



National Outbreak of *Escherichia coli* O157

Phage Type 32 in Scotland

September - October 2015

Report of the Incident Management Team

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1. Introduction

On Wednesday 30 September 2015, Health Protection Scotland (HPS) were informed by the Scottish *E. coli* O157 / VTEC Reference Laboratory (SERL) of six cases of *E. coli* O157 Phage Type (PT) 32 with an indistinguishable Multilocus Variable Number Tandem Repeat Analysis (MLVA) pattern. This MLVA pattern had not been seen in Scotland since MLVA typing of *E. coli* O157 began in December 2012. The cases were from three different NHS boards. Four of the cases were from within one household. Further investigations were initiated and a Problem Assessment Group (PAG) was scheduled to take place on the morning of Friday 2 October. On Thursday 1 October a further case of *E. coli* O157 PT 32 (MLVA awaited) was reported from another NHS board area and on Friday 2 October an outbreak was declared and an Incident Management Team (IMT) was formed to investigate and manage the incident. The IMT was led by HPS and included representation from the relevant NHS board health protection teams, the SERL and Food Standards Scotland (FSS). In total twelve cases of *E. coli* O157 PT 32 were identified in relation to this incident. Following its investigations, the IMT concluded that the most likely source of the outbreak was venison products which had been purchased raw and cooked at home.

This report describes the investigation and findings of the IMT and the control measures implemented, and sets out the lessons learned and recommendations from this incident.

2. Background

Verotoxigenic *Escherichia coli* (VTEC) are a group of toxin-producing bacteria which cause gastrointestinal illness in humans. In most European countries, including Scotland, the most common strain of VTEC to cause illness is *E. coli* O157. The reported rates of *E. coli* O157 in Scotland rose substantially in the mid 1990s and remain consistently high compared to other countries within the UK and Europe. In 2014, a total of 275 reports of *E. coli* O157 were made to HPS, of which 263 were faecal culture positive cases¹.

The incubation period for VTEC infection is usually three to four days, seldom less than one day or more than eight, but has been occasionally reported to be as long as 14 days². VTEC infection can be asymptomatic or cause a spectrum of illness from mild non-bloody diarrhoea, through bloody diarrhoea and haemorrhagic colitis, to haemolytic uraemic syndrome (HUS), other presentations of thrombotic microangiopathy (TMA) and even death. Children under 16 years old and adults over 60 years old are more likely to develop VTEC-

related HUS than those in the intervening years². A study of 2,228 *E. coli* O157 cases reported in Scotland between 1999 and 2008 found that 196 (9%) of cases developed HUS. The same study found that over 50% of reported cases had bloody diarrhoea and 41% were hospitalised for at least one night during their illness².

VTEC can colonise the gastro-intestinal tracts of healthy farmed, wild, and domesticated animals and birds and can be shed in their faeces. Cattle are considered to be the most important reservoir for VTEC infection in humans; however other ruminants such as sheep, goats and deer can also act as reservoirs of infection³⁻⁵.

Transmission to humans can occur as a result of direct contact with VTEC-contaminated faecal material, from handling or petting animals or by exposure to faecally contaminated soil or vegetation during recreational activities. Exposure can also occur from consumption of water or food which is contaminated. Fruit and vegetables can be contaminated if they come in contact with soil, animal faeces or manure which contains VTEC. The use of contaminated water for irrigation of food crops and washing of fruit and vegetables has also been identified as a transmission route for VTEC. Food of animal origin may be contaminated during milking (milk and dairy products) or during the slaughter process (meat and meat products). The carcass of the animal may become contaminated with VTEC in the abattoir due to exposure to organisms on the hide or in the animal's gut. This contamination by micro-organisms such as *E. coli* O157 can therefore occur on the surface of whole cuts of meat. The inside of a cut of meat will rarely contain *E. coli* O157 as the organism will not penetrate the meat significantly. This explains why serving steaks or joints of meats such as beef or lamb "pink" or rare is generally not discouraged as the cooking process, correctly adhered to, will kill any bacteria present on the surface of the beef. Where meat is ground, as used in the preparation of burgers, the potentially contaminated surface of the meat is mixed throughout the product mass. This is why it is advised that minced products should be fully cooked and not served "pink"⁶.

3. Investigation

3.1 Epidemiological investigation

3.1.1 Case definitions

Case definitions were agreed by the IMT and were classified as confirmed, probable or possible using the following criteria:

Cases must have been resident in Scotland for part or all of the seven days before onset of symptoms and have a date of onset on or after 11 September 2015.

Confirmed case

An individual with confirmed infection with *E. coli* O157 PT 32 of the outbreak MLVA profile
or

An individual with confirmed infection with *E. coli* O157 PT 32 with a difference from the outbreak MLVA profile at only one locus (single locus variant)

Probable case

An individual with confirmed infection with *E. coli* O157 PT 32 for which MLVA profile is awaited.

Possible case

An individual with symptoms compatible with *E. coli* O157 with an epidemiological link to a confirmed case.

or

An individual with a local diagnostic laboratory report of *E. coli* O157 infection.

