3.3 Verotoxigenic *E. coli*

Summary

Number of VTEC cases, 2012: 554
Crude incidence rate, 2011: 12.07/100,000
Number of VTEC-associated HUS 2012: 32
Number of VTEC cases, 2011: 283

Introduction

The reported verotoxigenic *E. coli* (VTEC) incidence rate in Ireland is generally high relative to other European countries. In 2011 (the latest year for which data are published), the overall VTEC incidence rate in the European Union was 1.93 per 100,000.[1] For several years, Ireland has reported the highest VTEC incidence rate of any Member State in the EU, although Germany reported the highest rate in 2011 due to the large VTEC O104 outbreak linked with fenugreek seeds.[2-3]

The dominant transmission routes reported for VTEC infection in Ireland have been person-to-person spread, especially in childcare facilities and among families with young children, and waterborne transmission associated with exposure to water from untreated or poorly treated private water sources. [4-7] Other important transmission routes identified internationally include food (often minced beef products or fresh produce such as lettuce and spinach), and contact with infected animals or contaminated environments.[3, 8-10]

Materials and Methods

Infection with verotoxigenic *E. coli* became a notifiable disease in 2012; prior to that VTEC were notifiable under the category Enterohaemorrhagic *E. coli* (EHEC) since 2004. Enhanced epidemiological information was supplied as in previous years by HSE personnel, and the National VTEC Reference Service at the Public Health Laboratory HSE Dublin at Cherry Orchard Hospital (-PHL-Dub.) provided the VTEC confirmation and typing data. Data from all sources are maintained in the Computerised Infectious Disease Reporting (CIDR) system. Outbreaks of VTEC are notifiable since 2004 and data are provided to CIDR by regional public health departments.

Data from the CSO 2011 census were used to provide denominators for the calculation of national, regional and age-specific incidence rates in 2012.

Results

Incidence

In 2012, there were 554 notifications of VTEC, equating to a crude incidence rate (CIR) of 12.07 per 100,000 (95% CI 11.07-13.08). This compares to an overall rate of 6.2 per 100,000 in 2011, an increase of 96%. 408 notifications in 2012 were reported as confirmed cases (CIR 8.89 95% CI 8.03-9.76), 144 were probable and there were two cases reported in the new possible case class. The criteria under which notified cases were reported in 2012 under the VTEC case definition is outlined in Table 1. As the classification of VTEC cases changed significantly upon the amendment of the Irish VTEC case definition in 2012, it is not valid to directly compare the number of notifications by case classification with previous years.

Of the 535 cases with laboratory evidence of infection, 229 cases were reported as being infected with *E. coli*

Table 1. Number of VTEC notifications by criteria for notification, Ireland 2012

Notification criteria	Confirmed	Probable	Possible	Total
Culture confirmation[a]	382	122		**504**
Laboratory confirmation by PCR[b]	24	5		**29**
Serodiagnosis (valid for HUS only)	2			**2**
Reported solely on the basis of epidemiological link		17		**17**
Clinical HUS not meeting laboratory or epidemiological criteria			2	**2**
Total	408	144	2	**554**

[a]Symptomatic culture confirmed cases are classified as confirmed cases, while asymptomatic culture confirmed cases are classified as probable cases

[b] Symptomatic PCR-confirmed cases are classified as confirmed cases, while asymptomatic PCR-confirmed cases are classified as probable cases

O157 (5.0 per 100,000 (95% CI 4.3-5.6), 207 with *E. coli* O26 (4.5 per 100,000 (95% CI 3.9-5.1), 91 with other VTEC strains, and 8 cases had mixed VTEC infections, being infected with more than one VTEC strain. Of the 17 probable cases reported on the basis of an epidemiological link to a confirmed case, 8 were linked to *E. coli* O157 outbreaks, and 9 were linked to *E. coli* O26 outbreaks. Figure 1 illustrates the distribution of VTEC cases in Ireland by serogroup since 1999. The serogroup distribution this year represents a 16% increase in O157 infections and a 315% increase in non-O157 infections compared to 2011.

