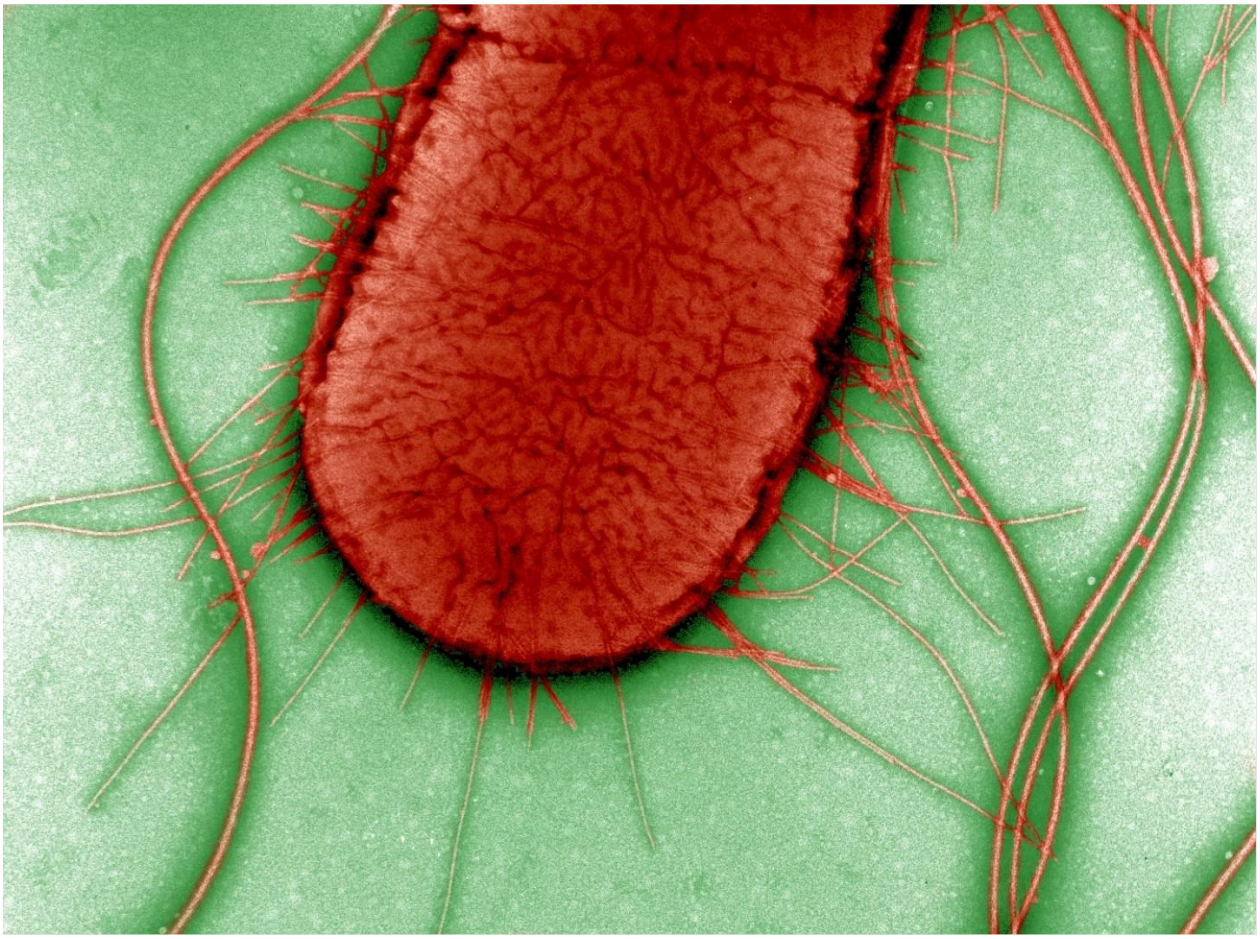
East Lothian (Haddington and Musselburgh) *Shiga toxin-producing E. coli* (STEC) Outbreak August to October 2022

Incident Management Team Report



September 2024

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2 Acknowledgements

The Co-chairs of the Incident Management Team (IMT) would like to acknowledge with much appreciation the crucial role played by partner agencies and institutions listed below in the investigation and control of the *E. coli* outbreak. The Co-chairs would also like to express their deepest appreciation to families, individuals, groups and communities whose cooperation made all the investigations and control of the outbreak possible. That includes the nurseries who agreed to voluntary closure while the outbreak was investigated.

A special thanks to parents and families who endured the exclusions and restrictions.

Healthcare

NHS Lothian Health Protection Team

NHS Lothian Public Health Business Support and Administration Team

NHS Lothian Clinical Microbiology Team

NHS Lothian Communications Department

NHS Lothian Royal Hospital for Children and Young People

NHS Lothian Regional Infectious Diseases Unit

NHS Lothian Public Health, Health Policy and Intelligence Teams

NHS Lothian Patient Experience Team

NHS Lothian TB Nurses

Mutual Aid from NHS Fife, NHS Grampian, NHS Western Isles, NHS Ayrshire and Arran, NHS Lanarkshire

Public Health Scotland GIZ Team, Consultants and Healthcare Scientists (Epidemiology)

Scottish *Escherichia coli* O157/STEC Reference Laboratory (SERL)

Government and Local Authority

Scottish Government Health Protection Division and Chief Medical Officer Division

East Lothian Council Education Department

East Lothian Environmental Health Team

Other Partners

The Care Inspectorate

Scotland's Rural College

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3 Abbreviations/Acronyms

Abbreviation	Full title
AHPN	Advanced Health Protection Nurse
cgMLST	Core Genome Multi-Locus Sequence Typing
CI	Care Inspectorate
CL	Containment Level
DNA	Deoxyribonucleic acid
DWQR	Drinking Water Quality Regulator
eae	Not an abbreviation – the name of a gene involved in attachment of *E. coli* to the epithelial linking of the intestine
E. coli	*Escherichia coli*
EH	Environmental Health
EHO	Environmental Health Officers
ELC	East Lothian Council
FAQ	Frequently Asked Question
FOI	Freedom of Information Request
FSS	Food Standards Scotland
GIZ	Gastrointestinal and Zoonoses (a specialist team in Public Health Scotland)
HPT	Health Protection Team
HSE	Health and Safety Executive
HUS	Haemolytic uremic syndrome
IMT	Incident Management Team
JSON	JavaScript Object Notation
MLST	Multi-Locus Sequence Typing
NHS	National Health Service
NSF	Non-Sorbitol Fermenter – an *E. coli* strain that does not ferment sorbitol. *E. coli* O157:H7, for example, are typically non-sorbitol fermenters.
PAG	Problem Assessment Group
PCR	Polymerase chain reaction – a test used in this context by microbiology labs to amplify specific bacterial genes
PHS GIZ	Public Health Scotland Gastrointestinal and Zoonoses Team
PHS	Public Health Scotland
RDNC	Reactions Do Not Conform
rfbO157	A gene used as a proxy for the presence of *E. coli* O157
RHCYP	Royal Hospital for Children and Young People
SBAR	Situation Background Assessment Recommendation (style of report summary)
SEPA	Scottish Environment Protection Agency
SERL	Scottish *E. coli* O157/STEC Reference Laboratory
SF	Sorbitol Fermenter – an *E. coli* strain that ferments sorbitol. Many *E. coli* strains, other than serotype *E. coli* O157:H7, ferment sorbitol. These include harmless *E. coli* and also most non-O157 STEC strains.
SMiRLWBP	Scottish Microbiology Reference Laboratories WGS Pipeline

Abbreviation	Full title
SNP	Core Single Nucleotide Polymorphism
SOP	Standard Operating Procedure
SRUC	Scotland's Rural College
ST	Sequence Type
STEC	Shiga toxin-producing *Escherichia coli*
*stx*1	Shiga toxin 1 gene
*stx*2	Shiga toxin 2 gene
UKHSA	United Kingdom Health Security Agency
UPGMA	Unweighted Pair Group Method with Arithmetic Mean (a clustering method that assumes a constant rate of evolution)
VTEC	Verocytotoxin-producing *Escherichia coli*
WGS	Whole Genome Sequencing
O157	A serogroup of *E. coli* defined by its 'O' antigen
non-O157	*E. coli* bacteria of a serogroup other than O157

4 Executive Summary

Introduction

A complex outbreak of Shiga toxin-producing *E. coli* (STEC) occurred in the local authority area of East Lothian between August and October 2022. Cases were associated with four nurseries in two towns: two branches of Pear Tree Nurseries in Haddington; and two branches of Musselburgh Private Nursery.

STEC infection can lead to serious morbidity and mortality, particularly in very young or elderly populations. This STEC outbreak was therefore treated as a public health emergency requiring prompt response and control measures.

Investigation

An Incident Management Team was formed on the day of notification of the second case, to investigate and put in place control measures to protect public health. Active case finding and environmental sampling were undertaken, surveillance forms completed, and microbiological testing conducted for all children and staff across the nurseries. All isolated organisms underwent Whole Genome Sequencing (WGS) analysis. A transmission network analysis was conducted to visualise common community exposures and examine potential links between cases.

Results

A total of 57 confirmed cases were identified which included 5 adults (9%) and 52 children (91%). Of the confirmed cases 51% reported no symptoms. An additional 75 probable cases were identified. Five children with confirmed STEC infection required hospital admission, one with early signs of haemolytic uraemic syndrome, but none of the cases required renal support. There were a further 9 symptomatic children with epidemiological links to the outbreak who required hospital admission, but who tested negative for infection.

Sampling did not identify *E. coli* O157 or non-O157 STEC in the nursery environment. Microbiological testing of the cases identified both *E. coli* O157 and non-O157 STEC. Whole genome sequencing (WGS) identified eight different strains of STEC with six different serotypes. Two of the strains were associated with two distinct *E. coli* O157 outbreaks at separate nurseries. All cases of O157:H7 (n=19) found were associated with one nursery, and 89% (n=17 of 19) of O157:H39 cases were associated with another of the nurseries. Smaller numbers of other STEC strains were identified across the four nurseries. Analysis of virulence factors demonstrated that Shiga toxin *stx*2a gene, found for example in O157:H7, was associated with the most severe illness (hospitalisation, bloody diarrhoea and haemolytic uraemic syndrome). Children attending the nursery with O157:H7 had an attack rate of 24%, while children attending the nursery with O157:H39 had an attack rate of 12%. In contrast the attack rates for children attending the other nurseries, and staff in all nurseries, were less than 1%.

Conclusions

Early identification of cases followed by immediate exclusion and communication to parents and guardians about the risks associated with STEC are likely to have controlled the spread of infection. The voluntary closure of the nurseries by their owners is also likely to have contributed to controlling the spread of infection. This was a complex outbreak that resulted in considerable disruption for families, communities, health and education services.

Since the level of asymptomatic carriage of *E. coli* O157/STEC in nursery age children in Scotland is unknown, these findings will be important when reviewing national STEC guidance.

The disruption caused by the outbreak generated anxiety in the community. The multi-pronged communication strategy deployed by the IMT comprised direct information to the parents and guardians, press releases and media interviews and aimed to provide clear, consistent and transparent communication and address concerns.

Recommendations

After the outbreak was declared over, a debrief was held and lessons were identified. Additional lessons were drawn from the experience of the co-chairs and members of the IMT. The main lessons identified were: the need for prompt detection and prompt management of cases; the importance of multiagency collaboration and working closely with nursery owners and families. In total 18 recommendations were made to improve future outbreak management and *E. coli* guidance including resource identification, availability, and effective management; joint training and development with partners; streamlining microbiological investigation processes and enhanced communication.

See Appendix 1 for full membership of the IMT.

5 Introduction

This report describes the investigation and management of an outbreak of Shiga toxin-producing *E. coli (*STEC) involving four nurseries in East Lothian between August - October 2022. Fifty-two children and five adults, all with links to the nurseries, tested positive for *E. coli* O157/STEC during the outbreak. This period overlapped with an unrelated UK-wide increase in STEC infections, particularly *E. coli* O157.

STEC infection can lead to serious morbidity and mortality, particularly in children, older people, and people with weak immune systems. Therefore, an STEC outbreak in a nursery is a public health emergency.

The first case of *E. coli O157* related to a Pear Tree Nurseries nursery in Haddington was notified to the Health Protection Team by NHS Lothian Microbiology on 29 July 2022 and was managed as per guidance.[1]

On 1 August 2022, an alert was then received from another Public Health Agency, regarding a child who had tested positive for *E. coli* O157. This child attended the same nursery as the previous case. An initial Problem Assessment Group took place 3 hours after this alert was received.

Incident Management Team (IMT) meetings took place three times between 2 August and 5 August 2022. The meetings were then held twice a week from 10 August to 14 September and then once a week from 20 September to 28 September 2022. All IMT meetings were conducted by video conferencing using Microsoft Teams, with relevant supporting documentation shared by email. IMT meetings were always chaired by a Consultant in Public Health. The last meeting of the IMT was held on 13 October 2022.

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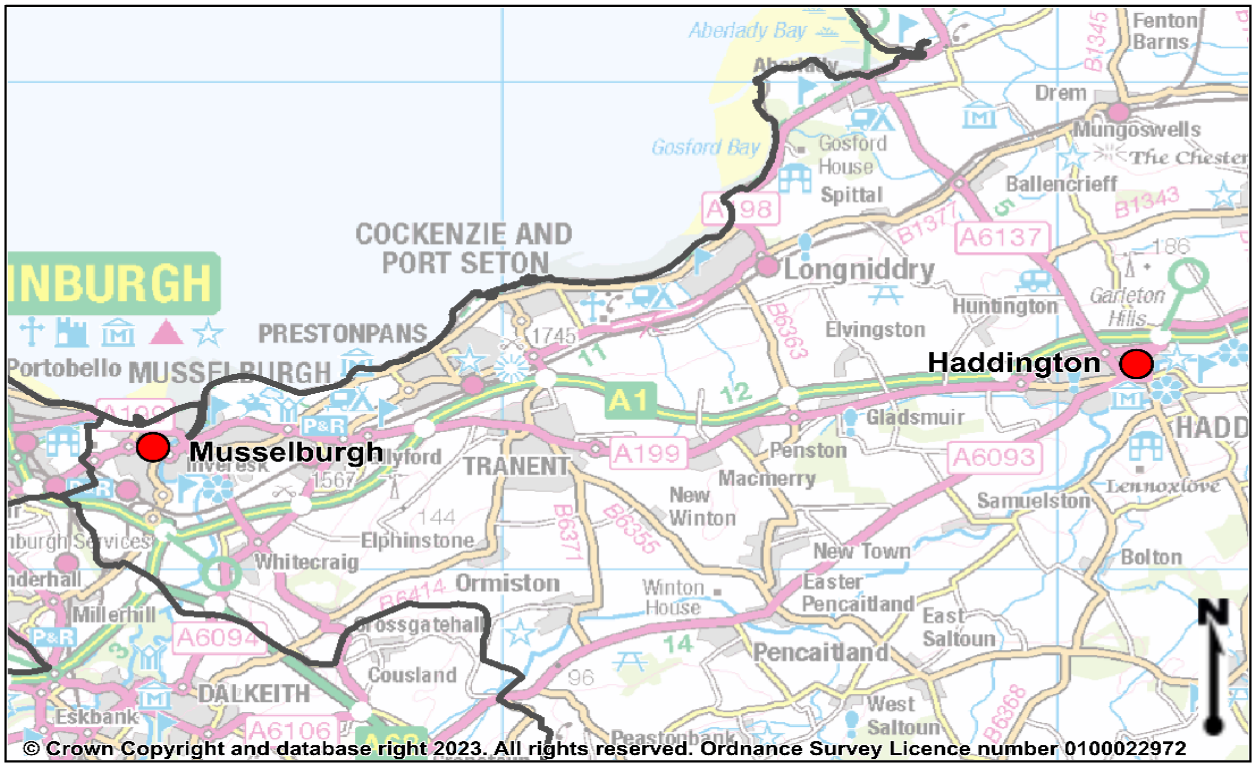
6 Background

6.1 Location of incident

East Lothian is predominantly rural with a population of approximately 105,000 people. The towns of Musselburgh, Prestonpans, Cockenzie and Port Seton, Gullane, North Berwick and Dunbar lie along 64km of coastline on the Firth of Forth. The two other large East Lothian towns are Tranent and Haddington, both of which are inland (Figure 1).