3.1.2 Case finding

Case ascertainment was through reports of *E. coli* O157 PT32 and the subsequent MLVA profile from the SERL. Public Health England (PHE) had recently discontinued routine MLVA typing of VTEC isolates replacing this with whole genome sequencing (WGS). The outbreak isolate was therefore sent to the PHE Gastrointestinal Bacteria Reference Unit (GBRU) to allow comparison by WGS with any *E. coli* O157 PT32 cases identified in the rest of the UK.

Close contacts of confirmed cases were screened where indicated in line with Scottish guidance for the management of VTEC in Scotland⁷.

3.1.3 Questionnaires and case interviews

All cases of VTEC infection reported to health protection teams in Scotland are interviewed by the local health protection team or environmental health colleagues as part of the routine response to VTEC infections. These interviews are conducted on the same day as notification (or as soon as possible thereafter) using locally developed enteric disease questionnaires. HPS obtained copies of the completed enteric questionnaires for all cases and four of the initial cases were also re-interviewed using a longer and more in-depth trawling questionnaire which had been developed by PHE for use in outbreak investigations. The trawling questionnaire asked about a wide range of exposures in the seven days prior to the onset of symptoms in the case including travel, events or functions attended, recreational and outdoor exposures as well as a very detailed food history. Based on the results of the initial trawling questionnaires, an additional more focussed questionnaire was developed which collected more information in relation to the purchase, preparation and consumption of a number of items (venison, beef mince and vegetables) which had been identified through the trawling questionnaires as being of particular interest in relation to this outbreak.

3.1.4 Timeline of events

The time line of events is summarised in table 1.

On Wednesday 30th September, HPS were informed by the SERL of six cases of *E. coli* O157 PT32 verotoxin 1 gene negative, verotoxin 2 gene positive with an indistinguishable MLVA pattern. The cases were from three NHS board areas. This MLVA pattern had not been seen in Scotland since MLVA typing began in December 2012. *E. coli* O157 PT32 is one of the more uncommon phage types identified in Scotland with only 17 cases reported in the whole of 2014. Prior to this outbreak the last case of PT32 in Scotland had been reported at the start of August 2015.

Four of the reported cases were from within one household, one of whom was asymptomatic and two were secondary cases. The other two cases were from different NHS boards. Copies of the routine enteric disease investigation forms for the cases were requested from the NHS board health protection teams and a PAG arranged for the morning of Friday 2

October. Examination of the routine enteric forms did not identify any common factors between the three primary cases and so, to obtain a more accurate exposure history, it was agreed that an in-depth trawling questionnaire would be administered to the symptomatic primary cases.

Between Wednesday 30 September and the morning of Friday 1 October HPS was notified of a further three cases of *E. coli* O157 PT32 (MLVA typing awaited). This brought the total to nine cases (six confirmed and three probable). Of these, six were considered to be primary cases, two secondary cases and one was asymptomatic. A PAG was held, an outbreak declared, and an IMT was formed to investigate and manage the incident. This was led by HPS with representation from HPS, NHS board health protection teams, the SERL and FSS. The membership of the IMT expanded over the length of the incident to include representatives from local authority environmental health services and PHE and is listed in full in Appendix 3. At this point FSS also activated their incident management plan to coordinate the operational aspects of the FSS response. The FSS representative on the HPS-led IMT acted as a liaison between these two teams.

By the evening of Friday 2 October information from the first four completed trawling questionnaires indicated that all four cases had eaten venison products prior to the onset of symptoms. Further IMTs were held on Saturday 3 October, and by 3pm that day it had been established that five of the six primary cases had eaten venison products which had been purchased raw and cooked in the home. It had not been possible to contact the sixth primary case and so their exposure history was unknown. The venison products had been purchased at various supermarket outlets across Scotland and included sausages, grill steaks, meatballs and steak. The IMT agreed that there was sufficient evidence linking this outbreak to the handling or consumption of venison products and a pro-active press statement was therefore issued by the IMT, alerting the public to the outbreak and emphasising the importance of the safe handling and cooking of venison products in the home.

At this stage of the investigation, four of the cases had reported eating venison products from ranges manufactured by a single Food Business Operator (FBO). FSS therefore initiated contact with the FBO and commenced investigations into its venison production and supply chains.

A further IMT was held on Monday 5 October, by which time the three probable cases had been confirmed as having the outbreak MLVA profile, bringing the total to nine confirmed cases. Following the IMT, FSS issued an advice notice informing consumers of the names

and use by dates of the relevant venison products and reinforcing the importance of safe handling and cooking of these products to avoid infection. A similar notice was issued by the Food Standards Agency in England as the FBO was known to supply some of its product range to outlets in England.

In total twelve confirmed cases of *E. coli* O157 PT32 with the outbreak MLVA profile were identified in relation to this outbreak. All were Scottish residents. Nine were primary cases, two were secondary cases and one case was asymptomatic. All of the nine primary cases had eaten or handled venison products purchased raw and cooked in the home. The secondary and asymptomatic cases were members of the same household of a confirmed case. The outbreak was declared over on 22 October 2015.