Severity of illness

Four hundred and twenty eight of the 554 notified cases were symptomatic (77.3%), 151 (35.3%) of which developed bloody diarrhoea (42.5% when only cases with this variable completed are included). Thirty-two individuals (5.8%) developed HUS, an increase of 68% on 2011. No deaths were reported, however one HUS case developed long-term sequelae. Where reported (n=504), 159 (31.5%) of notified cases were hospitalised (37.1% of symptomatic cases).

Thirteen HUS cases were infected with *E. coli* O157, with a further HUS case epidemiologically linked to an *E. coli* O157 outbreak. Nine had laboratory evidence of VTEC O26 infection, with a further two HUS cases epidemiologically linked to *E. coli* O26 outbreaks. One had a mixed VTEC O26/O145 infection, two had VTEC O145 infections and two were infected with other VTEC strains. The remaining two HUS cases were reported as possible VTEC notifications (table 2).

Seasonal distribution

Figure 2 shows the seasonal distribution of notifications in 2012 relative to the mean monthly number of cases in the years 2009-2011. Despite the very large increase in the number of notifications, the typical summer seasonal peak was maintained - albeit possibly slightly earlier than usual - with the highest number of cases being in August.

There was variation in the seasonal distribution by serogroup, with VTEC O157 showing the typical peak in numbers in late summer; in contrast, VTEC O26 notifications peaked in June during 2012 (figure 3).

Regional distribution

The highest VTEC incidence rates were reported in the HSE-M followed by the HSE-MW and the HSE-S, where the rates were two to two and half times the national crude rate (Table 3). The HSE-E reported the lowest overall crude incidence rate (Table 3), followed by the HSE-SE and HSE-NE. The rate of VTEC associated HUS in the HSE-M was also higher than all other areas, and was six times the national rate. Over one third of all VTEC-associated HUS cases in 2012 were reported in HSE-M.

In 2012, the national annual incidence rate for non-O157 infections exceeded the rate for VTEC O157 infections

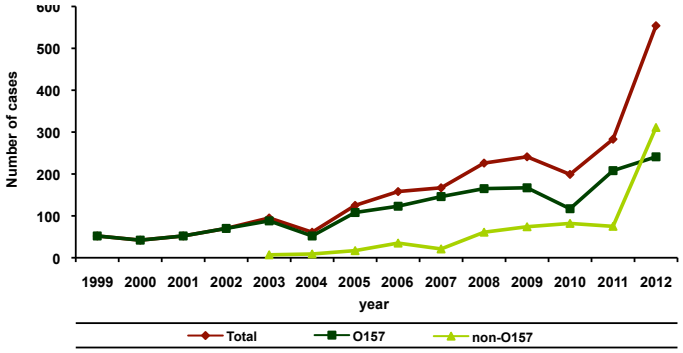

Figure 1. Annual number of VTEC cases by serogroup, Ireland 1999-2012

Note: For simplicity in this figure, cases with mixed VTEC O157/other serogroup infections are included in the data for O157, as are probable cases linked to known E. coli O157 outbreaks. Non-O157 data includes cases with mixed non-O157 infections and probable cases linked to known O26 outbreaks

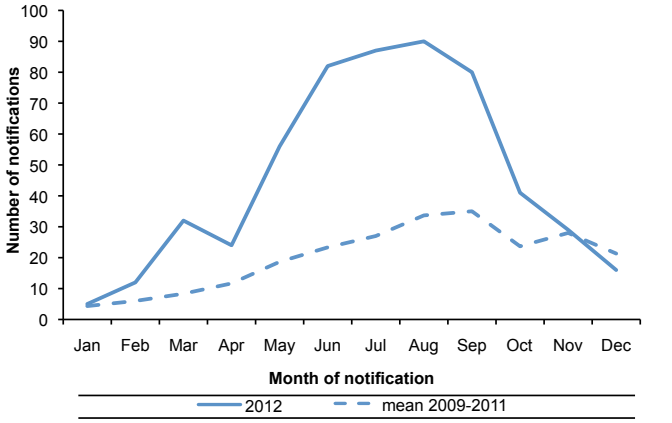

Figure 2. Seasonal distribution of VTEC notifications, Ireland 2012 compared to the mean number of notifications 2009-2011