Figure 1: Map of relevant part of East Lothian showing the towns of Haddington and Musselburgh



Within East Lothian there are over forty nursery childcare providers. The nurseries initially identified with STEC cases were Pear Tree Nursery Church Street and subsequently Pear Tree Nursery Meadowpark*. These are operated by "Pear Tree Nurseries Ltd" and are both situated in Haddington. A further Pear Tree nursery in Haddington (West Road) had children with gastrointestinal symptoms, but they did not test positive for STEC infection. At the time of the outbreak these nurseries were in a funded partnership with East Lothian Council.

The two further nursery settings included in the outbreak investigation, in the neighbouring town of Musselburgh, are owned by Musselburgh Private Nursery Ltd. These are Musselburgh Private Nursery Bridge Street+ and Musselburgh Private Nursery Stoneybank Terrace. They are entirely separate from Pear Tree Nurseries Ltd.

* The official name for Pear Tree Nursery Meadowpark is "Pear Tree Nurseries Ltd". However, as this risks confusion with the company that owns these nurseries, this report uses Pear Tree Nursery Meadowpark or Pear Tree Nursery Church Street throughout.

+ The official name for the Musselburgh Private Nursery Bridge Street branch is "Musselburgh Private Nursery". However, for clarity, the two nurseries are referred to as Musselburgh Private Nursery Bridge Street and Musselburgh Private Nursery Stoneybank Terrace throughout the report.

6.2 Circumstances of this Outbreak

This outbreak was primarily related to preschool and nursery settings. Cases were associated with four nurseries in two towns in the rural local authority area of East Lothian (two in Haddington and two in Musselburgh). The two nurseries in Haddington were run by Pear Tree Nurseries Ltd. These two nurseries – Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark – had links between the nurseries (management, staffing and catering). These nurseries closed voluntarily during the outbreak.

There was a further Haddington nursery in the Pear Tree Nurseries Ltd group. This nursery – Pear Tree Nursery West Road – had symptomatic individuals and management, staffing and catering links to Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark. Pear Tree Nursery West Road also closed voluntarily, pending investigations. However, no cases of STEC infection were identified from the microbiological testing performed at Pear Tree Nursery West Road. Children in Pear Tree Nursery West Road were not formally excluded. As initial testing of symptomatic children did not detect STEC, there was no further microbiological testing in Pear Tree Nursery West Road.

A link between the nurseries in Haddington and one of the two Musselburgh Private Nursery Ltd nurseries in Musselburgh was then identified, with confirmed STEC infection in Musselburgh Private Nursery Bridge Street. As there were both staff and family connections between the Musselburgh Private Nursery Ltd nurseries, and symptomatic children and staff were reported in both these nurseries, both Musselburgh Private Nursery Ltd nurseries voluntarily closed pending further investigations. These were Musselburgh Private Nursery Bridge Street and Musselburgh Private Nursery Stoneybank Terrace.

The priority for managing any outbreak of infectious disease is to protect the health of the population. Prompt action to minimise the spread is crucial in controlling an outbreak and thus minimising harm to the population.

At the time of the outbreak, some children within the settings identified above were due to start at a variety of other nurseries for their pre-school nursery year, or Primary 1 in schools across East Lothian, Midlothian and Edinburgh.

The circumstances of this outbreak were unusual in that it was happening at the same time as an unrelated UK-wide increase in STEC infections, particularly *E.coli* O157 infections. The timing of the East Lothian outbreak was also at a point when the population was just becoming accustomed to the longer term lifting of COVID-19 pandemic related ‘lockdowns’.

6.3 Shiga toxin-producing *Escherichia coli* species

6.3.1 Escherichia coli (E. coli)

E. coli is a Gram-negative rod-shaped bacterium commonly found in the intestinal tract of healthy humans and animals. In most cases these are harmless. However certain types of *E. coli* pathotypes are harmful when ingested, causing people to develop gastrointestinal illness. Children, older people, and people with weak immune systems are particularly at risk of more severe forms of illness. Therefore, nursery populations are highly vulnerable and at risk of significant disease.

6.3.2 Shiga toxin-producing *Escherichia coli* (STEC)

STEC (previously known as verotoxin-producing *E. coli* (VTEC)) are the most common type of *E. coli* known to cause bloody diarrhoea and haemolytic uraemic syndrome (HUS) in humans. STEC produce the toxins Shiga toxin 1 (ST1) and Shiga toxin 2 (ST2), which are encoded by the Shiga toxin genes *stx*1 and *stx*2. Under the current Scottish guidance any O157 and non-O157 that carry the Shiga toxin gene are of public health concern.[1]

STEC can be divided into a range of serogroups based on the O antigen present on the surface of the bacteria. In Scotland, the most commonly reported of these STEC are *E. coli* of serogroup O157, with all other *E. coli* serogroups often grouped together under the term non-O157 STEC. The bacteria can be further divided into serotype, where both the O and H antigens are defined, for example *E. coli* O157:H7.

The incubation period (the time from infection to symptom onset) of STEC is usually 3-4 days, but can be as long as 10-14 days.[2]

6.3.3 Clinical implications of STEC

The experiences of people with STEC range from no symptoms at all (asymptomatic) to severe illness. Symptoms can range from mild diarrhoea, stomach cramps and fever, to bloody diarrhoea (haemorrhagic colitis), and kidney damage if haemolytic uremic syndrome (HUS) occurs. Rarely, infection can be fatal.

Between 5% and 15% percent of people infected with STEC will develop HUS, with young children at highest risk.[3,4] In these cases, it is believed that STEC toxins enter the blood stream and damage the kidneys. Around 85% of people who develop HUS will recover their full kidney function; however, there is a risk of long-term health issues such as high blood pressure and kidney damage. The complications of HUS can be life threatening in some instances. Mortality is estimated to be between 3% and 5% for HUS cases.[4]

6.3.4 Diagnosis and Treatment

Diagnosis of STEC infection involves laboratory testing of faecal (stool) samples to grow (culture) *E. coli* O157 and non-O157 STEC on an agar (culture) plate before biochemically confirming the organisms as *E. coli*. In Scotland, NHS routine diagnostic laboratories culture faecal samples to detect a variety of different enteric pathogens including *E. coli* O157. Colonies (growth) of *E. coli* O157 are normally easily detected on an agar plate as *E. coli* O157 do not ferment sorbitol (these are termed non-sorbitol fermenting (NSF)) so appear as greyish colonies on the culture plate against a background of other organisms, that do ferment sorbitol, and appear pink in colour. This is a very effective visual flag for the presence of *E. coli* O157 and is key in assisting with the isolation of the organism from faeces. However, most non-O157 STEC, and some more uncommon serotypes of *E. coli* O157 do ferment sorbitol (known as sorbitol-fermenting (SF) *E. coli* O157), and appear as pink colonies on culture plates and therefore cannot be easily identified, and consequently isolated, for further testing. Consequently, most Scottish diagnostic laboratories will only detect the presence of NSF *E.*

coli O157. Scottish Guidance for the Management of STEC advises that, faecal samples from "high risk" cases that are negative following culture at local diagnostic labs are forwarded to the Scottish *E. coli* O157/STEC Reference Laboratory (SERL), where detection of SF and NSF *E. coli* O157 and non-O157 STEC is conducted by PCR.[5]

There is currently no standard curative treatment for STEC infections, although the symptoms may be managed if a person becomes significantly unwell. The use of antibiotics in individuals with STEC is not recommended due to a possible increased risk of developing HUS.[6]

6.3.5 Public Health Clearance Process

People who have contracted STEC are considered infectious until the bacteria can no longer be detected in their faeces (two "negative" stool samples collected at least 48 hours after symptoms have resolved, with the two samples collected at least 24 hours apart). This is of particular relevance to the people who are deemed to be in a 'risk group'. Risk groupings are described for some of the population who, because of other factors such as age or occupation, are considered to be at higher risk of spreading infection. Table 1 gives details of risk groups A-D. These groups of people are therefore often formally excluded from work or activities, under the Public Health etc. (Scotland) Act 2008[7], to reduce the spread of infection.

Table 1: Definitions of risk groups for Gastrointestinal illness in whom exclusion can be advised

Group	Definition of group
Group A	Any person of doubtful personal hygiene or with unsatisfactory toilet, hand washing or hand drying facilities at home, work or school.
Group B	Children who attend pre–school groups or nursery
Group C	People whose work involves preparing or serving unwrapped foods not subjected to further heating
Group D	Clinical and social care staff in high-risk care facilities who have direct contact with susceptible patients or person in whom gastrointestinal infection would have particularly serious consequences.

A 2013 study of children attending childcare facilities in England reported the median duration of shedding of STEC in stool was 31 days, and median period of exclusion was 39·5 days.[8] In some cases clearance can take considerably longer (one study recorded a child excluded for 283 days).[9] There is evidence that asymptomatic children cleared STEC infection faster than symptomatic children.[10]

6.3.6 Outbreaks

The easy transmission and severe complications of STEC infection mean that strict rules are required in the management of an outbreak of STEC infection. This is particularly the case in early years and school-based outbreaks. A problem assessment group (PAG) or incident management team (IMT) will assess the ongoing risk to the public and consider necessary control measures. This can include, for example, additional testing and exclusion of older children and staff members.[1]

6.4 Patterns of STEC infection in Scotland

Scotland has a higher incidence of STEC infections in humans compared to the rest of the UK. Infections in Scotland initially rose in the 1990s and have remained high.[10] The average annual laboratory confirmed reports of *E. coli* O157 in Scotland over the last 5 years (2017 – 2021) is 144 (range = 113 to 165). For non-O157 *E. coli* this is 104 (range = 83 to 122). For both O157 and non-O157, laboratory reports generally peak in the summer months.

For *E. coli* O157 in 2020 and 2021 there were 113 laboratory reports in Scotland (14 in Lothian) and 137 (12 in Lothian) respectively. For non-O157 *E. coli* in 2020 and 2021 there were 100 laboratory reports in Scotland (18 in Lothian) and 122 (17 in Lothian) respectively.[11]

During this outbreak in Lothian, there was an increase in expected levels of STEC infection in Scotland and the rest of the UK due to an unrelated national outbreak (see Appendix 2).

6.5 Modes of Exposure

STEC infections occur via the faecal-oral route. That is when water or food contaminated by faecal matter from an infected animal or individual is ingested. Since the quantity of STEC required to transmit the infection to a person is small enough to be invisible to the eye, hands and surfaces may appear clean, yet still carry sufficient bacteria to transmit infection. The infectious dose of STEC is very low. Only 50 to 100 organisms are estimated to be required to pass on an infection.[12] For perspective, 10,000 *E.coli* bacteria could fit on a pin head.

Routes of infection can include:

- Ingesting bacteria from hands which have been in contact with animals or areas where animals have been, and that are contaminated with traces of faecal matter.
- Drinking inadequately treated water which has been contaminated with faecal matter (for example directly from a loch or stream).
- Consuming foods that have been contaminated with traces of faecal matter, commonly including undercooked meat, unpasteurised milk, and unwashed salads.
- Consuming other foods that have become cross-contaminated from infected foods or an infected person's inadequately washed hands.
- Ingesting bacteria from hands that have come into direct contact with an infected person's inadequately washed hands.
- Ingesting bacteria from hands that have been in contact with surfaces or objects touched by an infected person's inadequately washed hands (for example on a toilet flush or bathroom taps).

Accordingly, young children are particularly at risk of passing on the infection due to their inability to perform adequate hand washing and their poorer hygiene practices. There are additional risks in children requiring nappy changes.

6.6 Health Protection Function

Health Protection is the Public Health speciality that focuses on protecting the public from exposure to hazards which may be detrimental to their health, and to mitigate any impact on health when such exposures cannot be avoided. It primarily involves: preventing the transmission of infectious disease; ensuring the safety and quality of air, water, food and the environment; managing outbreaks of communicable disease or other incidents which threaten population health. Under the Public Health etc. (Scotland) Act 2008,[7] NHS Lothian Health Protection Team (HPT) is mandated to protect the public from health hazards, contamination, or infection across Lothian. In addition, under this and separate legislation, other agencies including the Environmental Health (EH) team, East Lothian Council and the Care Inspectorate have legislative responsibilities relevant to the Health Protection Function.

6.7 Outbreak Investigation Governance

An IMT was constituted according to the Scottish Government guidance, Managing Public Incident Guidance: Roles and Responsibilities.[13] NHS Lothian Health Protection Team implemented the operational activities recommended by the IMT. During the course of the outbreak, two subgroups were established: one for data analysis (referred to as an "epicell"), and a liaison group for field visits and nursery liaison. These subgroups reported directly to the IMT. The IMT functioned as an independent unit. See Appendix 1 for membership. The IMT sought expert advice from national agencies such as Public Health Scotland (PHS) and the NHS Scotland Central Legal Office. To support the activities of the IMT, the existing management structures assessed resource needs.

7 Investigations

The investigation and management of this outbreak is categorised into epidemiological, environmental and microbiological. The term “negative” in the context of the investigations described in this report means free of evidence of infection.

7.1 Epidemiological Investigation

The epidemiological investigation was aimed at identifying and describing cases associated with the outbreak, and to identify and confirm the likely source/vehicle of the outbreak. The main aspects of the epidemiological investigation included agreeing the outbreak case definition, case finding, collection and review of epidemiological data for hypothesis generation and confirmation.

7.1.1 Timeline of the key events in the outbreak

The first case of STEC in a child in a nursery setting in this outbreak was notified to the NHS Lothian Health Protection Team by a Consultant Clinical Microbiologist on Friday 29 July 2022. The child was attending Pear Tree Nursery Church Street, Haddington.

A second case was notified to the NHS Lothian Health Protection Team on Monday 1 August, by another health protection agency in the UK, and they were noted to also attend Pear Tree Nursery Church Street. Accordingly, a Problem Assessment Group was held on Monday 1 August 2022.

