3.3 Verotoxigenic *E. coli*

Summary

Number of VTEC cases, 2014: 707
Crude incidence rate, 2014: 15.4/100,000
Number of VTEC-associated HUS, 2014: 27
Number of VTEC cases, 2013: 701

Introduction

The reported verotoxigenic *Escherichia coli* (VTEC) incidence rate in Ireland is generally high relative to other European countries. In 2012 (the latest year for which data are published), the overall VTEC incidence rate in the European Union was 1.59 per 100,000, which was 5.9% higher than in 2012.[1] The highest country-specific rates were observed in Ireland, the Netherlands and Sweden (12.3, 7.1 and 5.8 per 100,000 population, respectively). For many years, Ireland has reported the highest VTEC incidence rate of any Member State in the EU, except in 2011 when Germany reported the highest rate due to a 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, 8-9]

Materials and Methods

Infection with verotoxigenic *E. coli* became a notifiable disease in 2012; prior to that VTEC were notifiable since 2004 under the category Enterohaemorrhagic *E. coli* (EHEC). Enhanced epidemiological information was supplied as in previous years by HSE personnel, and the VTEC National Reference Laboratory at the Public Health Laboratory, Cherry Orchard Hospital Dublin (VTEC-NRL at PHL) provided 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 the eight regional public health departments. The data used in this report were extracted from CIDR on 31st August 2015.

Data from the Central Statistics Office (CSO) 2011 census were used to provide denominators for the calculation of national, regional and age-specific incidence rates in 2014.

Results

Incidence

In 2014, there were 707 notifications of VTEC, equating to a crude incidence rate (CIR) of 15.4 per 100,000 (95% CI 14.3-16.5). This compares to an overall incidence rate of 13.1 per 100,000 in 2013, an increase of 0.9% and an overall incidence rate of 12.1 per 100,000 in 2012, an increase of 28%. Of the 707 VTEC notifications in 2014, 569 (80%) were classified as confirmed cases (CIR 12.4 95% CI 11.4-13.4), 136 as probable and 2 as possible cases. The criteria under which notified cases were reported in 2014 under the VTEC case definition

Table 1. Number of VTEC notifications by criteria for notification, Ireland, 2014

Notification criteria	Confirmed	Probable	Possible	Total
Culture confirmation[a]	467	123	-	**590**
Laboratory confirmation by PCR[b]	102	12	-	**114**
Serodiagnosis (valid for HUS only)	-	-	-	**0**
Reported solely on the basis of epidemiological link	-	1	-	**1**
Clinical HUS not meeting lab or epi criteria	-	-	2	**2**
Total	569	136	2	**707**

[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

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 the period before 2012.

Of the 704 cases with laboratory evidence of infection, 233 cases were reported as being infected with *E. coli* O26 (5.1 per 100,000; 95% CI 4.4-5.7), 177 with *E. coli* O157 (3.9 per 100,000; 95% CI 3.3-4.4), 290 with other VTEC strains, and 4 cases had mixed VTEC infections, being infected with more than one VTEC strain. The one probable case reported on the basis of an epidemiological link to a confirmed case, was linked to an *E. coli* O157 outbreak. Figure 1 illustrates the distribution of VTEC cases in Ireland by serogroup since 1999. Compared to 2013, the serogroup distribution in 2014 represents a 20.4% decrease in O157 infections, a 7.8% increase in O26 infections, and a 12.4% increase in other non-O157/O26 infections.

Severity of illness

Five hundred and sixty-eight (80.3%) of the 707 notified cases were symptomatic, 220 (38.7%) of which developed bloody diarrhoea (42.3% when only symptomatic cases where the bloody diarrhoea variable completed are included). Twenty-seven individuals (3.8%) developed HUS, a decrease of 12.9% on 2013 (n=31). There was one death in a confirmed VTEC case; three other persons diagnosed with VTEC infection in 2014 also died, but their deaths were not reported as due to VTEC. Where reported (n=688), 237 (34.4%) of notified cases were hospitalised (40.0% of symptomatic cases).

