Traditional Sources of *E. coli* O157:H7

Outbreaks or sporadic cases........

- Associated with ingestion of undercooked ground meat
- In recent times, more often associated with salad vegetables, raw milk and contaminated water
- Ruminant reservoirs, both sheep and cattle
- Animal associated transfer, particularly from young animals
- High stocking rates in feedlots
Ruminants as a Source

- Common inhabitant of the gastrointestinal tract of ruminants, especially cattle
- Young animals tend to be higher risk
- *E. coli* O157:H7 carriage is asymptomatic and often transient
- Intermittent and variable shedding but can get persistent shredders
  - Seasonal, age, diet, stress etc affects shedding rates.
- STEC appear to be a part of the microbiota of healthy ruminants
  - 8.7 - 35.2% cattle STEC positive
  - 32.1 - 66.7% sheep STEC positive

Entry into the food chain...........

STEC in New Zealand Ruminants

- On farm recto-anal mucosal swabs of cattle & sheep (Manawatu & Rangitikei)
  - 2003 - 187 healthy cattle & 132 healthy sheep sampled for STEC
  - 27.3% cattle and 65.9% sheep positive for STEC
  - Direct selection on CT-SMAC & TBX with no IMS selection for O157
  - 3 sheep: *eae*-positive STEC (O26:H11, O84:H-)
  - 19 cattle: *eae*-positive STEC (O5:H-, O26:H11, O84:H-, O84:H2)  
    (Cookson et al., 2006)

- STEC O157 quantitative risk assessment from bobby calves
  - 2005 - 160 calves sampled prior to slaughter
  - 17 (11%) faecal samples positive for O157
  - 69 (43%) hide samples positive for O157  
    (Mills et al., 2006)
Other Sources and Other STECs

- Familial transmission
- Other foods
- Environmental
- Human reservoirs?

Infections by non-O157 STECs to 2008

Illness attributed to non-0157s per year in US

- 36,700 illness
- 1100 hospitalisations
- 30 deaths
What about *E. coli* O157:H7 infections in New Zealand?

In New Zealand……

- Identification of foodstuffs as vehicle of *E. coli* O157:H7 infection extremely rare
- No large outbreaks of STEC infection
- Infection rates similar to those of England & Wales but less than Scotland
- ~ 90% STEC isolates O157:H7

![Graph showing infection rates of STEC O157 in Great Britain and New Zealand](image)
Human Cases in New Zealand?

First case - 1993 an 11 month old boy from Whakatane with HUS

D+HUS in under 15s /100,000

In NZ, it tends to be sporadic and rural rather than associated with food

Cases in New Zealand

Figure 1. Number of Paediatric VTEC cases & HUS in New Zealand, 1998-2008
(Personal Communication. Wong 2009 Presentation)
In 2010……..

Yearly Notifications

Monthly Variation - Notifications

Continuing to increase in numbers with clear seasonal trends

5 outbreaks – 4 were person to person
- 1 may be also food associated

Of 128 confirmed cases 115 were O157:H7, 13 cases were non-O157

Most cases reported in 1- 4 yr age group with 4 cases reported as HUS

So far in 2011……..

Significant rise in notifications

183 (2011) compared to 130/100,000 (2010)
Genetics and Genomes of STECs
Defining *E. coli* O157:H7

**STEC:** shiga-toxin producing *E. coli*

- Haemorrhagic colitis
- HUS (Haemolytic-uremic syndrome)
- TTP (Thrombotic thrombocytopenic purpura)

Possess either one or both Stx1 and Stx2 toxins
- found on lysogenic lambda bacteriophage
- stx1 identical to that found in *Shigella dysenteriae*
- toxins inhibit protein synthesis leading to cell death

**Outer membrane protein intimin** *(eae)*
- attaching and effacing (AE) lesions on host epithelial cells
- in the absence of *eae*, *iha* promotes adhesion

Antibiotic resistance - none

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Other STEC Virulence Factors

- haemolysin
- serine protease
- catalase peroxidase
- Saa adhesin
- SubA toxin

- **STEC/E. coli** genome made up of a mosaic of ‘foreign’ DNA acquired through *horizontal gene transfer*, phage insertion

- Virulence genes flanked by transposable/insertion elements
  - often inserted into large plasmids, common in STEC & other *E. coli* pathotypes
**E. coli O104:H4**

As of July 1st – 4121 cases reported, 845 HUS and 50 deaths

Predominant involvement of adult women in initial stages of outbreak

Average age of afflicted decreased

Severe neurological complications – encephalopathy and epileptic seizures

High mortality rate \textit{cf} O157 (20\% (HUS) and 6\% (Death))

EHEC strain which until this outbreak was very rare

Other documented cases were in Korea, Germany, Finland and France

Previous German HUS case – closely related but does not appear to be the same strain

**SOURCE** – Fenugreek seeds

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**Origins of HUS causing \textit{Escherichia coli}**

- **EaggEC**
  - Ø stx Shigella
  - O104:H4 Germany
  - \textit{aggA}
  - \textit{stx2a}
  - ESBL

- **EPEC**
  - O55 (\textit{ee+})
  - Ø stx Shigella
  - STEC
  - Non-O157
  - O26
  - O103
  - O111
  - O45
  - O145
  - O113
  - GANG of SIX

- **EAHEC**
  - EHEC
  - O157
Core genome comparative analysis of pathogenic *E. coli*

Relatedness of O157 Isolates and Epidemiology

Isolate and characterise O157 and non-O157 from a range of sources
- environmental
- bovine
- clinical

Serotyping to confirm isolate but need genotyping and sequencing to get source attribution
- MLST
- Pulse Field Gel Electrophoresis
- Insertion Site Mapping
- Others?

Mellmann et al 2011 PLoS