There were three IMT meetings in the first week of August, then meetings followed a twice weekly then once weekly cadence as required until the last IMT meeting on 13 October 2022.

Appendix 3 lists the key events over the following weeks.

7.1.2 Case Definitions

Case definitions were derived from national guidance and adjusted during the outbreak by the inclusion of environments of interest and timelines and agreed by the IMT. The wording of these case definitions has been left as originally agreed, including names of nursery chain/ individual nurseries.

The following case definitions were used during the management of the outbreak, and were adapted by the IMT from national guidance.

STEC symptoms including any of the following:

- Diarrhoea
- Bloody diarrhoea
- Abdominal pain
- Nausea and vomiting
- Fever
- Lethargy/Fatigue

Pear Tree Nurseries Haddington:

Possible Case:

- Any of the symptoms above but with no known links to children or staff who attended Pear Tree Nurseries Haddington since 15/07/22
- Any confirmed *E. coli* O157[#] case in Lothian with onset of symptoms since 15/07/22 with **NO** epidemiological links to children or staff attending the Pear Tree Nursery since 15/07/22

Probable cases:

- Any of the symptoms above and is a child or staff member attending Pear Tree Nursery (Church Street or Meadowpark) since 15/07/22
- Any of the symptoms above and is a close contact of a child or staff member who attends Pear Tree Nursery (Church Street or Meadowpark) since 15/07/22

Confirmed Case:

- *E. coli* O157 microbiologically confirmed, by PCR or Culture, in a child or staff member who attends the Pear Tree Nursery (Church Street or Meadowpark) since 15/07/22
- *E. coli* O157 microbiologically confirmed, by PCR or Culture, in any individual with links to any children or staff members attending Pear Tree Nursery (Church Street or Meadowpark) since 15/07/22

Close contact of a confirmed or probable case:

- Never had symptoms and attends/works at the Pear Tree Nursery (Church Street or Meadowpark) since 15/07/22
- Never had symptoms and is a close contact of a symptomatic child or staff member who attends Pear Tree Nursery (Church Street or Meadowpark) since 15/07/22

Primary and secondary cases:

- Primary cases were children or staff from the nurseries investigated in this outbreak, who had confirmed STEC infection
- Secondary cases were household or other close contacts of a child or staff member with confirmed STEC infection.

Musselburgh Private Nursery:

The equivalent definitions were used for the Musselburgh nurseries, but for those attending either of the two nurseries from 8 August 2022.

[#] This was the original definition agreed by IMT. It was extended during the outbreak to include non-O157 STEC. In Scotland *stx* negative O157 *E. coli* strains are managed the same way as other STEC

7.1.3 Case Findings

The IMT used the following approaches to find other cases that may have been in the community or other locations and linked to the outbreak:

- For every case identified, HPT made enquiries from household and other contacts of known cases as to whether they knew of other people who suffered symptoms similar to that caused by STEC
- HPT reviewed notifications of STEC cases and lab results to find out if they were linked to East Lothian area
- Letters were sent to local GPs, other health boards asking them to be on the lookout for cases of STEC that might be linked to East Lothian

7.1.4 Exposure histories

The National Enhanced Surveillance form for STEC at PHS includes the collection of standard demographic, clinical and exposure data on all confirmed and a proportion of probable cases. An iterative interview process was used to ensure relevant information was gathered about places visited, activities undertaken, recent travel and food consumed and purchased. (Questionnaire Appendix 4).

Nursery attendance records were reviewed for: (i) dates attended; (ii) illnesses and (iii) rooms used by attendees and staff. Further interviews of staff were undertaken to establish any links between nurseries.

7.1.5 Background rates

This outbreak took place at the same time as an unrelated UK-wide increase in STEC infections, particularly *E. coli* O157. Therefore, observed vs expected levels within the area were examined over a five-year period, to compare the expected rates of disease, and what would be expected given the national rise in cases.

7.1.6 Network analysis

Additionally, a transmission network analysis was conducted to visualise common community exposures and examine thoroughly all links between cases in person, place and time (data are not included in this report as they are potentially patient identifiable).

7.2 Environmental Investigation

EH inspected the nursery premises, typically in joint visits with other agencies represented at the IMT. During these visits, menus and temperature records pertaining to the periods in question were inspected. Swabs were taken from Pear Tree Nursery Church Street in conjunction with City of Edinburgh Scientific Services. The areas swabbed included the nappy changing area, surfaces in the kitchen, utility room, all three nursery rooms, staff room and toilets together with water from a mop bucket. The swabs/samples were analysed (where appropriate) for indicator organisms (Enterobacteriaceae plus colony counts), *E. coli* and *E. coli* O157 (by both traditional and PCR means), Shiga toxin genes (*stx1*, *stx2*, *stx2f*) and O26 WZX gene, none of which were detected.

Records provided by Scottish Water for the period up to and including the Pear Tree Nursery Church Street outbreak were assessed.

Private water supply samples were taken from one of the households on a Private Water Supply, as testing for *E. coli* O157 is not performed as part of the routine regulatory testing suite for private water supply or mains water.[14,15]

Community venues which had been visited by cases during the incubation periods were contacted and/or visited.

7.2.1 Scotland's Rural College (SRUC)

Additional environmental soil sampling was obtained from the garden of one case, as well as samples from animals, and animal faeces and a veterinary inspection of sheep and chickens in a nearby field.

7.2.2 Multiagency visits

Joint site visits were carried out by Environmental Health, the Care Inspectorate, the Education Department of ELC, and HPT on behalf of the IMT. These helped to inform the investigation. Table 2 details the dates of the multiagency visits.

Table 2: Dates of multi-agency visits to nursery premises

Nursery	Provider	Date of visit (all 2022)
Church Street	Pear Tree Nurseries Ltd	2 August
Church Street	Pear Tree Nurseries Ltd	9 August
Church Street	Pear Tree Nurseries Ltd	23 August
West Road	Pear Tree Nurseries Ltd	12 August
West Road	Pear Tree Nurseries Ltd	9 September
Meadowpark	Pear Tree Nurseries Ltd	10 August
Meadowpark	Pear Tree Nurseries Ltd	17 August
Bridge Street	Musselburgh Private Nursery	2 September
Bridge Street	Musselburgh Private Nursery	13 September
Stoneybank Terrace	Musselburgh Private Nursery	2 September
Stoneybank Terrace	Musselburgh Private Nursery	12 September

7.3 Microbiological investigation

7.3.1 Referral of samples to NHS Lothian Enteric Laboratory and Scottish *E. coli* Reference Laboratory (SERL)

Faecal samples were submitted to the NHS Lothian Enteric Laboratory for culture. Presumptive isolates of *E. coli* O157 were forwarded to SERL for confirmation and typing. In addition, faeces testing negative by culture at the NHS Lothian Enteric Laboratory but from:

- individuals with symptoms suggestive of an STEC infection
- from symptomatic contacts of known cases
- all contacts of outbreak-associated cases

were forwarded to SERL for more sensitive testing by PCR in line with current Scottish guidance.[1] This ensured that high-risk samples were screened for all STEC, in addition to *E. coli* O157.

At the start of the outbreak, *E. coli* O157 was detected and isolated from five different patients at the NHS Lothian Enteric Laboratory and presumptive isolates were forwarded to SERL for confirmation and further characterisation. As the outbreak progressed and following the detection of non-O157 STEC, all outbreak-related faecal samples were sent directly to SERL for testing and bypassed preliminary culture in the NHS Lothian Enteric Laboratory. All remaining cases were therefore identified at SERL.

7.3.2 Microbiological methods

Faecal Extraction

Each faecal sample was enriched in tryptic soy broth then DNA extraction performed using Instagene (Bio-Rad), prior to PCR.

Real-time PCR

SERL uses an in-house real-time PCR[16] as part of the faecal screening process to detect Shiga toxin genes (*stx*1 and *stx*2), including all common *stx* variants, and a gene specific for *E. coli* O157 (*rfb*$_{O157}$). The presence of *rfb*$_{O157}$ (with or without *stx*) following real-time PCR, indicates the potential presence of *E. coli* O157. If real-time PCR detects the presence of *stx*1 and/or *stx*2, in the absence of *rfb*$_{O157}$, this indicates the potential presence of non-O157 STEC. The pattern of genes present following real-time PCR will determine what methods may be more successful in isolating an organism.

Isolation from PCR Positive Faeces

As NSF *E. coli* O157 possess a unique biochemical characteristic, meaning they can be detected on a special culture media, they can be isolated either by direct plating or by immunomagnetic separation. However, isolation of non-O157 STEC and SF *E. coli* O157 from faeces is not straightforward as these organisms look like most other organisms on a culture plate and this step is a bottleneck in the isolation and subsequent typing process, experienced by reference laboratories globally. The isolation of non-O157 STEC and SF *E. coli* O157 involves carrying out individual PCR reactions on multiple colonies (sometimes 100s) on a culture plate to identify the PCR positive organism. As current WGS methods are not performed directly on a faecal sample, it is important to isolate an organism to sequence as this will provide further detailed characterisation and permit an assessment of how this organism might be related to another and, in some instances, may indicate a common source of infection. However, although every attempt is made to isolate an organism following a positive PCR, this is not always possible. If an organism cannot be isolated, no further typing can be performed.

Phage Typing

All non-sorbitol fermenting (NSF) *E. coli* O157 isolates were sub-typed using phage typing[17,18] which determines the susceptibility of *E. coli* O157:H7 strains to a panel of sixteen different bacteriophages. The resulting pattern was scored against the international phage typing scheme and a phage type assigned.

Whole Genome Sequencing (WGS)

Genomic DNA was manually extracted from each *E. coli* organism under investigation using the DNeasy Blood and Tissue Kit (Qiagen, Crawley, UK). Libraries were prepared using the Nextera XT DNA kit (Illumina, Cambridge, UK) and pair-end sequencing performed on the Illumina MiSeq using 500 cycle v2 reagent kits to produce 2 x 250bp reads. Sequencing files (fastqs) were analysed using the Scottish Microbiology Reference Laboratories WGS Pipeline (SMiRLWBP) and BioNumerics v8 (Applied Maths) using the cgMLST and *E. coli* genotyping plug-in tools.[16,19]

Outputs from the bioinformatic analysis workflow, used to characterise the strains and determine their genetic relatedness, were predicted serotype (O:H), sequence type (ST), Shiga toxin gene (*stx*) subtype and presence/ absence of *eae* (thought to be an indicator of human pathogenic potential), cgMLST allelic profile and SNP address.[20]

SNP addresses were produced by sending files (JavaScript Object Notation (JSONs)) generated by the SMiRLWBP pipeline to UKHSA for processing to enable a comparison with organisms circulating in England and Wales and to obtain a UK-wide nomenclature[16]. UKHSA perform hierarchical single linkage clustering on the pairwise SNP difference between all isolates at various distance thresholds (Δ250, Δ100, Δ50, Δ25, Δ10, Δ5, Δ0). The result of the clustering is a seven-digit SNP address that can be used to describe the population structure. Isolates with identical SNP addresses or with fewer than five SNPs differences (termed a t5 match) are considered closely related and likely to have an epidemiological link. Similarly, cgMLST allelic profiles with a maximum of three loci separating the isolates are investigated as they may have an epidemiological link.

A phylogenetic tree (or dendogram) was constructed in BioNumerics to visualise the relatedness between the strains and shows the percentage similarity of each strain in relation to each other. Categorical coefficients were used for defining similarity levels and unweighted pair group method with arithmetic mean (UPGMA) was used as the clustering algorithm. The SNP address and other typing data were presented on the tree.

In addition, a subset of the strains were further characterised by the Public Health Scotland BioInformatics team to try to infer direction of transmission in one of the nursery settings, using core genome single nucleotide polymorphisms (SNPs) identified using a tool called Snippy. A phylogenetic tree generated from the SNPs was visualised in Microreact, which enables phylogenetic trees and genomic data to be viewed and compared alongside epidemiological information including place and time data.

8 Results

8.1 Epidemiology

8.1.1 Numbers of cases and contacts

There were 57 confirmed cases, 75 probable cases and fewer than 5 possible cases identified in the outbreak. In total, 479 contacts of confirmed or probably infected individuals were identified. Table 3 summarises the numbers and proportions of the confirmed and probable cases.

There are risks of identification of cases when using small numbers (less than 5). Accordingly, some details have been aggregated throughout this section of the report.

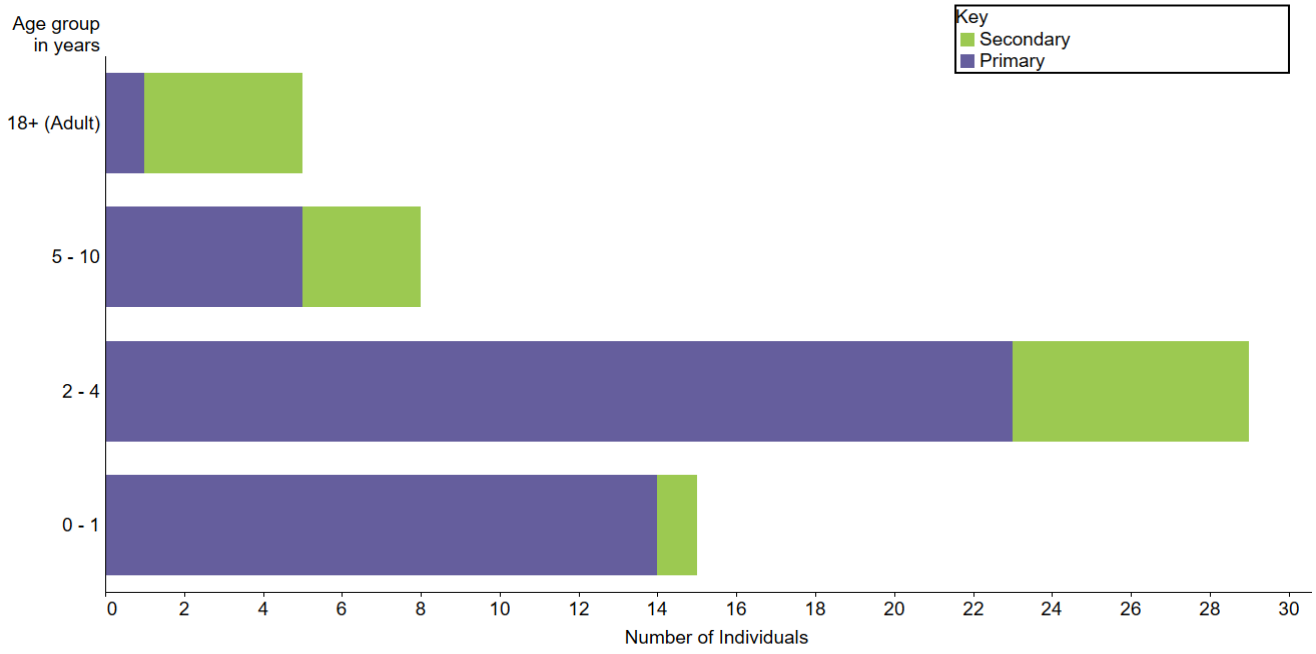
Table 3: Numbers and proportions of confirmed and probable cases and contacts

Type of case	Number of individuals	Proportion of total (%)
Confirmed	57	9.3
Probable	75	12.3
Contact	479	78.4
Total	611	100

8.1.2 Demographics of confirmed and probable cases

Figure 2 details the age of the confirmed cases and indicates in colour which cases were 'primary cases' (from the nursery) or 'secondary cases' (from household or other close contacts / 'not nursery').