Of the 27 HUS cases, 13 were infected with *E. coli* O157, eight with *E. coli* O26 and one each with *E. coli* O103, O111, O145 and ungroupable (Table 2). The remaining two HUS cases were reported as possible VTEC notifications. HUS cases ranged in age from 9 months to 68 years and 77.8% (n=21) of the cases were in children under 10 years of age. Seventeen of the HUS cases were sporadic cases, eight were part of family outbreaks (including two cases in one household), and two were part of a general outbreak (i.e. two cases in a childcare setting).

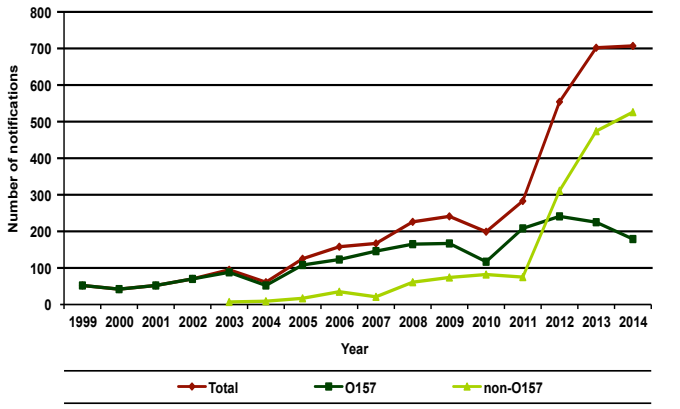

Figure 1. Annual number of confirmed and probable VTEC cases by serogroup, Ireland 1999-2014
Note: For simplicity in this figure, cases with mixed VTEC O157/other serogroup infections are included in the data for O157, as are probable cases linked to known E. coli O157 outbreaks. Non-O157 data includes cases with mixed non-O157 infections and probable cases linked to known O26 outbreaks

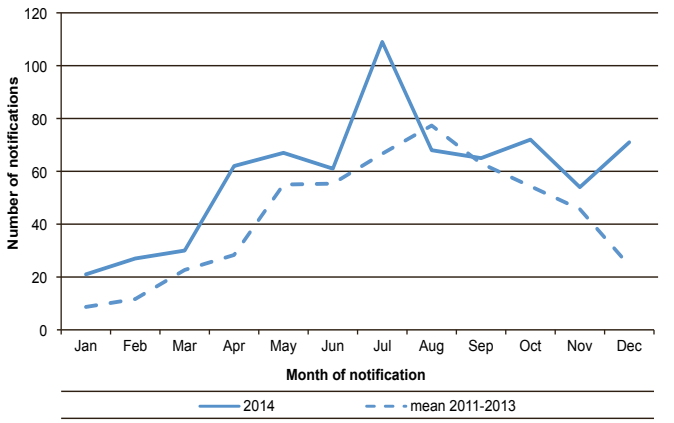

Figure 2. Seasonal distribution of the number of VTEC notifications in Ireland, 2014 and the mean of 2011-2013

Table 2. Number of VTEC notifications by serogroup and verotoxin and HUS status, Ireland, 2014

Serogroup[a]	HUS	non-HUS	Total
O157 VT2[b]	13	135	**148**
O157 VT1+VT2	0	31	**31**
O26 VT1	0	100	**100**
O26 VT2	1	8	**9**
O26 VT1+VT2	7	120	**127**
Other VT1	1	121	**122**
Other VT2	1	93	**94**
Other VT1+VT2	2	72	**74**
No organism	2	0	**5**
Total	**27**	**680**	**707**

[a]For simplicity mixed infections were recorded as O157 if at least one strain was O157, as O26 if at least one strain was O26 but not O157, and as Other if only non-O157 non-O26 strains were detected.
[b]Includes one probable case epi-linked to an O157 VT2 outbreak

Seasonal distribution

Figure 2 shows the seasonal distribution of notifications in 2014 relative to the mean monthly number of cases in the years 2011-2013. Despite the increase in the number of notifications, the typical summer seasonal peak was maintained, the peak month was July followed by September/October and April/May. An increase in December was also noted in 2014.