Table 1: Time line of Events

30 September 2015	HPS informed of six cases of <i>E. coli</i> O157 PT32 with an indistinguishable MLVA profile. Investigations initiated and PAG arranged
1 October 2015	Further case of <i>E. coli</i> O157 PT32 reported – MLVA awaited
2 October 2015	Further two cases of <i>E. coli</i> O157 PT32 reported – MLVA awaited PAG held, outbreak declared and IMT formed. Alert issued to NHS boards in Scotland
3 October 2015	IMT held First press statement issued by HPS (further statements issued 6, 8 and 16 October)
4 October 2015	Contact made with FBO and investigations initiated
5 October 2015	IMT held Nine confirmed cases with the outbreak MLVA FSS issue advice to public
8 October 2015	IMT held Further case confirmed = ten confirmed cases.
15 October 2015	IMT held Further case confirmed = eleven confirmed cases
22 October 2015	IMT held Outbreak declared over
29 October 2015	Further case confirmed * = twelve confirmed cases

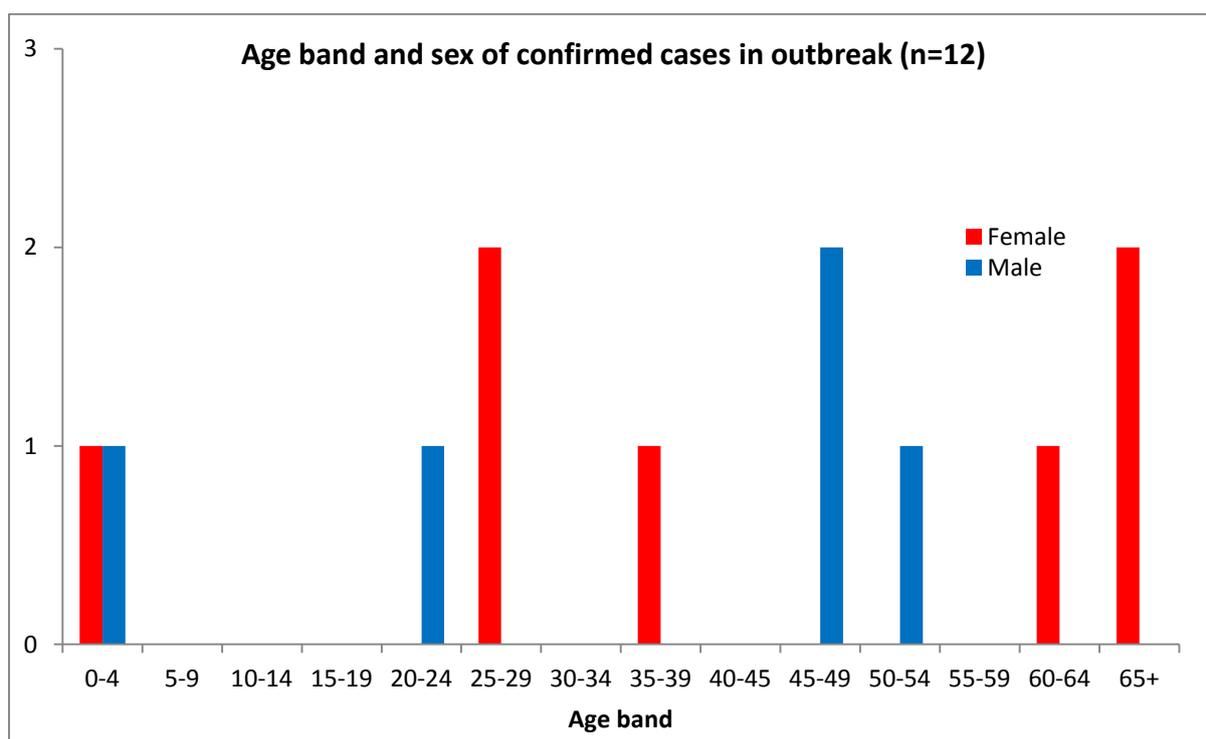
*This case was identified after the outbreak was declared over. However, this case had purchased venison products during the same time frame as the other cases; these products were then frozen following purchase and consumed at a later date

3.1.5 Demographics

Age and sex

Seven cases were female and five cases were male. The age of the cases ranged from three years to 81 years, with a mean of 40 years and median 41 years (figure 1).