Figure 2: Graphs showing primary and secondary cases by age (n=57)

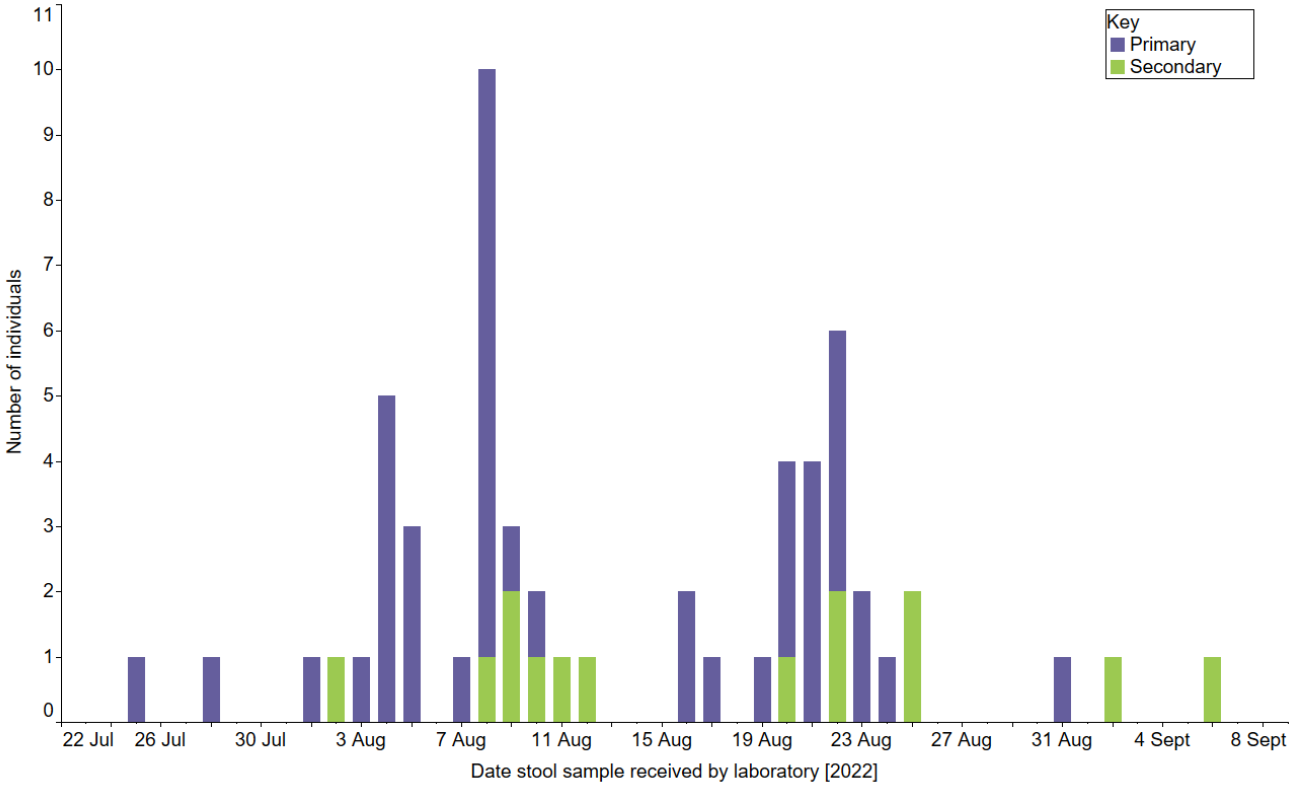


The adult population had the highest proportion of secondary cases (n=4; 80%). The majority of cases in the children aged 1 year or younger were primary cases from nursery (n=14, 93%).

8.1.3 Outbreak curves

Diagnostic specimen collection date for confirmed cases ranged from 25 July to 6 September 2022. Figure 3 shows two peaks in the outbreak. This pattern is consistent with there being more than one outbreak; in this case one peaking around the 8 August 2022, then a later one peaking around 22 August 2022.

Figure 3: Outbreak curve by stool sample date (n=57)



8.1.4 Symptoms

Of the 57 confirmed cases, 28 (49%) reported symptoms, while 29 were asymptomatic. Of the 28 cases reporting symptoms these included; diarrhoea (n=21, 75%), bloody diarrhoea (n<5, 14%), nausea (n<5, 14%), vomiting (n=12, 43%), abdominal pain (n=6, 21%) and fever (n=11, 39%). There were no deaths. Timing of symptom onset for these 28 cases ranged from 14 July to 31 August 2022.

At the initial hospital visit, children were assessed and investigations were performed to establish whether they fell into a low or high risk group for developing HUS. Every child's initial investigations included weight, height, urgent stool for culture, urinalysis, BP and bloods for full blood count, urea and electrolytes, creatinine, liver functions tests, lactate dehydrogenase, C-reactive protein, amylase, venous blood gas, blood culture if febrile, coagulation, and a "group and save" for the Scottish National Blood Transfusion Service.

Protocols and flow charts were designed based on the Scottish Paediatric Renal Urology Network guidance, and modified during the first few weeks of the outbreak, in conjunction with the paediatric infectious disease and renal team (Appendix 5).

There were 71 children associated with this outbreak who were reviewed at Royal Hospital for Children and Young People (RHCYP), 52 of whom had confirmed *E. coli* O157/STEC

infection on testing, the other 19 ultimately testing negative for *E. coli* O157/STEC infection. Children in the latter group were reviewed because of symptoms and epidemiological links to the outbreak (e.g. attended nursery, household contacts who were confirmed cases), some of whom were found to have other medical reasons for their symptoms and required further investigations and hospital treatment as a result. Overall, there were 14 children admitted to hospital (5 positive, 9 negative). They spent a total of 48 days in hospital (24 days for positive cases, 24 days for those testing negative). The length of hospital admission ranged from 2-11 days for positive cases and 2-4 days for those testing negative. In addition, there were 187 clinic reviews (158 for positive cases, 29 for those testing negative). There was a median of 3 outpatient clinic reviews for positive cases (max 6), and a median of 1 outpatient clinic review for negative cases (maximum 4) One confirmed case developed haemolysis requiring blood product support. No patients required renal support in the way of dialysis and all patients recovered.

8.1.5 Exposure histories

The outbreak occurred between August and October 2022. The first cases of microbiologically confirmed STEC reported to HPT from the different nurseries had stool samples submitted on the following dates (Table 4). None of the cases had recent foreign travel. One case lived at a house with a Private Water Supply. Where cases had attended a recent party/ barbeque, food histories did not identify high risk foods (e.g. beef burger or goat cheese).

Table 4: Dates of first sample submitted from a confirmed E. coli O157/ STEC case, first positive result and date of voluntary nursery closures (Pear Tree Nursery West Road did not have a confirmed case, but is included here for completeness)

Nursery	Date first sample submitted from a confirmed case	First positive STEC result notified to HPT	Date of voluntary nursery closure
Pear Tree Nursery Church Street	25 July	29 July	2 August
Pear Tree Nursery Meadowpark	16 August	18 August	12 August
Pear Tree Nursery West Road	No confirmed cases of STEC	No confirmed cases of STEC	16 August
Musselburgh Private Nursery Bridge Street	<5 confirmed cases	<5 confirmed cases	19 August
Musselburgh Private Nursery Stoneybank Terrace	<5 confirmed cases	<5 confirmed cases	26 August

The voluntary closure of both Pear Tree Nursery Meadowpark and Musselburgh Private Nursery Bridge Street occurred before the first positive *E. coli O157*/STEC case was confirmed at each site, on the basis of symptoms and epidemiological links between these nurseries.

Table 5 reports the number of confirmed cases related to each nursery, including both attendees of the nursery and their contacts. For confirmed cases, classification of nursery exposure is according to the epidemiological link that the individual had rather than necessarily attendance at the nursery. Accordingly, for the purposes of this report, household contacts of a nursery child are grouped along with the nursery that the child attended at the time of the outbreak.

Table 5: Confirmed E. coli O157/ STEC cases. Totals include nursery attendees, their contacts (both household and play contacts) and nursery staff

Operator, Nursery Name, Location	Confirmed cases
Pear Tree Nursery Church Street, Haddington	32
Pear Tree Nursery Meadowpark, Haddington	22
Musselburgh Private Nursery, Stoneybank Terrace, Musselburgh	<5
Musselburgh Private Nursery, Bridge Street, Musselburgh	<5
Total	57 cases

Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark represented the focus of the outbreak, accounting for 54/57 (95%) of confirmed cases between them. The distance between Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark is 0.5 miles.

Pear Tree Nursery Church Street

Pear Tree Nursery Church Street was the first to have confirmed STEC cases, and closed voluntarily on 2 August 2022. There are three rooms at Pear Tree Nursery Church Street: 0-2 year olds; 2-3 year olds; and 3-5 year olds. During the course of the outbreak, confirmed cases were reported in children from all three rooms.

By the end of the outbreak, 27 confirmed cases of *E. coli O157/*STEC were identified in children attending Pear Tree Nursery Church Street. Five household contacts of these confirmed cases were also confirmed to have contracted *E. coli O157/*STEC.

Pear Tree Nursery Meadowpark

There are three age group rooms in Pear Tree Nursery Meadowpark. Over the course of the outbreak, confirmed cases were reported in children from the pre-school, toddler and baby nursery rooms (i.e. all three rooms).

Pear Tree Nursery Meadowpark closed voluntarily to all children on 12 August 2022 after reports of children with symptoms of gastrointestinal illness, on a precautionary basis because of the links with Pear Tree Nursery Church Street. This was before there were any microbiologically confirmed cases of STEC at Pear Tree Nursery Meadowpark.

Over the course of the outbreak, 16 confirmed cases of *E. coli O157/*STEC were identified in children attending Pear Tree Nursery Meadowpark). Six household and other contacts of these confirmed cases were also confirmed to have contracted *E. coli O157/*STEC. Some families had confirmed cases in children from more than one room at the nursery. A small number of confirmed cases (fewer than five) developed symptoms more than 14 days after nursery closure, so beyond the accepted incubation period for STEC infection.

Pear Tree Nursery West Road

Pear Tree Nursery West Road closed on a voluntary basis on 16 August 2022 after reports of children with symptoms (enterovirus and norovirus were identified on virological testing, in fewer than 5 children). There were no confirmed STEC cases here, and fewer than 5 probable cases. Pear Tree Nursery West Road is the location of the food preparation for Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark.

Musselburgh Private Nursery: Bridge Street and Stoneybank Terrace

Musselburgh Private Nursery Bridge Street closed on a voluntary basis on 19 August 2022. Musselburgh Private Nursery Stoneybank Terrace closed on a voluntary basis on 26 August 2022. In total there were fewer than 5 microbiologically confirmed cases of STEC at Musselburgh Private Nursery, and 20 probable cases.

Other Community Settings

Transmission network analysis was used to explore all disclosed common community exposures. All possible links between cases in person, place and time were examined, but showed no strong epidemiological evidence of infection source or transmission outwith nursery settings. This analysis did however highlight that some infected individuals had attended events with other children, during the period when they were excluded (data unpublished as patient identifiable).

Attack rates

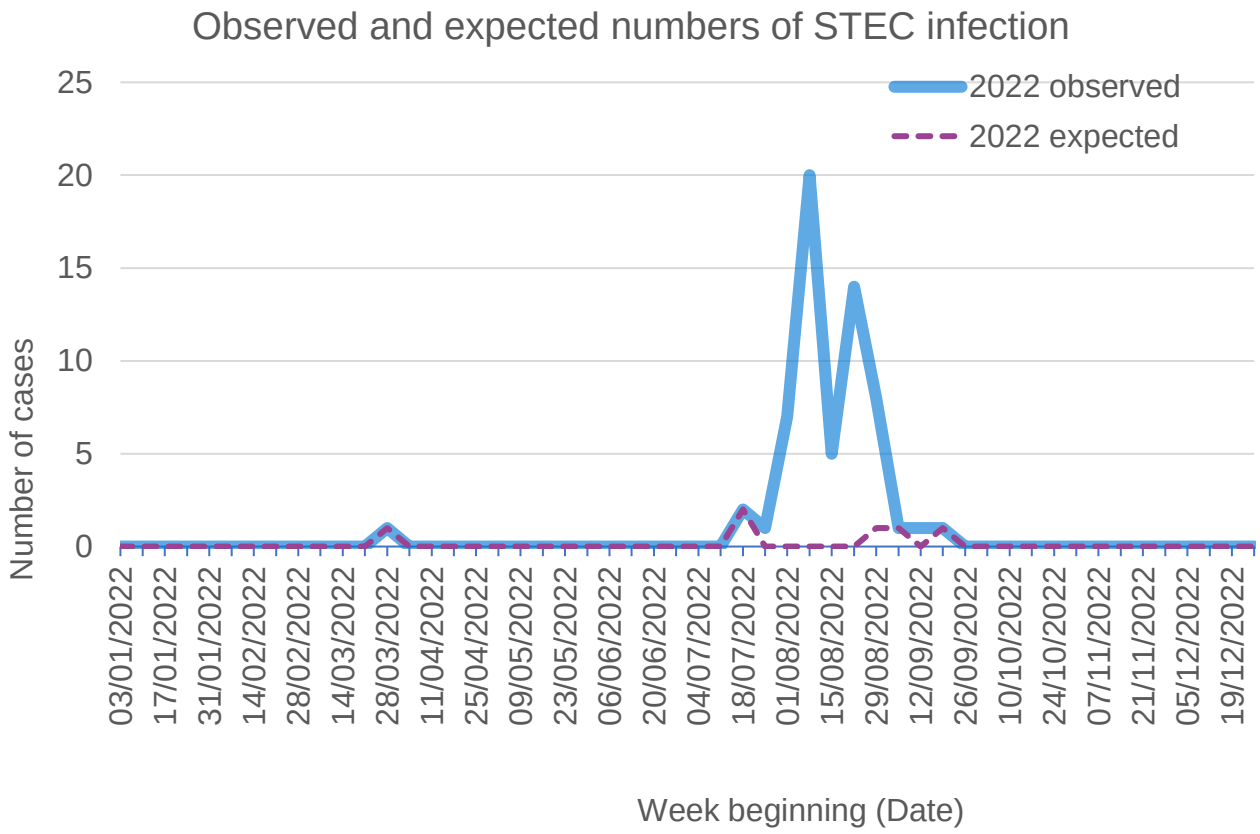
'Attack rate' is an epidemiological term describing a risk measure which calculates frequency of illness related to a specific exposure (in this case, attendance at nursery). The attack rates for children in these settings were 24% for Pear Tree Nursery Church Street (27 cases/111 nursery roll), 12% for Pear Tree Nursery Meadowpark (16/134) and 1% in the Musselburgh Private Nursery nurseries (total roll for these other nurseries was 171). The attack rate for staff at these four nurseries combined was 1% (numbers too small to break down any further). It is not possible to calculate attack rate for household contacts, because testing for that group was limited to symptomatic contacts and household contacts in risk groups only.