Similar to previous years, during 2014 there was variation in the seasonal distribution by serogroup, with VTEC O157 showing the typical peak in numbers in late summer / early autumn; in contrast, VTEC O26 notifications peaked in July with a smaller peak in May (Figure 3). Other non-O157 serogroups were also more common in early summer in 2014. Unlike previous years, in 2014 an upsurge in VTEC O157 and O26 notifications was also observed in December.

Regional distribution

In 2014, the highest VTEC incidence rates overall were reported in the HSE-W followed by the HSE-MW, HSE-M and HSE-SE, where the rates were significantly higher than the national crude incidence rate (Table 3). The incidence of VTEC overall in HSE-E and HSE-NW were significantly lower than the national crude incidence rate (Table 3).

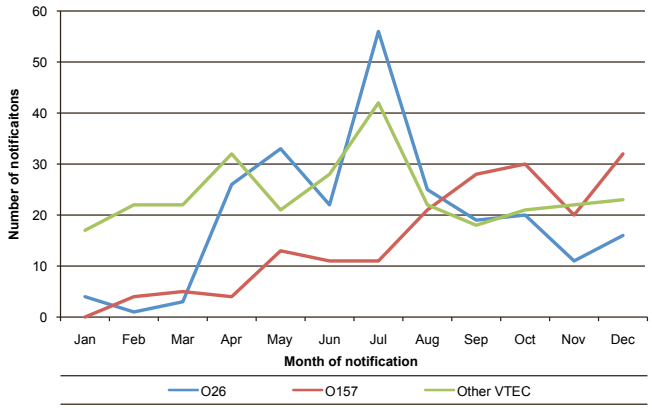

Figure 3: Seasonal distribution of VTEC notifications by serogroup, Ireland 2014

The incidence of *E. coli* O157 was significantly higher in HSE-W and significantly lower in HSE E when compared with the national crude incidence rate. With the exception of the HSE NW, in seven of the eight HSE areas, the incidence of non-O157 infections was at least twice that of *E. coli* O157 infections (Table 3).

The highest incidence of HUS amongst VTEC cases was in HSE-NE, despite being ranked sixth in the overall VTEC incidence rates (Table 3).

Age-sex distribution

As in previous years, the highest reported age-specific incidence rate was in the 0-4 years age group (92 per 100,000). Incidence rates were higher among females in the majority of the age groups; however, the incidence rate was higher in males compared with females in the 0-4 years age group (Figure 5).

Laboratory typing

In 2014, the serogroup and verotoxin profiles of VTEC isolates/samples referred to the VTEC-NRL at PHL, Cherry Orchard Hospital are displayed in Table 4. The most common serogroup reported was VTEC O26 (n=233), followed by VTEC O157 (n=178). Among the other serogroups listed by the World Health Organisation as having the highest association with HUS internationally, there were 18 VTEC O103 cases, 10 VTEC O111, and 31 VTEC O145. Compared with 2013, there was an 82% increase in the number of VTEC O145 notified in 2014 (17 and 31 cases, respectively). The number of serogroup 0146 quadrupled in 2014, compared with 2013 (20 and 5 cases, respectively).

As usual among VTEC O157 in Ireland, isolates containing the genes for verotoxin 2 (*vt2*) were more common (82.6%) than strains containing genes for both *vt1* and *vt2*. Among the VTEC O26 strains those containing the genes for both *vt1* and *vt2* accounted for the majority of these strains (54%), followed by *vt1*

Table 3. Number and crude incidence rates of by serogroup and HSE area, and number and crude incidence rate of VTEC-associated HUS by HSE area, Ireland, 2014