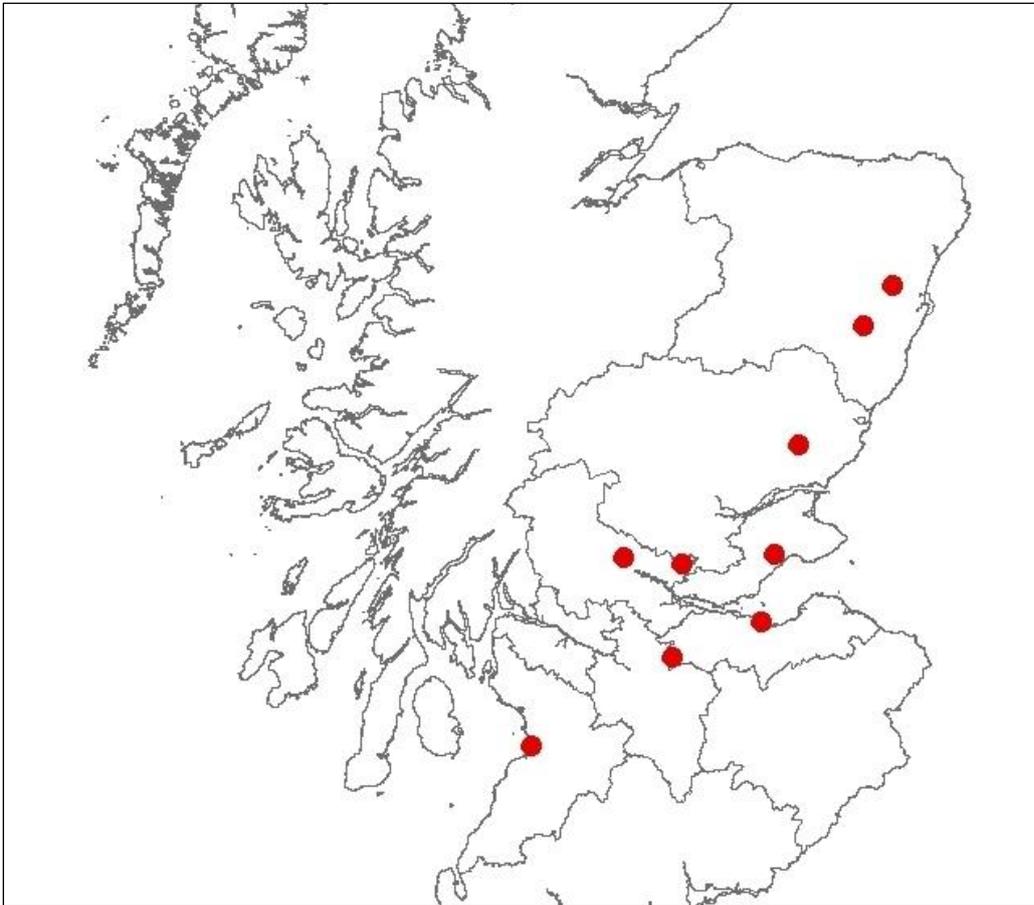
Figure 1: Age and sex of confirmed cases



Geographical distribution.

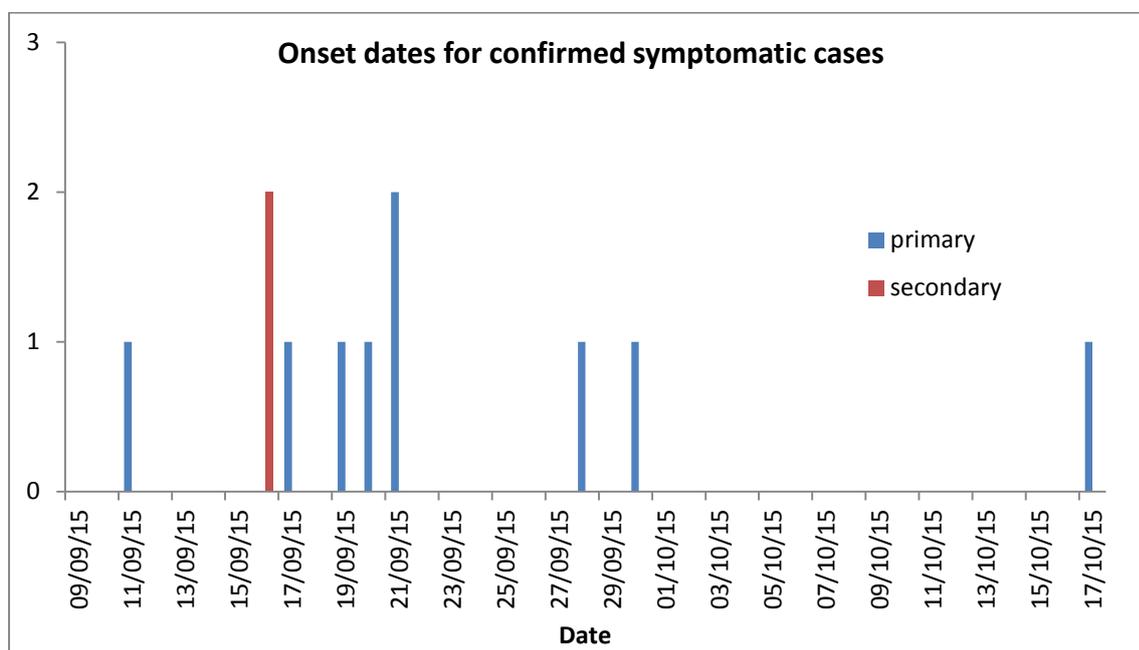
Confirmed cases were reported from six NHS board regions across Scotland – Ayrshire & Arran (4), Fife (1), Forth Valley (2), Grampian (2), Lothian (2) and Tayside (1). See figure 2 for map of primary cases.

Figure 2: Map of confirmed primary cases by NHS board of residence (n=9)



3.1.6 Epidemic curve

Dates of onset ranged from 11 September 2015 to 17 October 2015 (see figure 3). The last case (date of onset 17 October) consumed venison products purchased during the same time frame as the other cases; however these had been frozen following purchase and eaten at a later date. Of the remaining eight primary cases onset dates ranged from 11 September to 30 September.

Figure 3: Epidemic curve for date of onset of primary and secondary cases

3.1.7 Clinical presentations

Five of the twelve cases were admitted to hospital. All cases subsequently recovered and were discharged. One case was asymptomatic. Of the nine cases for whom symptom information was available, nine reported diarrhoea (six bloody diarrhoea), eight reported abdominal pain, five reported fever and three cases reported vomiting.

