Verocytotoxigenic *Escherichia coli* (VTEC)

**Summary**

**Introduction**

1. This note provides a brief summary of an analysis undertaken by a DISCONTOOLS group of experts on VTEC. They reviewed the current knowledge on the disease, considered the existing disease control tools, identified current gaps in the availability and quality of the control tools and finally determined the research necessary to develop new or improved tools. Full details can be downloaded from the web site at http://www.discontools.eu/ by selecting Disease Database, then the specific disease and highlighting the variables of interest. This is completed by selecting “create a report” which can then be downloaded as either a PDF or Excel spread sheet.

**Disease profile**

2. Most *Escherichia coli* bacteria are harmless commensals; however certain strains produce potent toxins and are known as verocytotoxin-producing *E. coli* (VTEC). VTEC are zoonotic pathogens, occurring worldwide. VTEC can cause severe human illnesses and ruminants, particularly cattle act as their natural reservoir. To date, more than 100 different serotypes have been identified as VTEC, with O157:H7 and O26 serotypes most commonly associated with severe human disease. Although, other serotypes, namely O104 have been prominent in the last few years.

3. VTEC can cause a wide spectrum of disease in humans, ranging from mild uncomplicated diarrhoea to severe bloody diarrhoea and the haemolytic uremic syndrome (HUS), a potentially life threatening condition which is mainly observed in young children.

4. Most VTEC infections in animals are asymptomatic with the exception of isolates implicated in diseases in pigs and poultry (these are not zoonotic). As well as in cattle, VTEC are common in other ruminants including sheep, goats, water buffalo and wild ruminants and have also been isolated from other species, including pigs, horses, dogs, chicken, pigeon and wild birds. VTEC colonize the distal gastrointestinal tract of animals and large numbers of organisms can be excreted in their faeces. VTEC can persist in individual animals for several months. Some animals may act as “Super shedders” excreting high numbers of VTEC in their faeces.

5. VTEC can survive in the environment for extended periods of time, reports suggest that survival can be more than 90 days in soil and months to years in manure and the farm environment. VTEC can spread within the farm by direct contact, contamination of water, feed, vehicles and environment, and by other animals such as dogs, cats and wildlife. Flies appear to also play a significant role.

6. Human VTEC infections can occur through exposure to extremely low infectious doses. Routes of transmission include ingestion of contaminated foods of animal origin, especially ground beef and dairy products, water and vegetables contaminated with farm slurry, direct contact with live animals, contaminated animal products or a contaminated environment. Person-to-person transmission does occur.

**Risk**

7. Surveillance systems are in place in industrialized areas such as Europe, North America, Japan, and Australia. In the US, the incidence is estimated to be around 100,000 cases per year. However, the prevalence and epidemiology of VTEC infection is poorly known in developing countries.

8. Food sources identified as providing a risk of infection include undercooked ground beef, unpasteurised milk and dairy products and contaminated fresh produce. Good food hygiene is essential to prevent zoonotic transmission.

9. Most control efforts have been aimed at ensuring that food and water are not contaminated with VTEC from cattle faeces. Prevention of infection in livestock is difficult. Many reservoir
hosts, many routes of transmission, and the persistence of environmental contamination represent the primary obstacles for control.

10. In infected animals, shedding of VTEC is usually intermittent. However, a few animals, defined as “Super shedders” can excrete very large numbers of organisms in the faeces, and can remain colonized for longer periods. These “Super shedders” might play a major role in maintaining and spreading the infection within herds. These animals are also a high risk for human infection.

Diagnostics

11. In general, the laboratory tools for VTEC O157 detection are adequate, while those for VTEC non-O157 detection are still relatively poor. A number of PCR-based methods to detect the other pathogenic serogroups (such as O26, O103, O111, O145) have been developed. More recently LAMP assays combined with lateral flow technology promise the potential for pen-side testing. However, these are relatively expensive, therefore rapid tests targeting the main non-O157 and O157 pathogenic serogroups are still urgently required. Moreover, rapid, economical sequence based typing systems are also required to aid epidemiological investigations.

Vaccines

12. Experimental vaccines to prevent the colonization of cattle with VTEC O157 have been developed, but their efficacy is still controversial. A vaccine has obtained licensing approval from the Canadian Food Inspection Agency and more recently in Europe. Another product has recently obtained a conditional approval by the U.S. Department of Agriculture. The efficacy of the available vaccines against VTEC O157 has still to be fully evaluated. As infected cattle are asymptomatic there could be little demand from farmers for a vaccine. More research on non-O157 vaccines is urgently required.

Pharmaceuticals

13. In cattle, neomycin administration is effective at eliminating most O157 in cattle, but its use is complicated by the possibility of promoting antibiotic resistant organisms. In humans, antimicrobial therapy is controversial and may be contraindicated due to a possible increase in the release of verocytotoxins in the gut.

Knowledge

14. In many countries, particularly in the developing world, the prevalence of disease due to VTEC is not well understood.

15. Better knowledge of the general pathobiology and ecology of VTEC is needed. More information is required on the survival of VTEC in soil and farm environments and the role of wild-life in the epidemiology of infection. More research is needed on the relative importance of the different routes of transmission and sources of infection. There are gaps in knowledge on how the organism is spread between farms and how animals are exposed within a single farm. Further research is needed on animal husbandry procedures which could mitigate the risk of contamination of the environment.

16. Better understanding of the mechanisms of the pathogenesis of infection in humans and of colonization is required. The role of past exposure and acquired immunity in relation to disease manifestation are unknown.

17. More research is required on the dynamics of infection in animals including investigating the factors involved in super shedding and determining whether tools and markers can be developed to identify Super shedders.

18. More research is required into vaccines, specifically those providing long lasting protection. More detailed studies on practical vaccine administration techniques are also required.

19. The potential of using bacteriophages, prebiotics, probiotics and synbiotics as possible approaches to control should be encouraged.
Conclusions

20. VTEC can cause serious disease in humans, but the widespread occurrence of asymptomatic infections in animals and the widespread presence of the organism in the environment make control in livestock difficult. A better understanding of the fundamental mechanisms of the pathogenesis of infection in humans and of colonization in livestock is required to identify the most suitable targets for diagnostics and vaccines and other novel interventions.

21. Diagnostic tests need to be improved and the availability of hundreds of VTEC genomes will facilitate this. The scientific community must capitalise on the well of data already available to develop rapid, economical point of care tests.