EDITORIAL

A spectrum of verocytotoxigenic *Escherichia coli*

There appears to be an increasing prevalence around the world of both sporadic cases and outbreaks of human infection associated with verocytotoxigenic *Escherichia coli* (VTEC). VTEC of serotypes O157:H7 and O157:H⁻ are most frequently reported from these cases, but many other *E. coli* serotypes have also been encountered. Several of these [1, 2] were recorded before the first report of outbreaks caused by strains of serogroup O157 in 1982 [3]. VTEC of serogroup O157 generally belong to a clone that has a number of unusual features, including an inability to ferment sorbitol and to produce β-D-glucuronidase, which most other *E. coli* are able to do. These characteristics make them comparatively easy to isolate and characterise, and specific media have been developed to facilitate the isolation of these strains from patients.

Studies in Australia have demonstrated that a wide variety of VTEC serotypes are associated with infection [4]. When the first outbreak occurred in 1995, the strains isolated were predominantly VTEC O111:H⁻, although a number of other serotypes, including O157:H7 and O157:H⁻ were also found [5]. Australia is by no means unique in isolating non-O157 VTEC from patients and the environment. Moreover, the experiences of the Australian O111:H⁻ outbreak have shown that if due care had not been taken, it may well have been described as an

O157 outbreak [6] and other reported outbreaks might similarly have been wrongly attributed.

From over 10 years experience of operating an *E. coli* reference laboratory with a full set of *E. coli* O and H antisera, it has been possible to establish a unique data set of VTEC serotypes in Australia. Realising that toxigenicity is unlikely to be restricted to the VTEC O157 clone, or just a few serotypes, we have kept an open mind on the likelihood of encountering other toxigenic strains. As a result, various VTEC serotypes from both human and environmental sources have been recognised. Apart from testing for the presence of one or both of the verocytotoxins, the strains were also tested for the presence of enterohaemolysin, which is considered to be a virulence factor associated with VTEC.

A selection of the strains that have recently been characterised are listed in Table 1. As can be seen, a wide spectrum of *E. coli* serotypes other than accepted VTEC types, such as the O157 and O111 serogroups, produce verocytotoxin, with or without enterohaemolysin. Serotypes with the O157 or H7 antigens that possess neither the verocytotoxin nor the enterohaemolysin are also found, but are not associated with disease. These findings indicate that VTEC serotypes O5:H⁻ and O91:H⁻ should be considered as pathogens regardless of source, as strains isolated

Table 1. Verocytotoxin and enterohaemolysin production of a selection of strains of *E. coli* recently isolated in Australia

Serotype	Verocytotoxin	Enterohaemolysin	Isolated from		Associated with HUS
			man	environment	
O157:H7	+	+	+	+	Yes
O157:H ⁻	+	+	+	+	Yes
O111:H ⁻	+	+	+	+	Yes
O48:H21	+	+	+	-	Yes
O128:H2	+	+	+	-	Yes
O5:H ⁻	+	+	+	+	Yes
O5:H ⁻	+	-	-	+	Yes
O91:H ⁻	+	+	+	+	Yes
O130:H11	+	+	+	-	Not reported
O116:H21	+	+	+	+	Not reported
O113:H21	+	-	+	+	Yes
O153:H ⁻	+	+	-	+	Not reported
O69:H8	+	-	-	+	Not reported
O137:H41	+	-	-	+	Not reported
O169:H28	+	-	-	+	Not reported
O128:H16	+	-	-	+	Not reported

HUS, haemolytic uraemic syndrome

from patients and the environment have been associated with cases of haemolytic uraemic syndrome (HUS) in Australia and elsewhere. VTEC serotypes O130:H11, O116:H21 and O153:H⁻ that produce both cytotoxin and haemolysin are most probably pathogens, although they have not yet been reported in cases of HUS. Serotypes of O5:H⁻ and O113:H21 that lack the enterohaemolysin have been associated with HUS and thus appear to be pathogenic. Other VTEC serotypes that lack the ability to produce enterohaemolysin (O69:H8; O137:H41; O169:H28; and O128:H16) have presently been isolated only from environmental samples. They may have the potential to cause human disease, but on present knowledge the case is not proven. Strains with the O157 or H7 antigen, but which produce neither verocytotoxin nor enterohaemolysin, can be isolated from patients, but should not be considered as pathogens.

The serotype O48:H21, which has only once been isolated in Australia, from a very severe case of HUS [7] had at that time not been reported elsewhere. If this serotype had only been isolated from some environmental source such as animal faeces, food etc., its pathogenic significance might have been overlooked. It has since been reported as a pathogen from a number of countries.

These results and a close examination of the world literature clearly show that, while strains belonging to the VTEC clone O157:H7/H⁻ are important, they are most certainly not the only VTEC in our environment that can cause human disease. There are plenty of strains belonging to various serotypes, which are potential pathogens, and which, in some cases, have actually been shown to be associated with disease. Australia has been considered by some as being unique in having such a variety of enterohaemorrhagic *E. coli* serotypes [8]. Although this may be true, it is more likely that these non-O157 VTEC have been detected by having maintained an open mind about their possible involvement in infection.

Unfortunately, non-O157 strains do not have a unique

set of biochemical markers, which makes their isolation much more difficult, especially as they are often present in small numbers. However, difficulty in recognising non-O157 VTEC isolates does not mean that the attempt should not be made. The recent description of the use of simple tests for the production of enterohaemolysin [9], which most VTEC, regardless of serotype, produce may well lead the way to the isolation of more non-O157 VTEC. Human ingenuity will no doubt come up with solutions to these problems and it will become possible to disentangle the true pathogens from other *E. coli* within this spectrum of VTEC serotypes.

KARL A. BETTELHEIM

National *Escherichia coli* Reference Laboratory,
Victorian Infectious Diseases Reference Laboratory,
Locked Bag 815, Carlton South,
Victoria 3053, Australia.
E-mail: kabsm@jolt.mpx.com.au

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