3.1.8 Food histories

Initial analysis of the enteric forms from the first three primary cases did not identify any common exposure. Given the unique MLVA profile of the isolates which had arisen over a short period of time, HPS requested that a trawling questionnaire be administered to the primary cases. Between 30/9/15 and 2/10/15 four primary cases were interviewed using the trawling questionnaire. None of the cases had been abroad or had attended any common restaurants or other venues.

A number of food items were identified as being of interest as they were considered to be plausible vehicles for the transmission of *E. coli* O157 and had been consumed by the majority or all of the cases. These were venison products, beef mince, potatoes, carrots and

onions. The IMT agreed that venison was of particular interest as it had been consumed by all four cases, which was more than expected given that venison would not be considered a commonly eaten food. From this information a more focussed questionnaire with additional questions regarding venison, beef mince, potatoes, carrots and onions was developed to be completed for the primary cases; the questionnaire asked about the brands, purchase dates, consumption dates and cooking of these products. It was agreed that the focussed questionnaire would also be administered to any new cases of *E. coli* O157 in addition to the standard local enteric disease investigation form. In order to expedite investigations, this was done without waiting for phage typing or MLVA results.

The focussed questionnaire was completed for eight of the nine primary cases (table 2). The ninth case was identified and interviewed after the outbreak was declared over and so a focussed questionnaire was not completed. All nine of the primary cases reported having consumed and / or handled venison products in the seven days before onset of their symptoms (table 3). These had been purchased raw and cooked in the home. Of the nine cases, eight had consumed venison, and one case had not eaten venison themselves but had handled and cooked raw venison within the household. Eight of the nine primary cases reported that the venison products they consumed or handled were from ranges manufactured by a single Food Business Operator (FBO). Of these, five reported consuming products made from wild venison from a particular range which is only sold within Scotland.

In order to put the consumption of venison reported by the primary cases into context, PHE interrogated their VTEC enhanced surveillance database to determine what proportion of historical VTEC cases in England had reported venison consumption in the seven days prior to onset of symptoms. The PHE VTEC enhanced surveillance system collects exposure information on all VTEC cases notified in England, including a detailed food history. Information on venison products is captured on the enhanced surveillance questionnaire under the 'other meat e.g. game' category. Of approximately 6000 laboratory confirmed cases notified to PHE since the enhanced surveillance began in 2009, 30 (0.005%) reported eating venison in the seven days prior to onset of symptoms. Although it was recognised that there could be some under ascertainment of venison consumption through the enhanced surveillance questionnaires, the IMT agreed that this data provided strong evidence in support of venison products being the source of the outbreak.

Table 2: Summary of food exposures from focussed questions (n=8)

Food item	Number consumed/handled
Venison	8/8
Mince	6/8
Potatoes	7/8
Onion	6/8
Carrots	6/8

Table 3: Venison products consumed or handled by confirmed primary cases (n=9)

Food	Number consumed/handled*
Venison sausages	8
Venison grillsteaks	4
Venison steak	2
Venison meatballs	1

*Some cases reported eating more than one product

3.2 Environmental investigation

On 4 October 2015, FSS contacted the Food Business Operator (FBO) in order to make them aware of the outbreak and the possible link to venison products that it manufactured and to advise that an investigation into processes and production at the FBO's premises was required. These premises are approved and inspected by FSS. Their previous audit result was good and the premises were considered to operate to the standards required by food safety regulations.

On 5 October 2015, an on-site inspection was carried out by FSS. During the on-site inspection FSS reviewed how the plant processes and produces its products, its storage facilities, and HACCP procedures. A review of traceability and microbiological sampling was also carried out. The FBO cooperated fully with the investigation and the prompt implementation of recommended control measures.

The on-site inspection found that production hygiene, structure and maintenance were generally of a high standard; however systems employed during carcase processing by the

FBO were noted to present a potential cross-contamination risk and the FBO procedures were adjusted and improved immediately to minimise future risk.

During the inspection it was ascertained that the FBO had been carrying out fortnightly routine testing of their products in line with regulatory requirements set out in Regulation (EC) 2073/2005 on microbiological criteria for foodstuffs. This regulation provides standards which can be used by food businesses to help them to validate and verify their food safety management procedures. It includes criteria for enterobacteriaceae and *E. coli*ⁱ as indicators for assessing the effectiveness of hygiene controls for meat carcasses, minced meat and meat preparations. The Regulation does not include a specific requirement to test raw meat for VTEC.

A review of testing carried out by the FBO identified an unsatisfactory *E. coli* result from a raw sausage sample (product made from wild venison) which had been tested on 17 September 2015. *E. coli* is indicative of faecal contamination; however its presence is not unexpected in the manufacture of raw meat products.

As a result of the unsatisfactory result the FBO had tested two further identical products with the same use by dates, both of which were negative for *E. coli*. The corrective action in response to such situations is to increase sampling to weekly, however this was not done. At the request of the IMT, stored samples of the raw sausage from which *E. coli* was isolated on 17 September were re-tested by an accredited food laboratory. This showed that *E. coli* O157 was not detected.

Environmental swabs and food samples were taken at the FBO premises as part of the inspection process. All were found to be negative except for samples taken from the cutting table and its associated drain. These showed the presence of *E. coli* O157; however this was of a different phage type than the outbreak strain. Again, this was not a wholly unexpected finding as these samples were taken from areas where raw meat was being processed. Further swabs taken following deep cleaning of the premises showed an absence of *E. coli*.