8.1.6 Background rates

This outbreak occurred during an unrelated UK-wide increase in STEC infections, particularly *E. coli O157*. Based on historic data, there would be expected to be an increase in sporadic cases of STEC infection in March and July to September each year.

Even after taking account of these seasonal variations, rates of *E. coli O157*/STEC infection in East Lothian in August 2022 greatly exceeded the historic figures for the area. An equivalent increase in rates was not seen in the rest of Lothian or Scotland overall. Figure 4 shows the expected and observed number of cases of *E. coli O157/STEC* infection in East Lothian.

Figure 4: Chart showing expected numbers of *E. coli* O157/ *STEC* infection in East Lothian in 2022 (based on preceding 5 years), compared with the observed numbers with two peaks



In summary, Figure 4 shows a biphasic epidemiological curve, greatly in excess of background figures. Based on epidemiological data alone, the biphasic pattern suggests either one outbreak with secondary cases, or two separate outbreaks. As the increase in cases occurred during the month of August, there would be expected to be some sporadic cases within these figures. The epidemiological analysis did not find a source for an outbreak.

8.2 Environmental Investigation Results

8.2.1 Private Water Supply

The water consumed by one of the cases was from a Private Water Supply. The Private Water Supply in question is a large supply, serving approximately 150 people (approximately thirty households). Environmental Health (EH) had not received any previous complaints about the supply and there had been no linked cases of illness associated with the supply. This supply had been previously tested in 2021 for microbiological parameters and found to be satisfactory[14] prior to the outbreak.

However, given known links between Private Water Supplies and STEC outbreaks[21,22] the Problem Assessment Group meeting on 1 August 2022 agreed that further microbiological testing of the Private Water Supply should be undertaken including examination for *E. coli* O157 as this is not part of the routine regulatory testing suite for either mains water or Private Water Supply.[14,15] A sample was taken on 2 August 2022, with the result from this sample being satisfactory for all of the microbiological parameters assessed including STEC.

Further samples of the supply were taken on both 11 August 2022 and 18 August 2022, and these results were also found to be of a satisfactory microbiological standard for the assessed parameters. The sample taken on 18 August 2022 was analysed for *E. coli* O157 by traditional microbiological methods and by PCR, with no *E. coli* O157 or other STEC detected.

8.2.2 Mains Water (Church Street)

Environmental Health contacted Scottish Water with regards to the quality of the mains water supply prior to the outbreak starting. The information and results obtained (covering from 1 July 2022 to 6 September 2022) indicated no microbiological issues with the Mains Water. Scottish Water subsequently took a water sample on 7 October 2022 from the area around the nursery and this was satisfactory for the drinking water quality parameters tested (this included the microbiological parameters detailed in the Regulations).[15]

8.2.3 Environmental Swabbing (Church Street)

An initial visit to Pear Tree Nursery Church Street by Environmental Health was undertaken on 2 August 2022. During this visit, it was noted that the nursery was visibly dirty and cluttered. There was no food left from meals served during the suspected incubation period (but temperature control records did not indicate a problem), with only pasteurised fresh milk and fruit being stored in the fridge (which was in a clean condition and operating at a temperature of less than 5°C). The only other foods present were breakfast cereals and other low risk ambient stable foods. Pear Tree Nursery Church Street had re-registered as a Food Business under new ownership during the COVID-19 pandemic but, due to national restrictions preventing on-site inspections, no inspection of these premises had been undertaken prior to the outbreak.

In conjunction with Environmental Health, Edinburgh Scientific Services undertook an extensive swabbing/sampling exercise at Pear Tree Nursery Church Street on 10 August 2022. There had been reported to have been a deep clean and fogging since the previous visit. The results from the swabs did not find any areas of contamination with the results being considered satisfactory for the parameters tested. Swabbing/sampling was not undertaken in any of the other nursery settings.

8.2.4 Results from other visits undertaken

Pear Tree Nursery West Road

Meals for the three Haddington nurseries are made in the West Road premises and distributed under temperature control to the sister nurseries. During a visit to this Nursery on 12 August 2022, it was noted that there was no leftover food from meals prepared during the incubation period. It was again noted that food consumed within each of the Haddington nurseries was made fresh daily and there was no 'carry over' or freezing down of food. Records on cooking temperatures for high-risk food supplied to and served in each of the Haddington nurseries indicated that the food was being cooked to a satisfactory temperature.

Pear Tree Nursery Meadowpark

On 10 August 2022, EH received notification that Pear Tree Nursery Meadowpark had symptomatic cases and were asked by HPT to carry out a visit to this nursery. This visit was carried out later that day and the premises were found to be generally compliant using definitions from the Food Law Rating System.[23]

On 17 August 2022, a further visit was carried out to Pear Tree Nursery Meadowpark by the Care Inspectorate (CI), HPT and EH. The premises were again found to be generally compliant by EH.

Sports Centre

On 21 August 2022, Enjoy Leisure Management contacted Environmental Health to advise that a bloody stool had been reported in a toilet beside the swimming pool changing area in one of their sports centres. EH visited the premises that same afternoon and it was noted that the swimming pools had been voluntarily closed by the Management prior to the visit. The disinfection procedures were discussed, and they were satisfactory. During the visit, Enjoy Leisure management agreed to super chlorinate the pool water prior to the pool being reopened.

Soft Play Centre and Sports Centre

On 24 August 2022, it was reported that a few cases had attended a soft play centre and a sports centre just prior to testing positive. A visit was undertaken to the soft play area later that day and it was noted that the premises were found to be well managed. The Sports Centre was also contacted with no issues being noted. Both premises advised that they were continuing to work using enhanced COVID cleaning and disinfection procedures.

Second Soft Play Centre

On 25 August 2022, EH were advised that some cases had attended another soft play centre the previous week. EH contacted the operator who advised that they were still using enhanced disinfection procedures and no issues were raised.

Musselburgh Private Nursery (Bridge Street and Stoneybank Terrace)

On 2nd September 2022, a joint visit was carried out by EH, CI, Education and the HPT to both Musselburgh Private Nursery Bridge Street and Musselburgh Private Nursery Stoneybank Terrace. During these visits, it was noted that there were various actions required in relation to the Musselburgh Private Nursery Bridge Street premises. A report was sent to the IMT advising of the issues that were requiring attention.

On 12 September a revisit was carried out by the joint agencies to Musselburgh Private Nursery Stoneybank Terrace and on 13 September 2022 a revisit to the Musselburgh Private Nursery Bridge Street was undertaken by CI, HPT, Education and EH and, thereafter, EH advised they had no objections to these nurseries re-opening.

8.2.5 Other Sampling Considerations

Other areas that were considered for sampling/further investigation included:

- Food - there were no 'higher risk' foods available to sample at Pear Tree Nursery Church Street from the incubation period for the earliest cases, with only lower risk cereals, other ambient stable foods and newly purchased pasteurised milk being available.

  Food was not thought to be the source of the infectious agent as the supply kitchen provided the same menu/foods on the same days to the other nursery premises in the same ownership. There were approximately 200+ meals served per day. Records of cooking temperatures for main meals and fridges indicated satisfactory temperature controls were in place, with previous visits to the production nursery kitchen indicating satisfactory cross contamination controls in place.

- The soil in the outside play area at Pear Tree Nursery Church Street: the IMT advised against it, as it would not provide evidence of a source.
- Windfall apples in the outside play area at Pear Tree Nursery Church Street: this was discounted for the reasons similar to the soil, plus the children did not get to eat the apples.
- Whether animal manure/compost was used in the nursery garden: the business advising they did not use this type of product.
- The camp site where some cases had visited: this was discounted as the site had not been visited by all of the early cases and some contacts were ill prior to visiting this site.

8.2.6 Scotland's Rural College (SRUC) results

STEC infection can be contracted from contact with animal faeces, so the SRUC investigated a number of potential animal sources. All results were negative and no source was identified.

One family pet dog had faeces samples submitted to SRUC for testing. The faeces sample was negative by immuno-magnetic separation for O157 and negative by PCR for O157, *stx*1 and *stx*2.

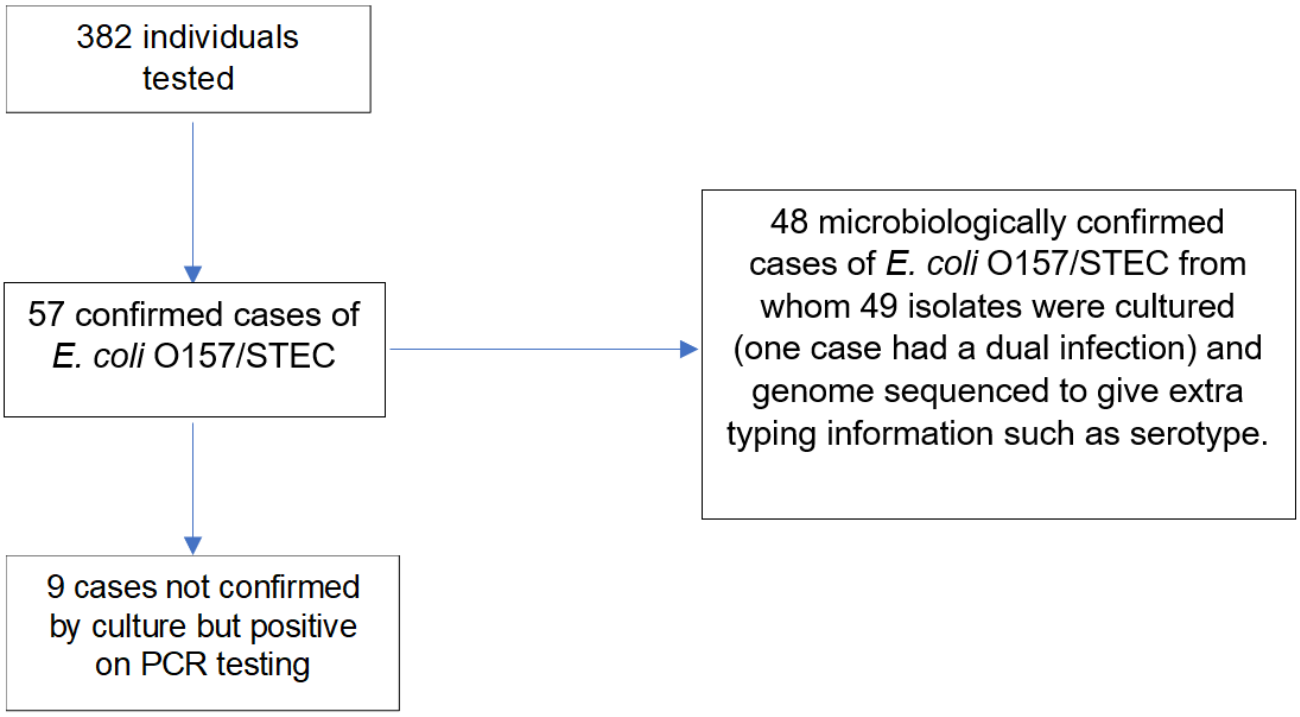
Some confirmed cases during this outbreak were known to have had access to a field where two sheep were kept. Six sheep faecal samples were collected from the ground on 5th September 2022 and tested at SRUC by immuno-magnetic separation for O157 and multiplex PCR for *rfb*O157, *stx*1 and *stx*2. All six samples were negative by both methods.

8.3 Microbiology

Figure 5 shows the breakdown of confirmed cases by culture or PCR testing.

E. coli O157 and non-O157 STEC

Figure 5: Summary of microbiological confirmation by culture or PCR



Microbiological typing results

An *E. coli* strain was isolated from 48 cases. In one case, two different strains were isolated. The strains identified included non-sorbitol fermenting (NSF) *E. coli* O157, non-O157 STEC and *stx*-negative sorbitol-fermenting (SF) *E. coli* O157. It was not possible to isolate an organism from faecal samples from nine cases testing positive by PCR; four samples positive for *stx*2 only and five positive for *rfb*O157only. This meant a further nine cases were identified as potentially part of the outbreak but were reported as "not confirmed by culture" with no further typing results available.

In the two Musselburgh Private Nursery branches (Bridge Street and Stoneybank) there were fewer than 5 total cases for the two nurseries combined (when fewer than 5 cases are reported it is standard practice not to publish further information to prevent deductive disclosure).

WGS analysis (Table 6 and Figure 6) identified six different serotypes, with O157:H7 and O157:H39 being the most prevalent. The O157:H7 identified were stx-positive non-SF *E. coli*. The O157:H39 identified were stx-negative NSF *E. coli*.

Table 6: Confirmed isolates from E. coli O157/STEC cases with typing results (n=49 isolates)

Num-ber of cases	*E.coli* Serotype	Virulence Profile	Nursery	Phage Type[1]	SNP Address[2]
19	O157:H7	*eae,stx*2a	Pear Tree Nursery Church Street	14/RDNC	18.35.380.738.1009.6697.%
5[3]	O109:H21	*eae, stx2f*	Pear Tree Nursery Church Street		9.60.63.66.69.69.%
<5	O125:H6	eae, *stx2f*	Pear Tree Nursery Church Street		4.4.4.81.93.95.104
<5	O128:H2	eae, *stx2f*	Pear Tree Nursery Church Street		No SNP address
<5[3]	O157:H16	*eae*	Pear Tree Nursery Church Street		25.25.559.1187.1290.1320.1391
<5	O157:H16	*eae*	School		25.25.249.262.1330.1361.1434
17	O157:H39 (B)	*eae*	Pear Tree Nursery Meadowpark		No SNP address[4]
<5	O157:H39 (A)	*eae*	Pear Tree Nursery Meadowpark		No SNP address[4]

Notes to table 6:

1 The Phage Typing scheme is used to type *E. coli* O157:H7. Although sometimes used to type other O157 serogroups, in this case, it did not give any useful typing information so was only used for H7 strains. RDNC (Reactions Do Not Conform) - the phage reactions observed did not align with any known profile. Only one isolate gave an RDNC result but was a t5 match with the other strains in this O157:H7 outbreak cluster following WGS.

2 A SNP address is only produced for certain clonal complexes. % at the end of a SNP address denotes all strains are a t5 match.

3 One case had a dual infection, carrying both *E. coli* O109:H21 and *E. coli* O157:H16.

4 The O157:H39 strains fell in to two different clusters following cgMLST analysis using BioNumerics.

The phylogenetic tree (Figure 6), based on cgMLST analysis performed in BioNumerics, clearly illustrates the genetic difference between the strains. In Pear Tree Nursery Church Street, there were 19 cases of O157:H7 *eae*+ *stx2a*+ (Phage type 14/RDNC) that matched at the 5-SNP single linkage clustering level (18.35.380.738.1009.6697.%) demonstrating these cases were infected with the same strain. Importantly, it did not cluster with an *E. coli*

O157 strain causing a concurrent P14 UK-wide outbreak at the time (purple on tree in Figure 6).

