6, O 55-B5, O 128-B12 in urinary infections in Sudanese patients.

The present report is based on the bacteriological examination of 3 261 midstream urine specimens from patients at the Tygerberg and Karl Bremer Hospitals in the northern municipalities of Cape Town.

MATERIALS AND METHODS

Over the period October 1972 to February 1973, 3 261 midstream urine specimens were collected in sterile containers and sent to the laboratory. Direct microscopy of a wet film eliminated 894 samples (27,4%) which were without cellular pathology. The remaining 2 367 specimens

TABLE I. BACTERIOLOGICAL FINDINGS IN URINARY TRACT INFECTIONS

Micro-organisms	Positive cultures	Approximate percentage
E. coli (pure culture)	566	34
E. coli + other organisms	367	22
Streptococcus faecalis	133	8
Proteus species	88	5
Enterobacter	83	5
Klebsiella	62	4
Pseudomonas	37	2
Mixed pathogens excluding *E. coli*	314	20
Total	1 650	100

were cultured on MacConkey agar and blood agar and incubated aerobically at 37°C. The plates were examined after overnight incubation.

No growth was obtained from 312 samples, and from 405 no pathogenic organisms were cultured. The bacteriological incidence of the remaining 1 650 samples is shown in Table I, indicating that *E. coli* was responsible for more than 50% of all urinary tract infections.

Strains of *E. coli* were recovered from 933 samples (28,6% of 3 261 or 56% of the 1 650 with bacteriological findings). Of the 933 isolates, 222 (23,8%) were identified as urinary or enteropathogenic serotypes, using Wellcome *E. coli* agglutinating sera. Table II shows the incidence of urinary types.

TABLE II. URINARY *E. COLI* TYPES IN THE CAPE

O antigen	Approximate percentage
6	>30
4	>18
75	> 7
5	> 6
18	> 5
2	> 5
7	> 3
9	> 3
39	< 2
1	< 2
11	< 1

The following serotypes were identified: O 1, O 2, O 4, O 5, O 6, O 7, O 9, O 11, O 18, O 39, O 75, the commonest being O 6, O 4, and O 75. Anti-O 14 and anti-O 22 sera were not available. The incidence of these types therefore could not be determined.

Forty-six (roughly 20%) of the 222 typeable isolates belonged to the enteropathogenic types O 112 (14 isolates), O 111 (11), O 126 (4), O 119 (3), O 26 (3), O 86 (3), O 125 (2), O 128 (2), and O 55, O 127, O 124 and O 142, with one isolation each.

Comparing our findings with other reported results, we find a different pattern in different geographical areas, as shown in Table III.

TABLE III. PREDOMINATING *E. COLI* O SEROTYPES IN URINARY INFECTION IN 3 AREAS

	Palo Alto (Rantz[4])	Cape Town (Brede *et al.*)	Khartoum (Erwa[5])
Dominating type 1	2	6	75
Dominating type 2	4	4	18
Dominating type 3	6	75	7
Less important	75	9	11

In the Cape there is a prevalence of serotype O 6, followed by O 4, O 75 and O 9. Palo Alto, Cape Town and Khartoum have different patterns. The future will show in how far these patterns are influenced by seasons and migration.

Serology

We tested sera of 100 persons, collected at random, for antibodies against the *E. coli* types O 6, O 2, and O 9. The results are shown in Table IV.

TABLE IV. URINARY *E. COLI* AGGLUTINATING ANTIBODIES IN 100 SERA OF WESTERN CAPE INHABITANTS

Type	Pos. reactors
O 6	11
O 2	29
O 9	19

Holmgren from the University of Göteborg[6] reported that the bactericidal activity of serum protects against many, but not against all, *E. coli* types. Therefore it is not surprising that in our series most antibodies were detected against the clinically rare types O 2, and O 9, and that less positive reactors were found against the clinically dominant type O 6. Types O 6 and O 4 are regarded as the main causes of pyelonephritis.