The FBO provided validation records for the cooking instructions provided on the packaging of each of their raw venison products. The validation records showed that the cooking instructions were adequate for ensuring these products reached the desired temperature to

ⁱ Such testing will identify the presence of *E. coli* bacteria but does not distinguish between toxigenic and non-toxigenic strains

eliminate pathogens as recommended by the Advisory Committee on the Microbiological Safety of Food (ACMSF).

3.3 Microbiological investigation

3.3.1 Faecal samples

Faecal samples from symptomatic individuals were submitted to local diagnostic laboratories for culture and presumptive isolates of *E. coli* O157 were then forwarded to the SERL for confirmation and typing. Faeces testing negative at the local diagnostic laboratory but from individuals with symptoms suggestive of a verotoxin-producing *E. coli* (VTEC) infection or from symptomatic contacts of known cases, were also forwarded to the SERL for more sensitive testing in line with current Scottish guidance⁷.

All *E. coli* O157 isolates were sub-typed using phage typing, verotoxin PCR testing and MLVA. At the beginning of October 2015 PHE discontinued MLVA typing and replaced it with WGS. Therefore, in order to compare PT 32 strains in Scotland with isolates from any cases in England & Wales, the Scottish outbreak strain was sent to PHE for WGS.

Typing results identified twelve cases of infection, sharing the same phage type (PT 32), verotoxin gene profile (*vtx1* negative, *vtx2* positive) and the same MLVA profile. SERL commenced routine MLVA typing in December 2012, and has a database of approximately 850 *E. coli* O157 MLVA entries. This particular MLVA profile was unique to the database so this strain had not been observed in Scotland since December 2012. WGS analysis of the Scottish outbreak strain by PHE revealed that this strain did not match any isolates in England & Wales.

3.3.2 Food samples

In addition to the food samples taken from the FBO premises which tested negative for VTEC, eight samples of products manufactured by the FBO were collected from point of sale by local authority Environmental Health Officers, and a further sample of venison sausages was collected from the home of one of the cases. Although none of these tested positive for *E. coli* O157, non-O157 VTEC strains were isolated from four of the samples.

4. Risk management

4.1 Care of cases

All cases were given advice on measures to reduce secondary spread including hand washing and hygiene advice. In addition, contacts of cases were screened where appropriate in line with national guidelines⁷. Where indicated, cases and / or their contacts were excluded from work or educational / care settings as per national guidelines.

4.2 Advice to the public

By the end of the afternoon of Saturday 3 October it had been established that five out of six primary cases had eaten venison products prior to the onset of their symptoms. The IMT agreed that there was now strong evidence linking the outbreak to venison products with the most likely hypothesis being that the cases became infected through either cross contamination or undercooking of a contaminated raw venison product in the home. It was agreed that a press statement should be issued alerting the public to the outbreak and providing advice on thorough cooking of venison products and on hand hygiene and safe food preparation to reduce the risk of further infections.

Based on information on purchase and consumption dates provided by the cases and manufacturing dates supplied by the FBO, FSS were able to identify the product ranges, batches and use-by dates most likely to be implicated in the outbreak. It was determined that, given the use-by dates, these products would no longer be on sale in retail premises; however it was recognised that some people may have these venison products stored in their freezers at home. The FSS therefore issued an advice notice informing consumers of the affected products and reinforcing the importance of safe handling and cooking of these products to avoid infectionⁱⁱ. The FBO also issued their own advisory statement on their website.

4.3 Actions taken in relation to the FBO

The FBO voluntarily suspended production of its venison products for retail to allow the investigation to take place. Production restarted following a series of deep cleans and negative environmental sampling taken at the premises.

ⁱⁱ <http://www.foodstandards.gov.scot/news/advice-consumers-regarding-certain-raw-venison-products>

In addition, based on the assumption that wild venison presents a higher theoretical risk of VTEC contamination than farmed venison, the FBO ceased the use of wild venison whilst it reviewed its HACCP and procedures for the dressing of large wild game in line with guidance provided by FSS. The FBO also reviewed and changed its procedures and frequency for microbiological sampling in line with guidance provided by FSS.

It was noted during the outbreak investigation that some raw products were packaged together with sachets of sauce. This was recognised as a possible source of cross contamination. As a result of learning from this outbreak, the FBO now vacuum packs raw meat products and sauces separately to reduce the risk of cross contamination.

5. Communications

On 2 October 2015 a HPS Health Protection Alert was issued to NHS board health protection teams, NHS microbiologists, and the health protection team of the Scottish Government Health and Social Care Directorate. The Health Protection team at Scottish Government were kept updated on the investigation and actions taken throughout the outbreak.

A proactive press statement was released by HPS on 3 October 2015 advising the public of the outbreak and measures to take to reduce the risk of infection. Further press statements with updated case numbers were issued on 6, 8 and 16 October. HPS and FSS also provided television interviews on 6 October.

On 5 October FSS released advice to consumers identifying the implicated venison products and providing advice on the preparation and cooking of venison and on measures to reduce cross contamination within the home.

NHS24 were briefed on the incident in case they received any calls following the media coverage.

FSS issued a note to Scottish Government Ministers on 8 October 2015 to update them on the incident and actions taken. The FSA issued a similar note to ministers in other parts of the UK to make them aware of the issue.