There were also nine cases of non-O157 STEC isolated*;* five cases of *E. coli* O109:H21 (*stx2f*, *eae*) that matched at the t5 level (9.60.63.66.69.69.%) - one of these cases presented as a dual infection with a *stx*-negative O157:H16 *eae*+ (25.25.559.1187.1290.1320.1391). Three cases of *E. coli* O125:H6 (*stx2f, eae*) shared an identical SNP address (4.4.4.81.93.95.104); and one case had an O128:H2 (*stx2f, eae*) infection - no SNP address was produced for this strain.

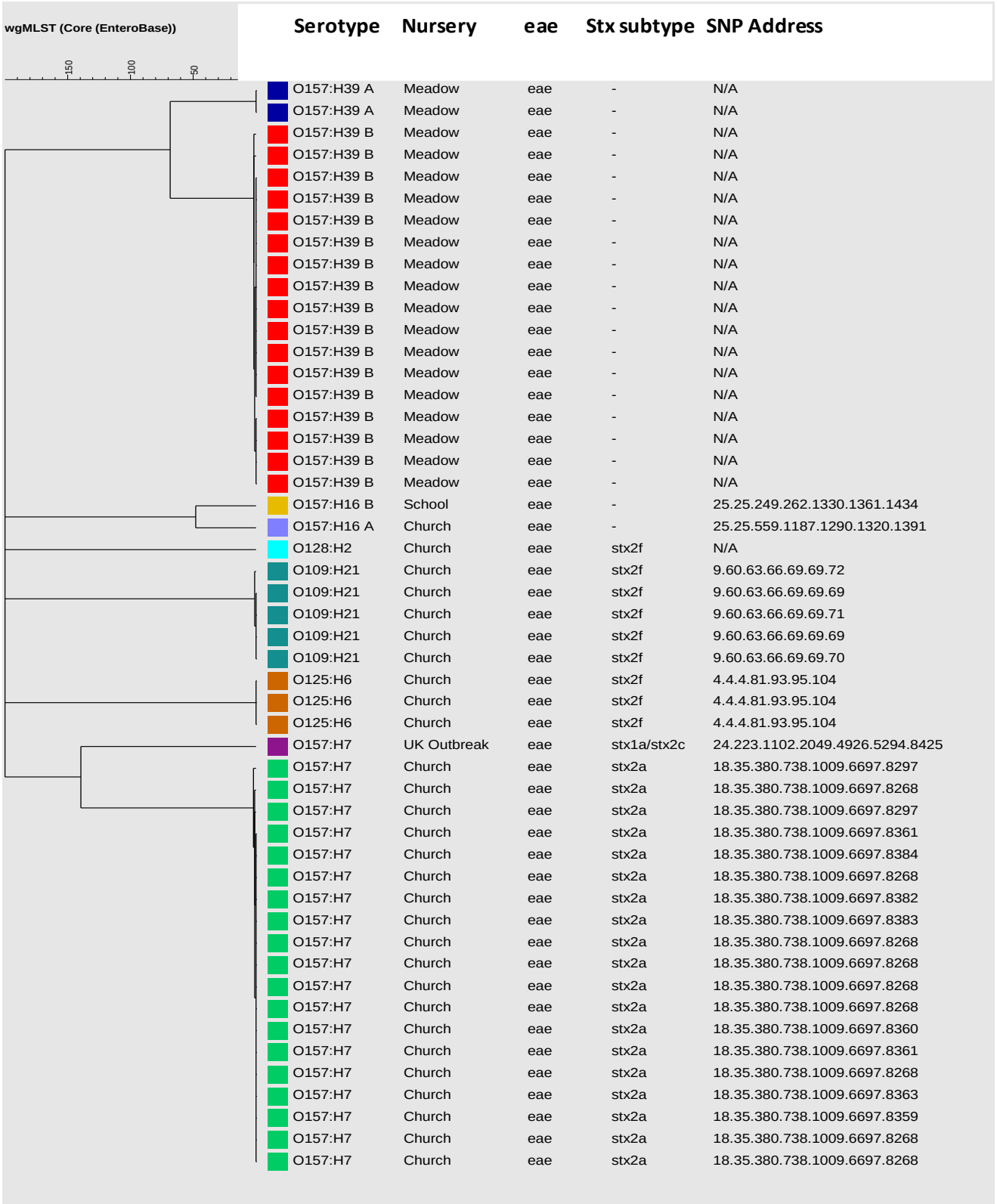
In Pear Tree Nursery Meadowpark there were 19 cases of *stx*-negative *E. coli* O157:H39 isolated from submitted faeces during this outbreak. SNP addresses were not produced for this serotype, however the cgMLST analysis clearly demonstrated that these fell into two distinct, unrelated clusters (Figure 6). The clusters were arbitrarily named A and B, with 17 cases belonging to group B and 2 cases belonging to group A, differing by <2 and 0 cgMLST alleles respectively.

Two cases of *E. coli* O157:H16 (*eae*) were confirmed, one of which was a dual infection with an *E. coli* O109:H21 strain (as described above). These had different SNP addresses suggesting these cases were infected with different strains of *E. coli* O157:H16.

No cases of *E. coli* O157 infection were identified from testing at Pear Tree Nursery West Road.

Figure 6: Whole Genome Sequencing Cluster Analysis - Phylogenetic tree based on the allelic profiles of 2513 cgMLST genes for the 49 isolates

The tree was created in BioNumerics v8 with the categorical (differences) coefficient of similarity (no scaling) and UPGMA cluster analysis method. "Church" = Pear Tree Nursery Church Street. "Meadow" = Pear Tree Nursery Meadowpark. (Also includes UK outbreak strain for context).



Serotype	Nursery	eae	Stx subtype	SNP Address
O157:H39 A	Meadow	eae	-	N/A
O157:H39 A	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H39 B	Meadow	eae	-	N/A
O157:H16 B	School	eae	-	25.25.249.262.1330.1361.1434
O157:H16 A	Church	eae	-	25.25.559.1187.1290.1320.1391
O128:H2	Church	eae	stx2f	N/A
O109:H21	Church	eae	stx2f	9.60.63.66.69.69.72
O109:H21	Church	eae	stx2f	9.60.63.66.69.69.69
O109:H21	Church	eae	stx2f	9.60.63.66.69.69.71
O109:H21	Church	eae	stx2f	9.60.63.66.69.69.69
O109:H21	Church	eae	stx2f	9.60.63.66.69.69.70
O125:H6	Church	eae	stx2f	4.4.4.81.93.95.104
O125:H6	Church	eae	stx2f	4.4.4.81.93.95.104
O125:H6	Church	eae	stx2f	4.4.4.81.93.95.104
O157:H7	UK Outbreak	eae	stx1a/stx2c	24.223.1102.2049.4926.5294.8425
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8297
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8297
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8361
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8384
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8382
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8383
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8360
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8361
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8363
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8359
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268
O157:H7	Church	eae	stx2a	18.35.380.738.1009.6697.8268

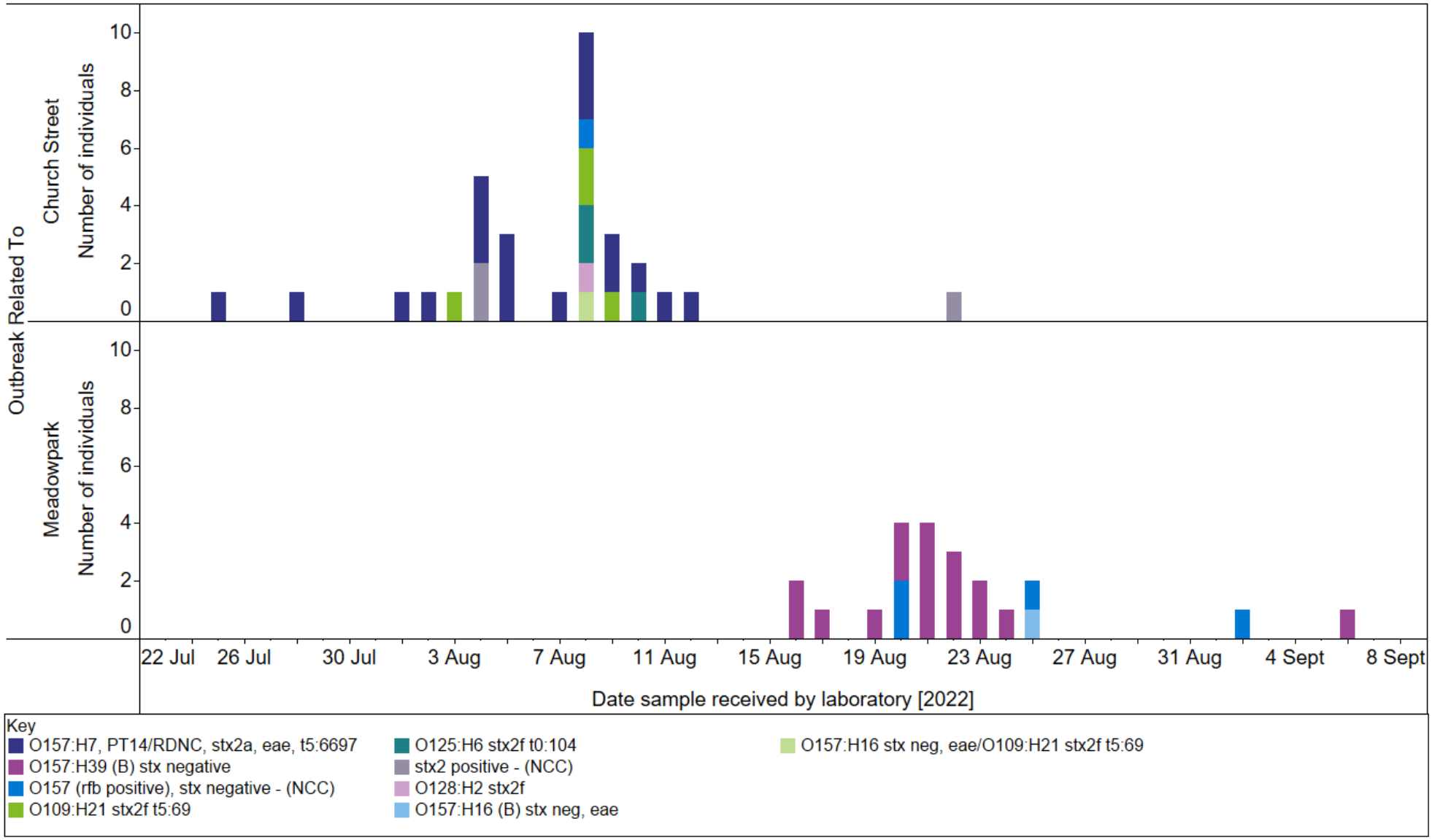
It was not possible to infer more detailed routes of transmission between certain cases using detailed bioinformatics tools due to the lack of variation, with the available results just confirming the clustering from BioNumerics.

In addition to comparing the STEC strains within the SERL *E. coli* Sequencing database (containing sequences from human, veterinary and food sources), the outbreak strains were compared with those occurring contemporaneously in England and Wales and there were no matches. Similarly, sequence data for the STEC strains was uploaded to EpiPulse (the European Surveillance portal for infectious diseases) for comparison with European/international strains and there were no direct matches.

Microbiological typing results by nursery

Figure 7 illustrates the number of cases in each nursery, and of each serotype over the same time period (Musselburgh Private Nursery is not included in this figure due to small numbers). These graphs show the difference in serotype pattern and timing of case presentation across two outbreaks. This chart illustrates that the dominant strain at Pear Tree Nursery Church Street was O157:H7 and the dominant strain at Pear Tree Nursery Meadowpark was O157:H39 (B); there was very minimal overlap in the timings of the majority of cases related to each setting.

Figure 7: Outbreak curve by nursery and *E. coli* serotype for Pear Tree Nursery Church Street (top) and Pear Tree Nursery Meadowpark (bottom). n=54

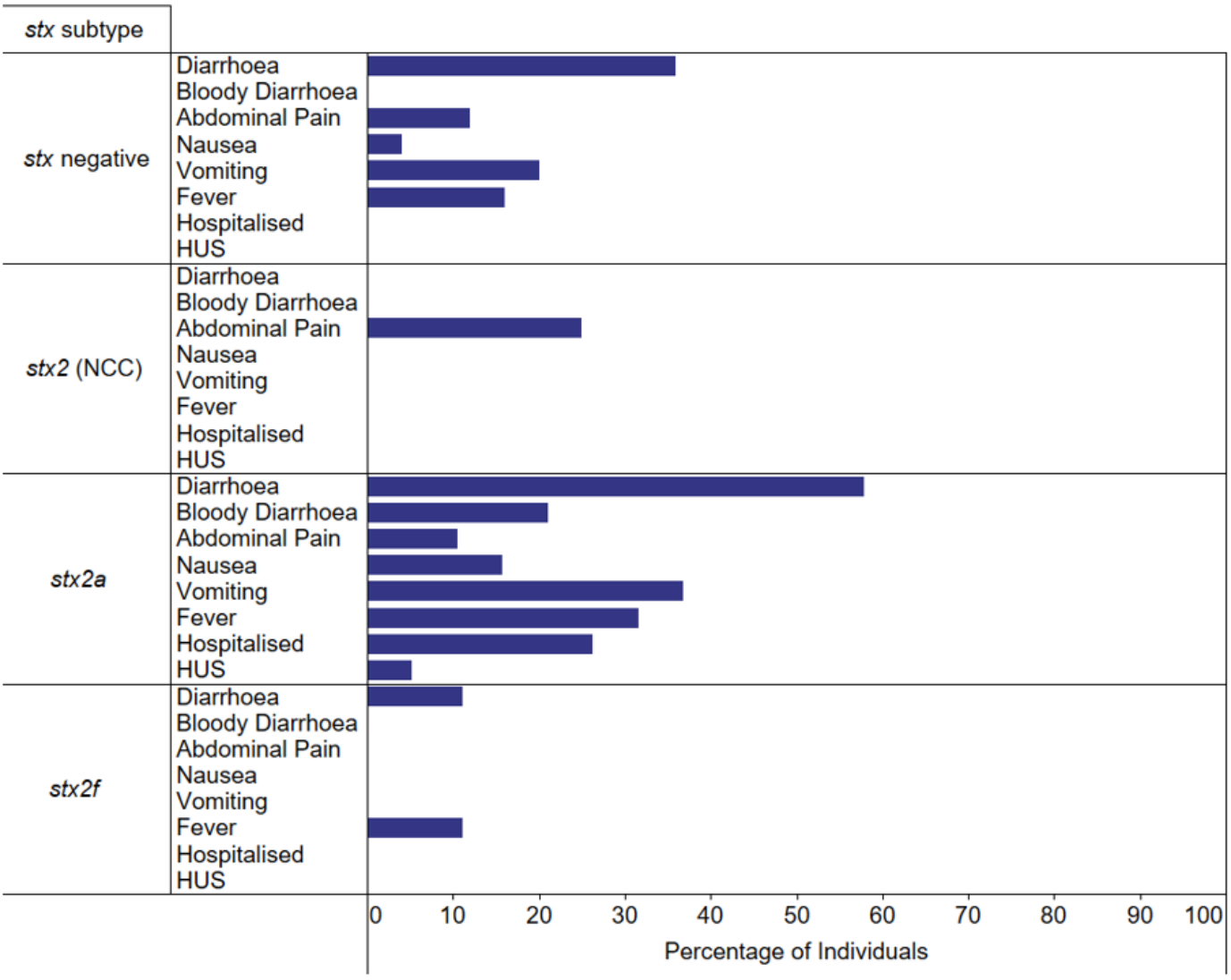


All cases with bloody diarrhoea were related to Pear Tree Nursery Church Street, where the outbreak was first identified, and were infected with the same strain (*E. coli* O157:H7, *stx*2a). The majority of the children with bloody diarrhoea were hospitalised (fewer than five). The two main *E. coli* serotypes identified in the cases in this outbreak were O157:H7 and O157:H39 (B) (Table 6). All 19 cases of O157:H7 were found at Pear Tree Nursery Church Street, and all 17 cases of O157:H39 were found at Pear Tree Nursery Meadow-park. No cases of *E. coli* O157 infection were identified from subsequent testing at Pear Tree Nursery West Road. Additionally, no confirmed link by *E. coli* serotype was identified between the nurseries.