Table 2. Number of VTEC notifications by infecting serogroup and HUS status, Ireland 2012

Serogroup	HUS	non-HUS	Total
O157 or epi-linked to O157 outbreak	14	223	**237**
O26 or epi-linked to O26 outbreak	11	205	**216**
Other	5	94	**99**
No organism	2	0	**2**
Total	**32**	**522**	**554**

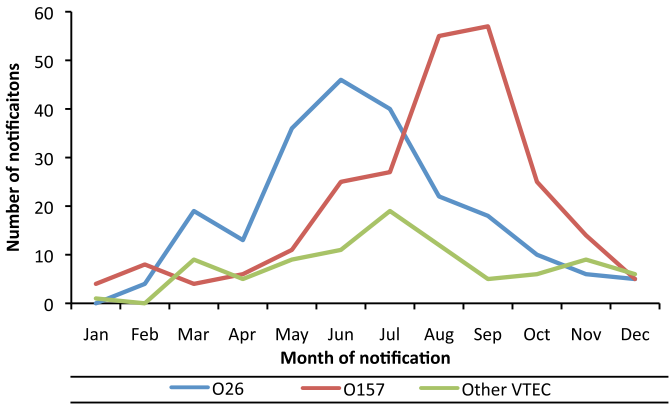

Figure 3: Seasonal distribution of VTEC notifications by serogroup, Ireland 2012

for the first time; when reviewed by HSE-area, the crude rate for non-O157 infections was higher than for VTEC O157 in five HSE-areas (Table 3; Figure 4). This geographic variation in serogroup distribution is likely to have been influenced by regional variation in diagnostic practices.

Laboratory typing

In 2012, the serogroup and verotoxin profiles of VTEC isolates referred to the PHL HSE Dublin Mid Leinster, Cherry Orchard Hospital are displayed in Table 4. The most common serogroup reported was VTEC O157, followed by VTEC O26. Among the other serogroups listed by the WHO as having the highest association with HUS internationally, there were six VTEC O103 cases, six VTEC O111 and 24 VTEC O145.

Table 3. Number and crude incidence rate VTEC by serogroup and HSE area, and number and crude incidence rate VTEC-associated HUS by HSE-area, Ireland 2012

HSE-area [a]	Number [CIR (95% CI)] VTEC O157 [b]	Number [CIR (95% CI)] non-O157 VTEC [c]	Number [CIR (95% CI)] all VTEC [d]	Number [CIR (95% CI)] VTEC-associated HUS
East	40 [2.5 (1.7-3.2)]	15 [0.9 (0.5-1.4)]	**55 [3.4 (2.5-4.3)]**	4 [0.3 (0.0-0.5]
Midlands	34 [12.0 (8.0-16.1)]	48 [17.0 (12.2-21.8)]	**82 [29.0 (22.8-35.3)]**	12 [4.3 (1.85-6.7)]
Mid-West	18 [4.8 (2.6-6.9)]	69 [18.2 (13.9-22.5)]	**87 [22.9 (18.1-27.8)]**	3 [1.8 (-0.1-1.7)]
North-East	30 [6.8 (4.4-9.2)]	1 [0.2 (-0.2-0.7)]	**31 [7.0 (4.6-9.5)]**	2 [0.5 (-0.2-1.1)]
North-West	13 [5.0 (2.3-7.8)]	24 [9.3 (5.6-13.0)]	**38 [14.7 (10.0-19.4)]**	2 [0.8 (-0.3-1.9)]
South-East	18 [3.6 (2.0-5.3)]	5 [1.0 (0.1-1.9)]	**23 [4.6 (2.7-6.5)]**	2 [1.4 (-0.2-1.0)]
South	58 [8.7 (6.5-11.0)]	91 [13.7 (10.9-16.5)]	**150 [22.6 (19.0-26.2)]**	6 [0.9 (0.2-1.6)]
West	30 [6.7 (4.3-9.2)]	58 [13.0 (9.7-16.4)]	**88 [19.8 (15.6-23.9)]**	1 [0.2 (-0.2-0.7)]
Ireland	241 [5.3 (4.6-5.9)]	311 [6.8(6.0-7.5)]	**554 [12.1 (11.1-13.1)]**	32 {0.7 (0.5-0.9)]