6. Discussion and conclusions

Twelve cases of infection with the same strain type of *E. coli* O157 PT32 as confirmed by MLVA were identified in this outbreak. Epidemiological investigation of the cases indicated that all the primary cases had consumed or handled venison products purchased raw and cooked in the home prior to the onset of illness. One case was identified after the outbreak was declared over. Analysis of the supermarket loyalty card of this case revealed that they had purchased venison products during the same time frame as the other cases. These had then been frozen at home and consumed at a later date. One case reported that they did not eat venison products themselves however they did handle and cook venison products within the home. This highlights the importance of the issue of cross contamination within the kitchen setting.

The conclusion of the IMT was that the source of this outbreak of *E. coli* O157 was raw venison products purchased for consumption in the home. Subsequent under-cooking or cross contamination within the home could then have led to infection in the cases. All but one of the cases reported consumption or handling of minced venison products (sausages, grill steaks or meatballs). This is in keeping with known risks associated with such products and reinforces the need for thorough cooking of these products to render them safe to eat. The majority of cases in this outbreak reported that they had cooked these products thoroughly and one case had only handled the products and not consumed them. It is likely therefore that cross-contamination within the home played a role in this outbreak.

Despite it being accepted that raw meat products such as venison may be contaminated with VTEC and associated outbreaks having been reported^{5,8,9}, outbreaks of this kind are not seen commonly in Scotland. It is possible therefore that the implicated product batches in this outbreak were particularly heavily contaminated with *E. coli* O157 presenting a greater risk of infection than is usual for a raw meat product. There is evidence from cattle studies to suggest that supershedding of VTEC by individual animals can occur¹⁰. If these animals were to then enter the food chain it is possible that this could result in higher loads of VTEC in raw meat products. As animals which carry VTEC do not display symptoms of infection it would not be possible to identify such supershedders and remove them from the food chain. An alternative hypothesis is that wild deer pose a greater risk of VTEC contamination due to the way in which they are shot and dressed in the field. The measures taken by the FBO to review their HACCP and procedures for the dressing of large wild game will help to mitigate this risk in future.

Although food samples taken in relation to this outbreak were not found to contain *E. coli* O157, non-O157 VTEC strains were isolated from a number of the samples. This finding provides further evidence that raw venison products can contain verotoxigenic *E. coli* and reinforces the importance of safe handling and adequate cooking of these products within the home to reduce the risk of *E. coli* O157 and other VTEC infections.

7. Lessons learned and recommendations

A debrief meeting was held in February 2016 with representation from HPS, FSS, the SERL, and NHS board health protection teams. The meeting was chaired by HPS and participants were asked to consider what went well, and what didn't go well in relation to the incident and to make recommendations for improvement as appropriate. The following key learning points were identified and related recommendations made:

Learning Point:

There was good inter-agency cooperation and participation in the IMTs, including those held over the weekend. However this was a fast moving investigation with information being updated on a regular basis and at times communication of accurate and up-to-date information from the IMT to the FSS incident team was challenging.

Recommendation:

A brief situation summary and action notes should be distributed to IMT members as soon as possible after each meeting, with the full IMT minutes to follow in due course.

An epidemiologist/consultant from HPS should be invited to attend internal FSS incident meetings to help explain the epidemiology of the incident and decision making of the IMT.

Learning point:

The prompt completion and return of questionnaires allowed quick identification of the source of the outbreak. However the trawling questionnaire was found to be long and repetitive, taking up to two hours to complete in some instances.

Recommendation

HPS to review and refine the VTEC trawling questionnaire for use in future incidents.

Learning point:

The inclusion of sachets of sauce inside packaging next to raw meat products may increase the risk of infection through cross-contamination. This practice was discontinued by the FBO concerned; however it may exist in products produced by other FBOs

Recommendation:

FSS and Local Authorities should collect intelligence on the availability of raw meat products on the market which include sachets of sauce inside the packaging. Depending on the findings of this exercise, consideration should be given to the need for improved guidance to deter relevant food businesses from packaging sauce sachets next to raw meat due to the potential for cross contamination.

Learning point:

The use of subjective measures to determine whether minced meat products are thoroughly cooked – such as cooking until the product is no longer pink inside – may not be adequate, especially where additional ingredients which give the meat a pink appearance have been added making it difficult for the consumer to tell if the product is cooked or not.

Recommendation:

FSS should promote the use of meat thermometers as the most reliable way to tell if minced meat preparations are adequately cooked and therefore safe for consumption.

Learning Point:

Press statements advising the public of the outbreak and measures to take to reduce the risk of infection were issued promptly and appropriately. However, the initial statement that all deer meat should be cooked thoroughly and not eaten medium or rare went beyond established food safety advice. Whilst this advice is appropriate for minced products such as sausages and grill steaks, whole cuts of red meat can be served medium or rare as long as they have been seared on the outside to remove surface contamination. This statement resulted in FSS receiving enquiries from consumers and manufacturers seeking clarification on appropriate food safety measures for these products.

Recommendation:

Drafting of consumer messaging for outbreak communications should be streamlined through the development of a set of pre-agreed statements on the safe handling and preparation of various food products which can be taken off the shelf and adapted for use during outbreak situations.

