Incidence of K1 antigen in *Escherichia coli* isolated from blood and cerebrospinal fluid of patients in the United Kingdom

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SUMMARY Altogether 411 cultures of *Escherichia coli* isolated from blood and 60 from cerebrospinal fluid (CSF) of patients in the United Kingdom were identified biochemically and serologically. They were tested for the presence of K1 antigen by an antiserum-agar method using horse meningo-coccus group B antiserum and by slide agglutination using *E. coli* 07.K1.H-antiserum.

In total 71 cultures from blood (17%) and 29 from CSF (48%) gave positive results by both methods and were considered to possess the K1 antigen. Among the cultures from patients less than 3 years of age the K1 antigen was found significantly more often in those isolated from CSF (53%) than in those from blood (29%). The K1 antigen was found significantly more frequently in cultures isolated from the blood of patients less than 3 years old (29%) than in those from the blood of older patients (13%).

Cultures which gave negative results in the slide agglutination test also gave negative results by the antiserum-agar method but positive results obtained by slide agglutination were not always confirmed using the antiserum-agar technique. Slide agglutination was considered to be valuable for the elimination of K1 negative cultures, but positive results required confirmation using the antiserum-agar method.

Escherichia coli was the fourth most common cause of bacterial meningitis in England and Wales during 1975 (Communicable Disease Report, 1976). Studies in the United States (Robbins *et al.*, 1974) and in Scandinavia (Ørskov and Ørskov, 1975) have established the relative frequency of occurrence of the various serotypes of *E. coli* in blood culture and cerebrospinal fluid (CSF) culture from patients in those countries. These studies have shown that the distribution of *E. coli* serotypes found in blood culture is similar to that in the faeces, while among cultures from CSF certain somatic antigens are found more frequently than in the faeces. The surface antigen K1 has been shown to occur with similar frequency in cultures isolated from blood and faeces but has been found in a disproportionately large number of CSF isolates, particularly those from neonates.

In the present study *E. coli* isolated from blood and CSF cultures of patients in the United Kingdom

were examined. Their O:H serotypes were determined and they were tested for the presence of the *E. coli* K1 antigen. The use of a simple slide agglutination technique for the identification of the K1 antigen was evaluated and compared with an antiserum-agar method.

Material and methods

ORGANISMS

The *E. coli* cultures were from the collection of the Salmonella and Shigella Reference Laboratory. They had been received during the period 1972-76 and had subsequently been maintained on Dorset egg medium at room temperature. They were isolated from sporadic cases of meningitis or septicaemia in the United Kingdom; 411 cultures were isolated from blood and 60 from CSF.

BACTERIOLOGICAL STUDIES

The organisms were identified biochemically by the methods of Cowan and Steel (1974) and were serotyped using antisera for *E. coli* O antigens 01 to 0164

and H antigens H1 to H56 (Ørskov and Ørskov, 1975).

TESTS FOR K1 ANTIGEN

The presence of K1 antigen was detected by means of the antiserum-agar technique of Sarff *et al.* (1975) using horse meningococcal group B antiserum kindly supplied by Dr John B. Robbins of the Food and Drug Administration, Bethesda, Maryland, USA. Since the cultures were derived from single colonies selected at the time of isolation it was considered unnecessary to test numerous colonies by streaking each culture on to antiserum-agar plates. Instead, each Dorset egg culture was stab-inoculated into the antiserum agar so that a number of cultures could be tested on each plate. In addition, each culture was tested by slide agglutination with a rabbit antiserum prepared using *E. coli* 07.K1.H- (strain number Bi7509/41).

Results

Only those cultures which gave positive reactions in both tests were considered to possess the K1 antigen; 71/411 (17%) cultures from blood and 29/60 (48%) cultures from CSF gave positive results in both tests (Table 1). Among the patients less than 3 years of age 25/86 (29%) of the cultures from blood possessed the K1 antigen compared with 29/55 (53%) of the cultures from CSF ($\chi^2 = 7.95$; $P < 0.005$). Among the older patients 32/245 (13%) of the cultures from blood possessed K1 compared with 25/86 (29%) of those from blood cultures of patients less than 3 years old ($\chi^2 = 11.44$; $P < 0.001$).

All the 329 cultures which gave negative results using slide agglutination tests with *E. coli* 07.K1 antiserum also gave negative results using the antiserum-agar technique with meningococcal B antiserum. However, 30 blood isolates and 12 CSF isolates gave positive slide agglutination which was not confirmed using the antiserum-agar technique.