[a] Rates per 100,000 calculated using CSO census 2011 for denominator data
[b] For simplicity, cases with mixed VTEC O157/other serogroup infections are included in the data for O157, as are probable cases linked to known E. coli O157 outbreaks.
[c] Non-O157 data includes cases with mixed non-O157 infections and probable cases linked to known O26 outbreaks.
[d] Possible cases (i.e. those with no associated organism are also included in this column), and therefore the total in this column will not always be the sum of the previous two columns.

Table 4. Serotype and verotoxin (VT) profiles for strains associated with laboratory confirmed VTEC cases, as determined at the PHL HSE Dublin Mid Leinster, Cherry Orchard Hospital in 2012

Serogroup	VT1	VT1+VT2	VT2	Not applicable	Total
O157		37	190	2 [a]	229
O26	83	104	20		207
Ungroupable	17	9	14		40
O145		1	23		24
O103	2	2	2		6
O111	5	1			6
O146	1	1	1		3
O182	3				3
O130			2		2
O55			2		2
O104	1				1
O121			1		1
O153			1		1
O166	1				1
O84	1				1
Mixed serogroup	4		4		8
Total	118	155	260	2	535

[a] No vt type for two VTEC O157 cases as diagnosed by serodiagnosis

As usual among VTEC O157 in Ireland, isolates containing the genes for verotoxin 2 (*vt2*) were more common (84%) than strains containing both *vt1* and *vt2*. VTEC O26 strains containing only *vt1* made up 40% of all VTEC O26 reported, with 50% of VTEC O26 containing the genes for both *vt1* and *vt2*, and those containing *vt2* making up the remaining 10% of VTEC O26.

Risk factors

Under enhanced surveillance for VTEC, risk factor information is routinely collected on VTEC notifications (Table 5).

Exposure to farm animals or their faeces and exposure to private well water were relatively common among cases; 45.5% and 46.6% reported these exposures respectively. This is consistent with the low incidence of VTEC infection among residents in the largely urban HSE-E population and the higher incidence recorded in more rural parts of the country. According to CSO data, in the general population, around 10.1% of households are served by private wells, indicating that, on a national basis, exposure to private wells is likely to be more common among VTEC cases than among the general population.

Unlike salmonellosis, foreign travel plays only a minor role in VTEC infection in Ireland, with the overwhelming majority of infections acquired indigenously.

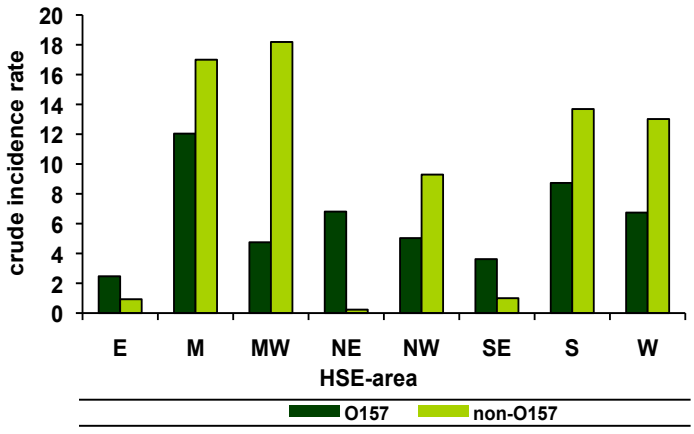

Figure 4: Crude incidence rate VTEC O157 and non-O157, Ireland 2012

Where the information was available, around a quarter of VTEC cases in 2012 were reported to attend a Childcare Facility (CCF). When these analyses were restricted to notified VTEC under five years of age, half reported attendance at a childcare facility. This is slightly higher than the proportion of children in the general population who use non-parental childcare (42%) as reported by the Central Statistics Office. [19]

Outbreak and environmental investigations

The outbreak surveillance system plays a key role in our understanding of VTEC transmission in Ireland. Ninety-seven VTEC outbreaks were notified in 2012, which included 334 of the 554 VTEC notifications. 47 outbreaks were due to VTEC O157, 39 to VTEC O26, two were mixed VTEC strain outbreaks, and nine were caused by other VTEC strains.