Learning point:

Real time PCR testing by the Tayside Scientific Services Public Analyst laboratory was helpful in relation to this outbreak investigation as it enabled local detection of VTEC in the environmental swabs and raw venison product samples submitted to the Public Analyst for testing. However, PCR testing is not currently provided by all Public Analyst laboratories used by local authorities in Scotland.

Recommendation:

Official food and feed control laboratories used by local authorities in Scotland should consider the provision of PCR testing (ISO/TS13136:2012) capability for foodstuffs and other relevant samples to support future outbreak investigations.

Learning point:

During the course of this outbreak, the PHE GBRU in Colindale replaced routine MLVA typing with whole genome sequencing (WGS). Therefore, in order to determine if the outbreak strain of *E. coli* O157 PT 32 had been detected in the rest of the UK, the SERL had to send an isolate down to Colindale for WGS analysis and comparison. This process takes longer than MLVA typing so WGS results relevant to the outbreak investigation were not available until 22 October, the day that the outbreak was declared over. In this instance there were no cases identified elsewhere in the UK and so this did not affect the management of the outbreak. However, such delays could complicate and compromise the investigation, management and coordination of future UK-wide VTEC outbreaks.

Recommendation:

HPS should work with SERL to develop capability to begin WGS and analysis of VTEC isolates in Scotland as soon as is practicably possible. The necessity for rapid turnaround time during outbreak investigations should be a prime consideration.

Learning point:

Whilst VTEC risks in raw red meat such as beef are well established, incidents involving raw venison have been reported much less frequently. Although this outbreak was considered to be a rare event, investigations have highlighted the potential for raw venison to be contaminated by VTEC.

Recommendation:

FSS should work with the Scottish game industry to raise awareness of the potential risks associated with VTEC in venison and consider whether there is a need to review existing guidance across the sector.

Learning point:

One case presented after the outbreak was declared over. With their permission, the IMT was able to use data collected through their supermarket loyalty card to confirm the date of purchase and details of the venison product they had consumed. This was invaluable in establishing that the product had been purchased during the same time period as the other cases and therefore did not indicate ongoing contamination of the food product.

Recommendation:

Consideration should be given to utilising loyalty card information – where indicated and with appropriate consent – in future outbreak investigations where a particular food vehicle is suspected.

Appendix 1: References

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Appendix 2: Abbreviations

ACMSF	Advisory Committee on the Microbiological Safety of Food
FBO	Food Business Operator
FSS	Food Standards Scotland
GBRU	Gastrointestinal Bacteria Reference Unit (of PHE)
HACCP	Hazard Analysis and Critical Control Point
HPS	Health Protection Scotland
HUS	Haemolytic Uraemic Syndrome
MLVA	Multilocus Variable Number Tandem Repeat Analysis
IMT	Incident Management Team
NHS	National Health Service
PAG	Problem Assessment Group
PCR	Polymerase Chain Reaction
PHE	Public Health England
PT 32	Phage Type 32
SERL	Scottish <i>E. coli</i> O157 / VTEC Reference Laboratory
TMA	Thrombotic microangiopathy
VTEC	Vero-cytotoxin producing <i>Escherichia coli</i>
WGS	Whole Genome Sequencing

Appendix 3: Membership of the Incident Management Team

Health Protection Scotland	Gill Hawkins Syed Ahmed Lynda Browning Alison Smith-Palmer Arlene Reynolds Lynne Kidd John Schofield Lynn Stoddart	Consultant in Health Protection (Chair) Consultant in Health Protection (Deputy Chair) Senior Epidemiologist Senior Epidemiologist Senior Epidemiologist Head of Communications Communications Manager Administrative Support
Food Standard Scotland	Ryan Bruce Bryan Campbell Jacqui McElhiney Maria Tocher	Incident and Investigation Manager Senior Enforcement Manager Head of Food Protection Science & Surveillance Branch Senior Communications Manager
Scottish <i>E. coli</i> O157 / VTEC Reference Laboratory	Mary Hanson Lesley Allison	Director Deputy Director / Principal Scientist
NHS Ayrshire & Arran South Ayrshire Council	Billy Cullinane Brian Lawrie	Health Protection Nurse Specialist Environmental Health Officer
NHS Forth Valley Stirling Council Clackmannanshire	Pamela Scoular Colin Sumpter Henry Prempeh Sandra Fisher Lorraine McGillvary Helen Henderson	Health Protection Nurse Specialty Registrar Consultant in Public Health Medicine Environmental Health Officer Environmental Health Officer Environmental Health Officer
NHS Grampian	Diana Webster Lynn Byers	Consultant in Public Health Medicine Health Protection Nurse Specialist
NHS Lothian	Jenni Strachan Louise Wellington	Health Protection Nurse Specialist Health Protection Nurse Specialist
NHS Tayside	Lucy Denvir Daniel Chandler Tina McMichael Heather Paul Emma Baird	Consultant in Public Health Consultant in Public Health Medicine Health Protection Nurse Specialist Health Protection Nurse Specialist Specialty Registrar
Scottish Government Health Protection Team	Duncan McCormick	Senior Medical Officer
Public Health England	Richard Elson Claire Jenkins	Head of Risk Assessment and Response, Gastrointestinal Infections Deputy Head Gastrointestinal Bacteria Reference Unit

*Members listed attended all or some of the IMTs depending on their availability and the stage of the incident.