Anderson *et al.*[7] described renal parenchymal reduction and arterial hypertension in patients with sterile urine, but with raised antibody titres to *E. coli* types O 2, O 14 and O 22.

So far the renal tissue cross-reacting strains are limited to the groups O 2, O 14 and O 22. These *E. coli* antibodies are, in fact, auto-antibodies and responsible for abacterial pyelonephritis.

We observed another interesting cross-reaction in testing our 14 *Vibrio cholerae* strains against *E. coli* agglutinating diagnostic sera. All were strongly agglutinated by *E. coli* O 39 antisera. We conclude that there are similarities between the enterotoxin of *V. cholerae* and enterotoxin from *E. coli*.

DISCUSSION

It may be assumed that some *E. coli* serotypes possess affinity to kidney tissue and are responsible for kidney diseases on a non-generalised basis. Apart from the accepted enteropathogenic *E. coli* types, a group of *E. coli* serotypes, associated with urinary tract infections, consists of the O serotypes: 1, 2, 4, 5, 7, 9, 11, 14, 18, 22, 39 and 75. Local patterns of urinary *E. coli* types differ and may be responsible for so-called 'geo-medical tendencies'. Cross-reactivity between renal tissue and *E. coli* strains is postulated for the serotypes O 2, O 14 and O 22.[7] *E. coli* antibodies, therefore, may act as auto-antibodies and could be responsible for the development of hypertension or renal insufficiency, or both, without evidence of bacterial infection.

Patients with signs of kidney and urinary tract pathology should therefore be screened for the presence of micro-organisms, including urinary *E. coli* types, and for the presence of antibodies against different *E. coli* serotypes. These limited first findings in sera of Western Cape inhabitants, sampled at random, show that the number of

antibody carriers is high and that the O 2 serotype, incriminated as being able to induce auto-antibodies, occurs in our region. At the moment it is not possible to state that other E. coli serotypes are unable to induce the formation of antibodies directed against kidney tissue. The nature of these antibodes is also not yet clearly defined. Agglutinating antibodies are mostly of the IgG type, but we can assume that while antigen is present, according to phylogenetic rules, IgM type antibodies will also be present. A new field for further combined clinical and laboratory research is clearly visible in connection with nephrology and E. coli research. The possibility of identifying potential cases of pyelonephritis lenta by determination of E. coli antibodies should not be overlooked.

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The Anhepatic Model in a Pig

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SUMMARY

A technique is described for creating the anhepatic state in the pig. Reconstitution of flow is achieved by the insertion of a prosthetic graft between portal and systemic vascular systems. Postoperatively, the animals may be studied for periods up to 15 hours.

This model is of value for studying the anhepatic state, and for assessing hepatic assist procedures, although the state is irreversible and does not mirror the syndrome of fulminant hepatic failure, as the abnormal liver is absent.

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Preparation of an anhepatic model allows investigation of various functions in the absence of the liver[1] and may be used to assess forms of hepatic assist.[2,3] The model

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was originally prepared in the dog in 1921 by Mann and Magath,[4] using glass tubing inserted between the portal vein and the upper and lower segments of the vena cava to reconstitute flow. Subsequently other techniques were devised in one or two stages with the creation of a portacaval shunt and ligation of the hepatic artery.[5-8] In some experiments the liver was resected off the vena cava,[9,10] in others part of the vena cava was removed with ligation of the vessel,[11] and a technique of end-to-end anastomosis of the vena cava has also been described.[12] Some models require a femorojugular bypass, with or without a pump, to allow venous return from the lower limbs.[11]

Most preparations have been made in dogs[4,5,7] with a few in the pig.[2,13] Preparation of the anhepatic pig always requires resection of the vena cava, since the vessel is almost totally surrounded by hepatic tissue. A technique has been devised in the pig for total hepatectomy, which allows recovery from anaesthesia and study for a period of 12 - 15 hours. No bypasses were required postoperatively. The animals were studied especially for alterations in fibrinolysis after this procedure, which have been previously reported.[14] Preliminary studies of acid-base metabolism were also made.