The O:H serotypes found most commonly among

Table 2 *E. coli* serotypes from blood

Serotype	Total	K1+
06.H1	35	0
018ac.H-	32	5
07.H-	19	11
04.H5	17	1
01.H7	16	9
075.H-	15	1
018ac.H7	11	5
01.H-	11	1
06.H-	9	3
0?.H-	9	1
0 rough H-	9	4
02.H4	8	2
0?.H19	7	0
02.H7	7	3
018ac.H1	6	1
018ac.H5	6	0
0?.H4	6	0
02.H-	6	0
016.H-	6	4
04.H-	5	2
016.H6	5	2
022.H1	5	0
075.H5	5	0
Others*	166	16
Total	411	71

*Less than five of each serotype; 106 different serotypes.

Table 3 *E. coli* serotypes from CSF

Serotype	Total	K1+
018ac.H7	6	5
0?.H4	5	0
016.H6	4	4
0 rough H-	4	4
07.H-	4	3
0 rough H7	3	3
01.H7	3	3
0?.H7	2	1
02.H1	2	0
02.H7	2	2
06.H31	2	0
083.H33	2	2
Others*	21	2
Total	60	29

*All different serotypes.

the blood isolates are shown in Table 2 and those in the CSF isolates in Table 3.

Discussion

Robbins *et al.* (1974), in a survey in the USA, established an association between the K1 surface antigen and neonatal *E. coli* meningitis but did not observe such an association in *E. coli* isolates from blood or urine of neonates or adults. The K1 antigen was detected in 84% of CSF isolates from neonates, in 39% of neonatal blood cultures, and from 12% of normal infant stool cultures. In adults, K1 was detected in 11% of blood cultures, in 11% of urine

Table 1 Age of patients

Age (yr)	Source of cultures					
	Blood		CSF		Total	
	Total	K1+	Total	K1+	Total	K1+
<3	86	25 (29)*	55	29 (53)	141	54 (38)
>3	245	32 (13)	5	0 (0)	250	32 (13)
Not known	80	14 (17)	0	0 (0)	80	14 (17)
Total	411	71 (17)	60	29 (48)	471	100 (21)

*Percentages are given in parentheses.

cultures, and in 13% of normal stools. Sarff *et al.* (1975), in a later study in North America, confirmed these findings and also showed that somatic antigens 018 and 07 were more frequent among CSF isolates than among those from rectal cultures. Ørskov and Ørskov (1975) found K1 in 18% of *E. coli* isolated from blood cultures in Denmark but suggested that the *E. coli* serotypes found simply reflected the composition of the intestinal flora.

In the present study the number of patients more than 3 years old with meningitis was too small to be meaningful and, as in previous studies, the incidence of the K1 antigen in *E. coli* from CSF could be compared with that in blood cultures only in patients less than 3 years old. It was confirmed that in patients in this age group the K1 antigen occurs significantly more frequently in CSF isolates (53%) than in those from blood (29%). The incidence of K1 in blood cultures could be compared for the two age groups and, as in previous studies, the incidence of K1 in blood cultures of patients less than 3 years old (29%) was significantly greater than that in older patients (13%).

The high frequency with which strains with somatic antigen 018ac were found among CSF isolates is in agreement with the findings of Sarff *et al.* (1975). However, in contrast to the findings of Ørskov and Ørskov (1975), our results show that 018ac was also the most common somatic antigen identified in the blood isolates. In general, our findings suggest that, as might be expected, those serotypes found frequently in CSF are also common in blood cultures. However, serotypes which are common among blood isolates but which lack the K1 antigen are found much less frequently in CSF. For example, *E. coli* 06.H1 was found in 35/411 blood isolates although none of these possessed the K1 antigen; in contrast,

only one strain of this O:H serotype was found among the 65 CSF isolates.

The use of slide agglutination tests with *E. coli* 07.K1 antiserum proved to be a useful screening technique since all the strains giving negative results in this test were also negative in the antiserum-agar test. This simple technique using an easily prepared antiserum could therefore enable a clinical laboratory to screen *E. coli* isolates from blood or CSF for the presence of K1 and to eliminate, without further testing, those isolates which lack the K1 antigen. However, 42 strains which gave positive slide agglutination results gave negative results in the antiserum agar test. It is, therefore, necessary to carry out confirmatory tests using the antiserum-agar technique on all strains giving positive results in the slide agglutination test before the presence of the K1 antigen can definitely be established.

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