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
E	27 [1.7; 1.0-2.3]	69 [4.3; 3.3-5.3]	**96 [5.9; 4.7-7.1]**	6 [0.4; 0.07-0.7]
M	15 [5.3; 2.6-8.0]	51 [18.1; 13.1-23.0]	**66 [23.4; 17.7-29.0]**	3 [1.1 ; 0.0-2.3]
MW	21 [5.5; 3.2-7.9]	85 [22.4; 17.6-27.2]	**107 [28.2; 22.9-33.6]**	5 [1.3; 0.2-2.5]
NE	15 [3.4; 1.7-5.1]	40 [9.1; 6.3-11.9]	**55 [12.5; 9.2-15.8]**	6 [1.4; 0.3-2.5]
NW	13 [5.0; 2.3-7.8]	4 [1.6; 0.03-3.1]	**17 [6.6; 3.5-9.7]**	1 [0.4; 0.0-1.2]
S	28 [4.2; 2.7-5.8]	92 [13.8; 11.0-16.7]	**120 [18.1; 14.8-21.3]**	2 [0.3; 0.0-0.7]
SE	16 [3.2; 1.6-4.8]	100 [20.1; 16.2-24.0]	**116 [23.3; 19.1-27.6]**	0 [0.0; 0.0-0.0]
W	44 [9.9; 7.0-12.8]	85 [19.1; 15.0-23.1]	**130 [29.2; 24.2-34.2]**	4 [0.9; 0.02-1.8]
IE	179 [3.9; 3.3-4.5]	526 [11.5; 10.5-12.4]	**707 [15.4; 14.3-16.5]**	27 [0.6; 0.4-0.8]

[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.

only (42.1%) and those containing *vt2* making up the remaining 9.1% of VTEC O26. In contrast, the majority (80.6%) of O145 strains were *vt2*-postive. Furthermore, *vt1*-containing strains made up the majority of O103 strains (88.8%), while VTEC O111 comprised mainly of and *vt1+vt2*-containing (90%) strains (Table 4).

Risk factors

Under the enhanced surveillance system 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; 34.2% and 32.0% reported these exposures respectively. However, both were less commonly reported than in 2013 and in 2012. 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 appears 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.

Where the information was available, just under a quarter of VTEC cases in 2014 reported attendance at a childcare facility (CCF). When these analyses were restricted to notified VTEC under five years of age, 47.8% reported attendance at a childcare facility. This is higher than the proportion of children in the general population who use non-parental childcare (42%) as reported by the Central Statistics Office. [10]

Outbreak and environmental investigations

The outbreak surveillance system plays a key role in our understanding of VTEC transmission in Ireland. Eighty-three VTEC outbreaks were notified in 2014, which included 275 of the 707 VTEC notifications. Twenty-two outbreaks were due to VTEC O157, 38 to VTEC O26, 12 were mixed VTEC strain outbreaks, and 11 were caused by other VTEC strains.

The majority of outbreaks (88%) were family outbreaks, with ten general outbreaks notified. The 73 family outbreaks resulted in 134 persons becoming ill, an average of 1.9 (range 1-4) persons ill per outbreak, while the ten general outbreaks resulted in 68 persons becoming ill, an average of 6.8 (range 2-23) persons ill per outbreak.

Sixty-nine outbreaks occurred in private homes, eight involved childcare facilities, one was a community outbreak, three involved extended families and the locations for two outbreaks was not specified.

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 45 (54%) VTEC outbreaks in

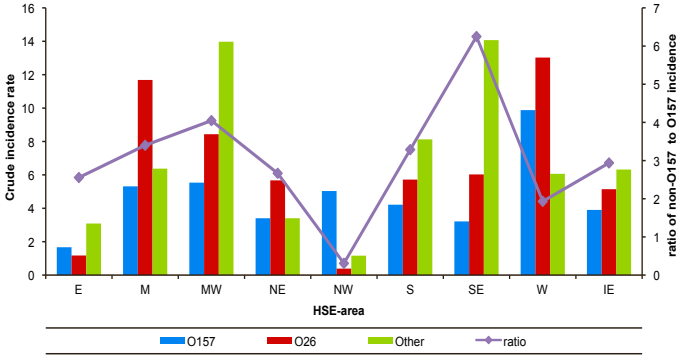

Figure 4: Crude incidence rate VTEC O157, O26 and other serogroups by HSE area, Ireland, 2014

Table 4. Serotype and verotoxin (vt) profiles for strains associated with laboratory confirmed VTEC cases, as determined at the VTEC-NRL at PHL, Cherry Orchard Hospital, 2014