The majority of outbreaks (82%) were family outbreaks, with seventeen general outbreaks notified. The 80 family outbreaks resulted in 156 persons becoming ill, an average of 2.0 (range 1-6) persons ill per outbreak, while the seventeen general outbreaks resulted in 126 persons becoming ill, an average of 7.4 (range 1 to 30) persons ill per outbreak.

The suspected modes of transmission are listed in Table 6.

Person-to-person spread is consistently the most common mode of VTEC transmission reported in Ireland, particularly between young children, and was suspected to have played a role in 34 (35%) VTEC outbreaks in 2012 in which 111 persons were reported ill (Table 6 and Figure 5). Twenty seven of these outbreaks were reported as being solely due to person-to-person transmission, including seven of the outbreaks associated with CCFs.

The second most common transmission route reported was waterborne transmission, which was reported to have contributed to 21 outbreaks (22%) with 83 persons ill. Four were general outbreaks and 17 were family outbreaks; these 21 outbreaks were linked to 17 private wells, one water scheme serving a private housing development, two group water schemes and exposure to river water. Microbiological evidence was obtained in ten outbreaks, where an indistinguishable strain was identified in both the implicated water supply and among the outbreak cases. For two further outbreaks, VTEC other than that identified in the outbreak cases

Table 5. Number of cases of VTEC (and percentage where known) for selected risk factors, Ireland 2012

Risk factor	Number 'Yes' and % where reported	Number 'No' and % where reported	Number where risk factor was unknown or not reported
Food suspected	28 (8.8%)	287 (92.2%)	239
Exposure to farm animals or their faeces	195 (45.5%)	233 (54.5%)	126
Exposure to private well water[a]	207 (46.6%)	237 (53.4%)	110
Travel-associated[b]	13 (2.8%)	451 (97.2%)	90
Attendance at a CCF[c]	101 (25.8%)	291 (74.2%)	162
Attendance at a CCF[c] (among <5 yrs)	95 (50.5%)	93 (49.5%)	61

[a]Composite variable recoded from two different water supply exposure enhanced variables in CIDR
[b]Inferred from CIDR core variable *Country of Infection*
[c] *Childcare Facility*

were found in the implicated supply. Evidence was circumstantial for water supplies suspected in 8 further drinking water associated outbreaks, and for one outbreak suspected to be associated with exposure to river water.

Three outbreaks (four person ill in total) were reported as being suspected to be foodborne; no definitive evidence was reported implicating any food vehicles, although one outbreak which was foreign travel related was suspected to be due to chicken. Animal/ environmental contact being reported as the suspected mode of transmission in an additional three family outbreaks; contact with a goat was reported as the suspected source of infection in one of these outbreaks. For 44% (n=43) of VTEC outbreaks in 2012, the transmission route was reported as unknown or not specified (Table 6 and Figure 5).

Focus on general outbreaks
Eight of the 17 general outbreaks were associated with childcare facilities/arrangements (CCFs), six were reported as community outbreaks, one foreign travel related general outbreak was linked to a hotel, one was reported in a private house and one reported among an extended family. This is the highest number of general VTEC outbreaks reported in a single year since surveillance for VTEC infection commenced in 1999.