8.4 Disease severity

Data for the Lothian outbreak shows that *stx*2a was associated with the most severe illness (HUS (5%), hospitalisation (26%) and diarrhoea (58%)). No other *stx* subtype was associated with bloody diarrhoea (Figure 8). Overall, 26% of cases with s*tx2a* were asymptomatic, compared with 56% for *stx* negative, 75% for *stx* 2 (NCC) and 78% for *stx* 2f.

Figure 8. Percentage bar chart of symptoms and outcome by *stx* subtype



9 Risk Management

The first multiagency meeting about this situation was the Problem Assessment Group held on 1 August. A Public Health Incident was declared and the IMT met on 2 August. The following measures were put in place on the advice of the IMT.

Prompt nursery closures: Pear Tree Nursery Church Street agreed to close voluntarily on the basis of confirmed cases of STEC and remained closed following joint inspection visits. However, as the outbreak unfolded it became necessary to modify this approach with a lower threshold for nursery closure. Pear Tree Nursery Meadowpark agreed to close voluntarily on the basis of the links to Pear Tree Nursery Church Street and children with symptoms. Pear Tree Nursery West Road closed voluntarily because of epidemiological and managerial links with other Pear Tree nurseries in Haddington and symptomatic children, but did not have confirmed cases of STEC. Musselburgh Private Nursery Bridge Street closed voluntarily because of confirmed case(s) of STEC and epidemiological links with one of the Pear Tree nurseries in Haddington. Musselburgh Private Nursery Stoneybank Terrace closed voluntarily and children and staff were excluded before a case of STEC was confirmed, because of epidemiological and managerial links with Musselburgh Private Nursery Bridge Street, and symptomatic children; STEC was subsequently identified in individual(s) attending Musselburgh Private Nursery Stoneybank Terrace.

Early testing to identify cause: this was the preferred approach (Pear Tree Nursery Church Street, Pear Tree Nursery Meadowpark and Pear Tree Bridge Street), helping to identify the pathogen and guiding the response.

Development of a clinical pathway: A pathway was created by the acute paediatric team, to ensure that all those who required any assessment, were investigated, managed and followed up appropriately.

Tracing of at risk individuals*:* through detailed interviews of cases and their guardians, at risk contacts were promptly identified and followed up to prevent risk to individuals, and the public's health.

Isolation of suspected and potential cases: All individuals who had been exposed and were at risk were verbally asked to isolate to protect their families, community and the public's health.

Exclusion letters were issued under the Public Health etc. (Scotland) Act 2008.[7] They detailed the testing required, activities from which named individuals were excluded/ restricted, and the clearance process. Once the HPT received two consecutive negative stool sample results, there was a follow up discussion to establish whether the exclusion could be lifted.

When exclusions were put in place, exclusion review meetings were arranged to ensure no individual was excluded for longer than 3 weeks without regular case review.

Care and support of families affected by the outbreak (cases and contacts) was a priority for the IMT. The IMT took action to provide both individual and structural support with the following actions:

- Financial support and compensation for financial losses were made available to support cases and their families to comply with the isolation advice, in line with the guidance for implementing the Public Health etc. (Scotland) Act 2008. [7]
- The Health Visitors for vulnerable families were contacted by the HPT, the details of the outbreak situation explained and an informal referral for additional support made. NHS Lothian Public Health and Health Policy Department reviewed their local policies on re-imbursing and financial compensation for those who were excluded or needed to take time off work to look after their excluded children.

Advice from multi-agency nursery inspections: The inspections identified issues relating to the nursery environment and processes. These inspection visits were conducted by EH staff, HPT nurses, Care Inspectorate staff and East Lothian Council education department staff. Reports were approved by the IMT and then shared with the nursery management. Decluttering and deep clean of nurseries were commonly required. Nurseries were advised to focus particularly on nappy changing areas and contact points. Nurseries were inspected and then re-inspected after an opportunity to make changes, before the nurseries reopened.

Inform and Advise letters to parents and staff: These letters provided an opportunity to explain decisions made by the IMT, immediate actions, and vigilance for symptoms (Appendix 6 and Appendix 7).

Information to GPs and hospital doctors in Emergency Departments in Lothian: As the outbreak developed, and symptomatic and potentially linked individuals were identified, communication was sent to NHS colleagues across Lothian to raise awareness and advise on testing processes (Appendix 8).

Information including FAQs on NHS Lothian public facing website: Information was uploaded to the NHS Lothian website during the course of the outbreak, and in the immediate aftermath as the focus shifted to financial compensation under the Public Health etc. (Scotland) Act 2008.[7]

Epidemiological investigation of potential source of outbreak: Identifying the source and routes of transmission in an outbreak is an important step in controlling the outbreak, minimising the duration and number of affected cases. A cause of these outbreaks has not been established. Methods and results are detailed elsewhere in this report.

10 Communications

10.1 Local communications

IMT meetings were conducted by video conferencing (Microsoft Teams). Reports that needed to be discussed during IMT meetings were e-mailed to participants for discussion either before the meeting if available or during the meeting. IMT meetings were always chaired by a Consultant in Public Health.

There were three IMT meetings in the first week of August, then meetings followed a twice weekly then once weekly cadence as required until the last IMT meeting on 13 October 2022.

Clinical teams: All GP practices, Out of Hours GPs and A&E departments received general update alert emails with major developments (Appendix 8).

NHS Lothian Executive Leadership: The IMT chairs regularly updated the Director of Public Health or Deputy in person, over telephone, MS Teams or via email. IMT summaries and SBARs were also produced and disseminated. The Director of Public Health for NHS Lothian regularly updated the Chief Executive and gave verbal updates at Executive Leadership Team meetings.

East Lothian Council: Inform and Advise letters were sent to Head Teachers via East Lothian Council on 16 August 2022 (Appendix 7).

Private nurseries: A letter was sent to ICP Education (also known as Bright Stars), the company that owned the three affected Pear Tree Nursery branches, to alert them of concerns about compliance with advice at Pear Tree Nursery Church Street on 12 August 2022 and to arrange a virtual meeting to discuss these concerns.

10.2 Communication with other health boards

On 19 August 2022, the IMT notified adjacent health boards, including Borders, Fife, Forth Valley and Lanarkshire, of the outbreak. Other health boards in Scotland were informed and updated verbally via the weekly national incident update meetings held by Public Health Scotland.

10.3 Communications with the Scottish Government and PHS

Scottish Government was updated periodically by the IMT chairs, following the initial notification on 2 August 2022.

PHS was represented at the IMT by a Consultant from Public Health Scotland Gastro-intestinal and Zoonoses Team. The representative briefed their team on the investigation and control of the outbreak after each IMT. They also provided updates to the Scottish Government at the request of the IMT chair, with a summary email sent on 11 August 2022.

Due to the need for the Scottish Government to receive real time information, the IMT invited a representative from the Scottish Government to attend the IMT meetings as an observer, and from 23 August 2022 IMT membership included a representative SG Senior Medical Officer who fed back to their team after each IMT meeting.

On 12 September 2022, PHS issued a Health Protection alert due to a general rise in STEC activity in the UK since August 2022 (Appendix 2). No PHS alerts specific to the cases/outbreak in East Lothian were issued.

10.4 Communication with Parents and Nursery Staff

Parents and guardians of nursery children were sent 'Inform and Advise' letters several times during the outbreak (listed in Table 7; full content Appendix 6). These were distributed by the nursery managers. Formal exclusion letters were posted directly to affected families by HPT.

Initial information on the outbreak was uploaded NHS Lothian website 13 August.[24] There were BBC and STV news reports on the outbreak that day, including sections from a recorded interview with IMT co-chair Dr Graham Mackenzie, Consultant in Public Health Medicine.

Table 7: Key letters to parents, carers and staff at affected nurseries

Date sent	Recipient	Content
3 August 2022	Parents/ carers and staff Pear Tree Nursery Church Street	Informing of STEC cases in the nursery, symptoms to look out for and requesting clearance samples
12 August 2022	Parents/carers and staff at Pear Tree Nursery Church Street	Update on symptoms to look out for
12 August 2022	Parents/carers at Pear Tree Nursery Meadowpark	Informing of cases of vomiting and diarrhoea in the nursery and subsequent closure
16 August 2022	Parents/carers at Pear Tree Nursery Meadowpark	Informing of cases of vomiting and diarrhoea in the nursery. Advice on submitting clearance samples
17 August 2022	Parents/carers at Pear Tree Nursery Meadowpark	Providing clarity on what to do if symptomatic
19 August 2022	Parent/carers and staff at Pear Tree Nursery Meadowpark	Informing of STEC cases in the nursery, symptoms to look out for and requesting clearance samples
19 August 2022	Parents/carers/staff at Musselburgh Private Nursery Bridge Street	Inform and Advise letter
21 August 2022	Parents/carers at Musselburgh Private Nursery Bridge Street	Further Inform and Advise letter
26 August 2022	Parents/carers and staff at Musselburgh Private Nursery (Bridge Street and Stoneybank Terrace branches)	Inform and Advise and Frequently Asked Questions document
29 August 2022	Parents/carers and staff Pear Tree Nursery Church Street	Advise of reopening of the nursery
31 August 2022	Parents/carers and staff Pear Tree Nursery Meadowpark	Advise of reopening of the nursery

Date sent	Recipient	Content
2 September 2022	Parents/carers of children attending party with STEC positive cases	Inform and Advise letter
8 September 2022	Parents/carers of children at Pear Tree Nursery branches (Church Street, Meadowpark and West Road) and Musselburgh Private Nursery branches (Bridge Street and Stoneybank Terrace)	Advice on receiving results Update on reopening of nurseries Advice on how to provide feedback to HPT
12 September 2022	Parents/carers and staff Pear Tree Nursery West Road	Advise of reopening of the nursery
13 September 2022	Parents/carers and staff Musselburgh Private Nursery Stoneybank Terrace	Advise of reopening of the nursery
14 September 2022	Parents/carers and staff Musselburgh Private Nursery Bridge Street	Advise of reopening of the nursery
27 September 2022	All affected families	FAQ information about how to claim compensation

Letters were sent out periodically to staff and parents/guardians with an update on the situation, the importance of not attending schools, nurseries or mixing with other children until cleared, and details of whom to contact for further information.

Cases and contacts, including pupils and staff, received exclusion letters which included a frequently asked questions sheet and forms with information on financial compensation.

In addition, parents/guardians of nursery children, nursery staff, adult cases and parents/guardians of paediatric cases received individualised letters when clearance was confirmed with two consecutive negative stool samples taken 24 hours or more apart.

10.5 Media and Press Releases

Media releases were issued and TV interviews provided during the outbreak to raise awareness of the fast-moving situation and provide immediate information and reassurance to the local community. These are listed in Appendix 9, along with a Frequently Asked Questions document from 26 August 2022, and compensation form.

Media updates were issued following discussions with, or letters being issued to, affected families. The nursery teams were able to pass on the ‘inform and advise’ and update letters to parents and provide confirmation that all of them were aware of any updates before they were issued to the media. The one exception to this was 26 August 2022 when unfortunately there was a delay in informing families whose children attended Musselburgh Private Nursery Stoneybank Terrace, with letters going out after an STV news bulletin had been broadcast.

The first media release was issued on 13 August 2022 and was followed by seven more press releases and updated information throughout the remainder of the month until 14 October 2024 after the outbreak was declared over.

The first media release was uploaded on to the NHS Lothian website on 13 August 2022 and issued to all local and national media. The release was also picked up by BBC and STV news who also carried a pre-recorded interview with IMT co-chair Dr Graham Mackenzie, Consultant in Public Health Medicine.

The same process was followed with all of the subsequent media releases and picked up in newspapers and online news sites.

The press releases covered a number of topics, including the beginning of the outbreak, an appeal for families and children not to mix and to stay home if they were unwell, as well as the end of the outbreak and the reopening of the nurseries.

A number of approaches by media and MSPs were also made directly to NHS Lothian's press office, either to ask for updates on numbers and about individual cases or provide any other details about the outbreak.

Some direct responses were provided, but in line with NHS Lothian's media protocols, no information relating to individual cases was provided. The running number of cases was not issued in response to media questions to prevent out of date information being published.

Information was released with the agreement of the IMT members and following discussion with the Chair.

The complex situation evolved rapidly and, as the outbreak progressed, families understandably had a number of concerns and questions. Many of the issues were around compensation and the financial help available for parents who had to stay home with their children.

The Health Protection Team and the NHS Lothian Communications Team pulled together a compensation application form as well as a set of the most frequently asked questions (FAQs) and posted them on NHS Lothian's website on 26 August 2022.

10.6 Telephone Communications and Helpline

Telephone call handling: Most calls were taken by NHS Lothian Health Protection Team nurses. As the outbreak progressed, the volume of calls increased dramatically. Due to the large volume of calls, staff who had worked for the Test and Protect service during the pandemic were deployed to provide support. They received a training session on call handling and were provided with a script and Frequently Asked Questions document. Additional support was also provided from HPTs across Scotland via Mutual Aid. Band 5 nurses from staff bank were also recruited to provide the HPT with support.

The large volume of calls included routine management of the outbreak, including exclusion, test results and clearance. It also involved more detailed management of families with prolonged excretion periods who therefore had extended periods of exclusion. The families most affected by long excretion periods were managed proactively, with health protection nurses and consultants supporting families, sharing results, checking wellbeing, and signposting or linking with other services when required (e.g. Education Department, East Lothian Council and welfare rights organisations). HPT also provided contributions to answering complaints through the NHS Lothian Patient Experience Team.

Between 29 July and 13 October 2022, the Health Protection Team took 2123 inbound calls and made 3443 outbound calls.