Serogroup	vt1	vt1+vt2	vt2	Total
O26	98	126	9	233
O157		31	147	178
O145	1	5	25	31
O146	9	6	5	20
O103	16		2	18
O111	1	9		10
O5	5	2		7
O182	6			6
O76	4	1		5
O84	5			5
O128ab		3	1	4
O55	2		2	4
O91	1	2	1	4
O108	3			3
O118	3			3
O177	2		1	3
O113	1	1		2
O163			2	2
O165		2		2
O75		1	1	2
O78	2			2
O8			2	2
O105ac			1	1
O107	1			1
O112ab	1			1
O123			1	1
O128ac	1			1
O128ad		1		1
O138			1	1
O181	1			1
O98	1			1
OE11362-78			1	1
Ungroupable	56	41	48	145
Mixed	2	1		3
Total	**220**	**232**	**250**	**704**

2014 in which 140 persons were reported ill (Table 6 and Figure 5). Forty of these outbreaks were reported as being solely due to person-to-person transmission, including six of the outbreaks which occurred in CCFs.

Animal/environmental contact and waterborne transmission were joint second as the most common reported routes of transmission. Animal/environmental contact was reported to have contributed to nine outbreaks (10.8%) with 16 persons ill. All were family outbreaks in private houses. This is similar to the number of VTEC outbreaks due to this transmission route, notified in 2013 (Figure 6).
Waterborne transmission was reported to have contributed to nine outbreaks (10.8%) with 19 persons ill. This is similar to the number of waterborne VTEC outbreaks reported in 2013 but less than half the number reported in 2012 (Figure 6). Two were general outbreaks and seven were family outbreaks; with private wells suspected in eight of the nine outbreaks.

One outbreak (family outbreak, 3 persons ill) was reported as being suspected to be foodborne, however the suspected food item was not reported.

For 29% (n=24) of VTEC outbreaks in 2014, the transmission route was reported as unknown or not specified (Table 6 and Figure 6).

Summary

The number of VTEC notifications remained stable in 2014 relative to 2013, following a statistically significant increase in 2013 compared with 2012. Since 2011, there has been a continuous increase in non-O157 notifications and this trend continued in 2014, reflecting the more widespread use of diagnostic methods in the primary hospital laboratories that detect both O157 and non-O157 VTEC.

Interesting the incidence of VTEC O157 continued to decrease in 2014.

Guidance for Laboratory Diagnosis of Human Verotoxigenic *E. coli* Infection developed by The Laboratory Sub-Group of the VTEC Sub-Committee of the HPSC Scientific Advisory Committee was issued in September 2014. It is anticipated that this will further contribute to a co-ordinated approach to VTEC diagnosis in Ireland.[11]

Within the European Union, Ireland continues to have the highest incidence rate for VTEC, reporting over seven times the European average in 2013.[1] It is anticipated when the data are available across Europe for 2014, that Ireland will have one of the highest reported incidence rates in Europe again

Foodborne transmission was the first recognised transmission route for VTEC infection historically, with minced beef, unpasteurised dairy products, and fresh produce consumed raw all having been implicated in outbreaks across the world. Foodborne outbreaks typically comprise a small percentage of the total number of VTEC outbreaks in Ireland and 2014 was not an exception with foodborne outbreaks comprising 1.2% of the VTEC outbreaks notified.

Table 5. Number of cases of VTEC (and percentage where information available) for selected risk factors, Ireland, 2014 (n=707)

Risk factor	Yes (% of known)	No	Unknown or not reported
Food suspected	30 (6.1)	465	212
Exposure to farm animals or their faeces	211 (34.2)	406	90
Exposure to private well water[a]	202 (32.0)	430	75
Travel-associated[b]	21 (3.3)	625	61
Attendance at a CCF[c]	137 (23.1)	455	115
Attendance at a CCF[c] (among <5 yrs)	128 (47.8)	140	59