Five of the outbreaks associated with CCFs were reported as being due to person-to-person spread. The mode of transmission for the remaining three CCF outbreaks was unknown. The number of cases per outbreak ranged from 1 to 30 (median 3). There was epidemiological and microbiological evidence linking two CCF outbreaks in the HSE-M. [14] Between the two outbreaks, there were 31 laboratory confirmed cases, and four cases developed HUS. Both outbreaks were reported to be due to person-to-spread with attack rates of 30-40%. [14]

Among the community VTEC outbreaks, three waterborne outbreaks was reported in the HSE-M, with 46 person ill (20 laboratory confirmed) between them. Six persons required admission to hospital and one person developed HUS. A community outbreak primarily centred in the HSE-MW but including cases from HSE-W and HSE-S, was investigated by the Dept. of public health HSE-MW. Fourteen persons developed illness and 17 persons had laboratory confirmed infection. Five cases required admission to hospital and two children developed HUS. The outbreak was caused by VTEC O26 VT2 and occurred over an 11 week period in early spring 2012. Foodborne transmission was suspected but no food item was identified; secondary person-to-person spread in private homes and in a childcare facility was also reported.

Four persons (age range 12-72) were reported ill over a nine day period in a community outbreak in the HSE-E; three required hospital admission and one adult developed HUS. Neither the source of infection nor the transmission route were identified. A sixth community outbreak was reported in HSE-W and there were two persons ill; the transmission route was also reported as unknown.

The remaining general outbreaks included (i) a travel-associated suspected foodborne outbreak (1 ill, 2 laboratory-confirmed) associated with a hotel; no specific food was reported as being responsible, (ii) an extended family outbreak in which six persons became ill and for which microbiological and epidemiological evidence suggested exposure to a private well as the source of infection, and (iii) a private house associated outbreak with two persons ill where no transmission route was reported..

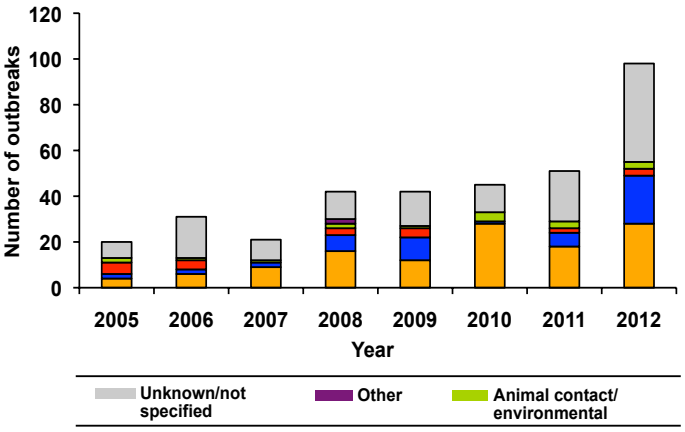

Figure 5. Number of VTEC outbreaks by suspected transmission route and year, Ireland 2004-2011
Note: In this figure, reported transmission routes were grouped for simplicity. Any outbreak where food contributed was reported as foodborne, any outbreak where water contributed was reported as waterborne, any outbreak where animal contact contributed was reported as Animal contact. Person-to-person outbreaks include only those outbreaks reported as being due only to person-to-person transmission.

Summary
There was a notable increase in the number of VTEC notifications in 2012 relative to previous years, with the reported number of cases almost doubling compared to 2011. The great majority of this increase was accounted for by non-O157 VTEC infections, which increased by 315% relative to 2011. This development was accompanied by more widespread use of methods that detect both VTEC O157 and non-O157 VTEC, for example, PCR (followed by culture confirmation where possible) and chromogenic agars. In addition, 2012 was notable for its high rainfall, which may have contributed to the rise through a range of mechanisms, including contamination of drinking water.

Surveillance for VTEC in the United Kingdom largely centres on surveillance for VTEC O157. The incidence rate of 5.0 per 100,000 for VTEC O157 in Ireland was around 11% higher than that for Scotland (4.5 per 100,000) and around double that reported in England and Wales in 2012.[11] In contrast, the VTEC O157 incidence rate in Northern Ireland was around twice that in Ireland in 2012, in part due to occurrence of a large outbreak in Belfast in late 2012.[12]

Within the European context, the latest available data shows that the overall incidence rate for VTEC in Europe in 2011 was 1.93 (range 0.0-6.8).[1] Germany, Ireland, the Netherlands and Sweden reported the highest incidence rates at that time. It seems likely when the data are available across Europe for 2012, that Ireland will have one of the highest reported incidence rates in Europe again.