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

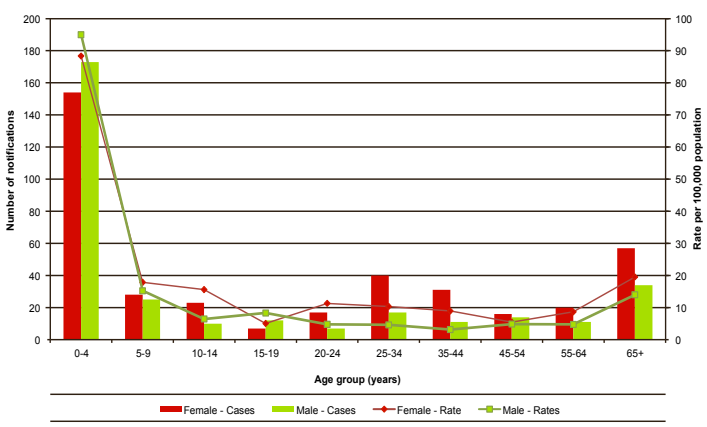

Figure 5. Age-sex distribution VTEC notifications, Ireland, 2014

Similar to 2013, animal/environmental contact was reported as the second most common route of transmission for VTEC outbreaks in 2014. This has long been recognised as a risk factor for VTEC infection[8-9] and cases due to this transmission route are not unexpected in Ireland given the large cattle population, the high proportion of rural dwellers, and the large number of farming families. Fortunately, none of these animal contact outbreaks were associated with public venues such as open farms, and so the numbers of people affected were small. Advice is available on the HPSC website on how to minimise the risk of gastrointestinal infections following exposure to farm animals and environments, and for the safe recreational use of farmland.[12]

In 2014, contaminated drinking water contributed to a similar number of outbreaks as 2013. As in previous years, the majority of the drinking water associated outbreaks reported were linked with private water supplies. Exposure to water from contaminated untreated or poorly treated private water supplies has historically been recognised as a strong risk factor for VTEC infection in Ireland.[6,7] This has been particularly pronounced following periods of heavy rainfall. The HSE and EPA have both developed resources for owners of private wells, providing advice on private well maintenance.[13-14]

Transmission by person-to-person spread, however, remained the most common transmission route reported in VTEC outbreaks and was involved in 54% of outbreaks. As usual, person-to-person spread was most frequently associated with private house and childcare facility outbreaks. Handwashing and exclusion of cases in risk groups from high risk settings remains a key prevention measures for VTEC.[15]

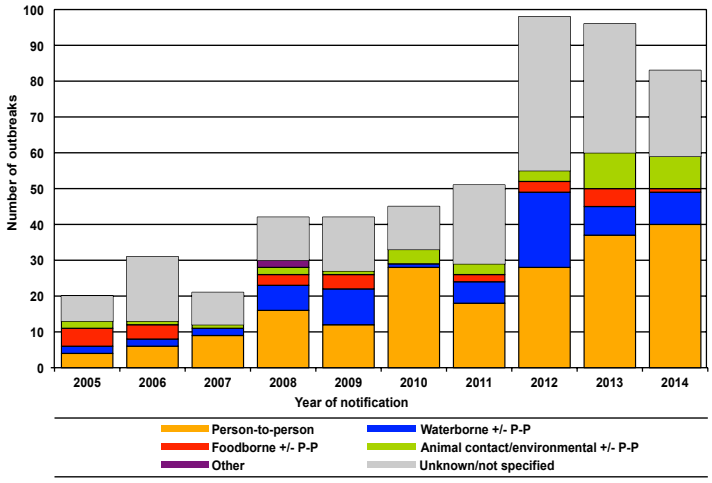

Figure 6. Number of VTEC outbreaks by suspected transmission route and year, Ireland 2005-2014

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 other 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.

Table 6. VTEC outbreaks by suspected mode of transmission, Ireland, 2014

Transmission Route	Number of outbreaks	Number ill	Number of associated CIDR Events
Person-to-person	40	124	166
Foodborne	1	3	5
Person-to-person and foodborne	0	0	0
Waterborne	7	12	15
Person-to-person and animal contact	3	9	8
Person-to-person and waterborne	2	7	8
Animal contact	3	2	6
Environmental / fomite	3	5	8
Foodborne and animal contact	0	0	0
Unknown	22	37	55
Not specified	2	3	4
Total	**83**	**202**	**275**

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