The HSE-M reported both the highest overall incidence of VTEC and the highest incidence of VTEC-associated HUS in 2012. Two large crèche outbreaks and two large outbreaks linked to private drinking water supplies contributed to this overall high incidence; [13, 14] the HSE-M however, consistently reports one of the highest VTEC incidence rates each year.

Transmission by person-to-person spread between young children in childcare facilities was a feature in other HSE-areas too, with 8 general and 2 family outbreaks reported in 2012 associated either with crèches or families and their childcare arrangements. This is the same number of outbreaks associated with childcare as in 2011, but is higher than in previous years. Active follow-up of facilities when VTEC cases are reported who attend a crèche/childminders remains a key public health intervention for VTEC given the greater potential for transmission in these situations because of the less developed hygiene skills in general of small children and because of the higher vulnerability of this group to the more severe manifestations of VTEC infection such as HUS. Guidance for crèche owners and management in the prevention of infectious disease spread in CCFs [15] and guidance for Public Health professionals on the management of VTEC cases and outbreaks in CCFs [16] have been published in 2012 and 2013 respectively.

This year, water was reported to have contributed to transmission in 21 outbreaks (38% of outbreaks with a reported transmission route); this is the highest annual number and percentage of VTEC outbreaks to be reported as waterborne since outbreaks became notifiable in 2004. As in previous years, all drinking water associated outbreaks reported were linked with private water supplies. Exposure to water from contaminated untreated or poorly treated private water supplies has previously been recognized as a strong risk factor for VTEC infection in Ireland.[6,7] This has been particularly pronounced following periods of heavy rainfall. Ireland experienced record rainfall amounts in many parts of the country in 2012, and this is likely to have contributed to the large number of waterborne VTEC outbreaks reported.

Private water supplies in Ireland include small water schemes managed by trustees or other private individuals, and private wells/springs serving one-off houses or business premises which are the responsibility of the home/business owner. These sources of water present a risk to public health when they have not been designed and managed appropriately, and those responsible should be mindful of the requirements for their maintenance and protection. In 2013, the HSE published a leaflet for well owners outlining the infectious disease risks associated with drinking water from private wells, providing advice on actions that can be taken including: checking the supply, water testing and treatment, and what to do in the event their well water is found to be contaminated .[18] Further advice on private wells is available from both HSE Environmental Health Service and local authorities, and at www.hpsc.ie/hpsc/A-Z/Gastroenteric/VTEC/VTECandwater/

Foodborne outbreaks were reported infrequently in the Irish VTEC dataset, but may be underestimated as evidence that an outbreak is foodborne can be difficult to establish. Within households, family members can have similar food histories making it difficult to conclude if a particular food item within the household was responsible for the outbreak. Moreover, it is rare for there to be food leftover for analyses in the household by the time an investigation commences. For general outbreaks that are suspected to be foodborne, unless a single food premises or meal is reported by the majority of cases, finding the source of foodborne outbreaks can be challenging, especially if the food is a widely distributed common food item or if it is an ingredient which has been incorporated into lots of different dishes reported by cases. The suspected food bourne general outbreak in the MW was not found to be associated with any particular food premises or retail outlet, an no specific food item was identified as a potential vehicle. The proportion of VTEC outbreaks where no suspected transmission route is reported remains very high.

Table 6. VTEC outbreaks by suspected mode of transmission, Ireland 2012

Suspected mode of transmission	Number of outbreaks	Number ill	Number of associated events
Person-to-person	27	103	138
Waterborne	15	75	51
Person-to-person and waterborne	4	4	14
Waterborne and animal contact	2	4	6
Animal contact	1	3	3
Person-to-person and animal contact	1	1	2
Foodborne	1	1	2
Person-to-person and foodborne	2	3	5
Environmental/Fomite	1	2	2
Unknown	38	77	97
Not Specified	5	10	14
Total	97	283	334

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