Telephone helpline: An NHS 24 telephone helpline was set up on 24 August 2022 and ran until 19 September 2022. It was open 9pm-5pm, Monday to Friday.

A list of questions and answers (a 'Frequently Asked Questions' document) was compiled and periodically updated; a public facing version was uploaded onto the NHS Lothian web-site, and a more detailed version was available as a resource for call-handling staff.

During this time 27 calls were taken by the helpline. However, as the numbers for the East Lothian Council and Health Protection Team were already in the public domain, calls contin-ued to be taken by the local authority and NHS board during this time.

10.7 Enquiries and Freedom of Information Requests

There were enquiries and Freedom of Information (FOI) requests from members of the public and elected representatives.

On 26 August 2022, the Director of Public Health provided an update letter to elected repre-sentatives and a further update to MSPs on 4 October 2022 as part of the Elected Members Update Speed Read document. In addition, NHS Lothian HPT responded to three MSP en-quiries.

The IMT discussed FOI requests at several points during the outbreak. It was agreed by the IMT that any FOI requests regarding the outbreak would be forwarded on to NHS Lothian and handled by the Health Board.

NHS Lothian responded to two individual FOI requests received in October 2022 and May 2023. Both were responded to within the 20 day target.

These requests were seeking information on:

- details of the bodies represented on the Incident Management Team
- number of confirmed cases
- number of exclusion orders, and details of lifting exclusion orders
- details of the epidemiological, environmental and microbiological investigations
- note of correspondence with government
- notes of correspondence relating to meetings of the Incident Management Team
- details of numbers of samples submitted and actions to increase number of samples getting to the right laboratory first time.

East Lothian Council received two FOI requests which the council responded to within 20 working days. These were processed under Environmental Information (Scotland) Regula-tions 2004[25] rather than FOI. Responses from the FOI team at East Lothian Council were based on information provided by Environmental Health, Education and Legal team.

PHS also received two FOI requests on the outbreak. Responses were again issued within 20 working days by PHS FOI team. The FOI requests could not be answered due to the ongoing investigations at that time or because PHS did not hold the information requested. Exemption and exception notices were used in these instances.

10.8 Concerns/Compliments

The NHS Lothian Patient Experience Team received 15 enquiries and 1 compliment related to the outbreak. The concerns regarded delays in testing and receiving results, and unhappiness with the handling of the outbreak. The compliment reflected on a positive experience with the Health Protection Team during the outbreak. Scottish Government received five complaints sent to their Infectious Diseases team relating to the STEC outbreak. Four of these concerns were of almost the same wording and content, and were related to processes and communications.

No formal concerns were raised to the Care Inspectorate or East Lothian Council Environmental Health regarding the outbreak.

11 Discussion

With confirmed STEC infections in multiple nurseries in two towns in East Lothian this outbreak represented a very significant challenge to the nurseries, families, wider community and supporting services.

Separate outbreaks: Our findings from epidemiology and microbiology investigation including WGS indicate that the outbreak in East Lothian was in fact two distinct outbreaks. Two nurseries with most of the confirmed cases (Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark) had two different dominant strains: *E. coli* O157:H7 in Pear Tree Nursery Church Street and *E. coli* O157:H39 in Pear Tree Nursery Meadowpark. Other strains were identified within these and the other nurseries.

The dominant strains at Pear Tree Nursery Church Street and at Pear Tree Nursery Meadowpark were different, which confirms that the infection did not spread from one nursery to the other. While it is not possible to demonstrate the original route of introduction of infection, the data suggest that infection was introduced and transmission occurred separately within Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark.

Although there were epidemiological links between Pear Tree Nursery Meadowpark (Haddington) and Musselburgh Private Nursery Bridge Street and from there to Musselburgh Private Nursery Stoneybank Terrace, the microbiological analysis demonstrates that the STEC strains from the two Musselburgh nurseries were unrelated to the Haddington cases. Comparison with the underlying rates of STEC infection within East Lothian suggests that the number of cases associated with Musselburgh Private Nursery branches were within expected levels, suggesting that the Musselburgh cases were sporadic rather than outbreak related.

The organisms identified in the concurrent UK-wide outbreak of *E. coli* O157 had a different SNP address to those isolates involved in the nursery outbreak, confirming the two outbreaks were not related to the national outbreak.

High attack rates in nurseries: Spread of STEC infection in this age group is facilitated by prolonged shedding, underdeveloped hand hygiene and immature immune system.[26] The poor hygiene observed in Pear Tree Nursery Church Street may have contributed to the high attack rate observed in this nursery, particularly in the youngest children, but the specific organism (*stx*2a with *eae*) is also likely to have impacted on this.

Virulence factors: Although all STEC strains have the potential to cause diarrhoeal disease and be of risk, especially in susceptible groups, the carriage of certain genes, rather than *E. coli* serotype, is thought to be a more accurate predictor of severe disease. The presence of certain virulence genes (including the *eae* gene) and *stx* subtype (particularly *stx*2a, 2c, 2d) is now accepted to be a reliable predictor of severe disease. Rather than managing all STEC cases in the same way, some countries now triage their public health response to those cases infected with STEC likely to cause the most severe disease. In this outbreak *stx*2a carriage was associated with more severe outcomes including hospital admissions, bloody diarrhoea and HUS.

Asymptomatic carriage: Faecal samples from asymptomatic cases were submitted to SERL, as recommended in the Scottish Health Protection Network STEC guidance[1], as they were categorised as being submitted from “outbreak-associated” cases. It is therefore possible that the outbreak of *E. coli* O157:H39 cases at Meadowpark (of which the majority did not

experience any symptoms consistent with *E. coli* infection) would not have been detected had there not been an outbreak investigation. Indeed, considering the mild symptoms/ absence of symptoms in these confirmed cases, it is likely that far fewer individuals would have sought medical advice had there not been awareness of a concurrent outbreak in East Lothian. This is an important consideration, as the process of clearance for cases and contacts in risk groups resulted in delays in individuals returning to education and employment, as confirmed cases in certain high risk groups must undergo microbiological clearance, requiring two negative faecal samples taken at least 24 hours apart.

The level of asymptomatic carriage of STEC in nursery age children in Scotland, outwith an outbreak setting, is unknown. The concern around asymptomatic carriage of gastrointestinal disease has been a known public health concern for many years[27] and studies from other countries suggest the risk of asymptomatic STEC secondary transmission to susceptible persons may be higher than originally thought[28] which is one of the reasons extensive testing was conducted in this outbreak. Another reason for "casting the net wide" from an early stage was the lack of clear epidemiological signal on a potential source of infection. The results of extensive testing of asymptomatic children under 5 years old during this outbreak are likely to have relevance to future national STEC guidance.

With the availability of more sensitive molecular testing, and potential roll-out of PCR platforms for detection of enteric pathogens in routine diagnostic laboratories, it is likely that laboratory detection of STEC will increase in the future. The impact of this on patients, laboratories and Health Protection Teams must be assessed, with consideration given to amending Scottish guidance and introducing a risk assessment approach for the management of infection, to include prioritising the public health response to those cases infected with STEC known to cause more severe disease.

Exploring origins: STEC O157:H7 is known to be responsible for the most severe STEC outbreaks reported worldwide.[29] STEC serotype O157:H7 is responsible for foodborne disease outbreaks, typically associated with the consumption of undercooked foods contaminated with cattle manure containing the bacterium.[30]

We observed that some of the *E. coli* serotypes were uncommon compared with the common subtypes that are often detected in the UK. The bioinformatic analyses indicated the strain of STEC in this outbreak clustered most closely with other strains isolated from cases reporting that they had not recently travelled outside the UK. The source of infection was therefore likely to be of domestic (Scotland) origin. This suggests that infection of the first case(s) was most likely due to (i) direct contact with UK cattle or their environment, (ii) contact with, or consumption of, contaminated meat or dairy products from Scotland cattle or sheep or (iii) consumption of produce cultivated in close proximity to a ruminant reservoir in Scotland.[1]

There was evidence of dual infection in at least one individual in this outbreak (a person infected with more than one strain of *E. coli* O157/STEC). It is difficult to microbiologically detect *E. coli* O157/STEC infection caused by dual or multiple strains. Cases infected with more than one strain only become apparent during the isolation process, following a positive PCR result. Subsequent isolation of more than one organism would only be pursued if the different strains had a different virulence profiles on PCR. It is therefore not possible to determine the extent of multiple carriage of more than one O157/STEC strain in every PCR positive patient sample. This would be a time consuming and costly exercise with little impact on the clinical management of individuals, as they would already be managed as an STEC case.

A detailed investigation to determine a source of infection was conducted, with extensive testing of food, water, environment and veterinary samples, but no source was identified. The animal samples, however, were taken a month after the outbreak started.

The transmission network analysis (results not shown to avoid identifying individuals) suggest person-to-person spread. However, questionnaires were used to try to identify any potential common exposure by examining food consumed and outdoor environments visited. This data collection relied on recall of the individuals, or their parents/ carers being interviewed. Therefore, it is possible that potential food or environmental sources have not been identified: for example, trips to other public venues such as play parks, leisure farms, beaches and country parks.

A case-control study was considered. However, descriptive epidemiology provided the evidence required for the control of the outbreak. In addition, the timescale for the control of this outbreak, and the challenge of finding "controls" from the same age group and similar setting, who had also been tested for STEC over the period of the outbreak, meant that a case-control study was not possible.

Communication: During the outbreak, Lothian HPT and East Lothian Council were contacted by some parents and carers who were anxious and frustrated. Some parents stated that they felt that the letters and press releases did not provide adequate information. Lothian HPT produced a Frequently Asked Questions document, which ended up being a long document to cover the specifics for each nursery. Inclusion of messages such as "stay at home" in Inform and Advise letters to parents led to enquiries about the detail, including impact on the wider family such as food shopping and attending essential appointments. On reflection, an alternative option to providing written material may have been scheduling regular "Town Hall" style video conference meetings. This would have provided opportunities for updates from HPT, but also for parents to ask questions and provide feedback to HPT, and to understand the rationale and detail of exclusions.

Hand hygiene in children: Children under 10 years old have variable levels of skill in effective hand washing. This is often expressed in infection control guidance as "doubtful hand hygiene". Consequently, children can be excluded from activities if they cannot reliably carry out hand washing to a standard that will prohibit spread of infectious diseases which are transmitted by the faecal-oral route (see Table 1).

Current Scottish guidance recommends exclusion of children under 5 years of age for the reasons detailed above, but also noting that "older children (5 to 10 years) may also fall into this risk group if there are concerns about hygiene practices, and an individualised risk assessment should be performed".[1] Alternatively, the current UKHSA guidance recommends exclusion of children up to their 6th birthday.[26] The NHS Lothian Standard Operating Procedure (SOP) excluded all children up to 10 years of age with the rationale that they had 'doubtful hand hygiene'.

Advice in national guidance can be viewed as a response to individual cases. An outbreak presents very different challenges, and individual risk assessments for all children in such a context may be of more limited value, whether confirmed cases, or contacts of confirmed cases. That is particularly the case if there are concerns about wider hygiene, as was the case in initial inspections of nurseries involved in this outbreak. The IMT therefore decided that cases and contacts under 10 years old were to be excluded in this outbreak. Individualised risk assessments were conducted in the later stages of the outbreak and beyond, as was possible for the small number of families experiencing longer mandatory isolation.

Following the outbreak NHS Lothian HPT SOP has changed for management of 5-10 year olds. The SOP now states "*A risk assessment may be required for cases and contacts aged 6-10 years to establish whether they meet the criteria for Risk Group A and therefore need to be excluded*". There is now more tailored risk assessment conducted for children aged 6-10 years. For future outbreaks, risk assessment will need to take into account the very considerable risks of STEC in this age group and guidance needs to be harmonised nationally.

Other factors: The outbreak occurred while strike action by Royal Mail employees was ongoing and there was a possibility that this could have caused delays in the delivery of exclusion letters from the HPT to cases and contacts.

12 Conclusions

This was an unusually complex incident that affected five nurseries (one of which did not have cases of STEC infection) in East Lothian over a period of over a month. Fifty-two children and five adults, all with links to nurseries, tested positive for *E. coli* O157/STEC during the outbreak. Half of these individuals were asymptomatic. The microbiological investigation identified that there were two distinct outbreaks and some sporadic cases. Subsequent investigation found that one of the five nurseries had no *E. coli* O157/STEC cases identified. This incident resulted in considerable disruption for families, communities and health and education services. The outbreak coincided with a national spike in *E. coli* O157/STEC cases unrelated to this outbreak and a subsequent (unrelated) outbreak in another region of Scotland, which put additional pressures on laboratory services.

Despite the extensive investigations, no source for the outbreak was identified. We conclude that after introduction of different types of STEC infection into two nursery settings (Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark), there was spread from child-to-child within but not between these nurseries. The way that infection was introduced into the nursery was not identified. There was also asymptomatic carriage of *stx*-negative sorbitol-fermenting *E. coli* O157:H39, the clinical relevance of which is unclear. The findings may have implications for future guidance.

Widespread screening, facilitating early identification of cases, followed by immediate exclusion and communication to parents and guardians about the risks associated with *E. coli* are likely to have controlled the spread of the infection. A multipronged communication strategy, deployed by the IMT, which involved direct information to the parents and guardians, press releases and media interviews aimed to allay the anxiety. Nonetheless, the disruption generated anxiety in the community and caused a large number of enquiries and two Freedom of Information requests to the HPT. The disruption caused to family life may have influenced and reduced the level of concordance with public health restrictions. A townhall-style meeting with parents might have helped explain the rationale for the actions, and reduced the distress, and should be considered in future outbreaks.

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13 Lessons Identified

1) Capacity of teams: This was a large and complex outbreak at a point when society, healthcare services, childcare settings and other organisations were adjusting to loosening of Covid restrictions. The IMT, clinical services and HPT had to ensure adequate capacity to manage a large outbreak over a period of almost two months. This had implications for capacity and stamina of all affected services. There was also considerable pressure on the HPT administration team to set up meetings, issue reports and produce minutes of IMT meetings in a timely fashion. Sharing this information, and providing regular updates, can put pressure on the whole IMT and individuals' inboxes.

Understanding the role of different teams, and individuals within the teams, is important. For example, Environmental Health noted that they could have helped complete the STEC questionnaire with families.

A complex outbreak of this nature can be expected to grow rapidly in size (number of cases and settings). Communicating with the public about a concern will result in increased testing, some of which will identify further STEC infections. The repercussions can be predicted, and information that is readily available (e.g. number of calls received) can be used to predict the likely workload in the near future. That information can be used to plan resources (e.g. testing for the laboratories, admin time for exclusion and clearance letters, number of nurses for call handling).

STEC infection can have serious complications for young children, and requires assessment, testing and monitoring of children at first diagnosis. This outbreak therefore had a significant impact on the acute paediatric team. It occurred at a particularly busy time of year for the acute team. Managing an outbreak of this scale requires additional nursing, medical and administration resources for the hospital. Furthermore, it occurred at a point when medical teams had a new intake of junior medical staff. The speed and flexibility with which the whole team introduced and implemented a clinical pathway for assessment, investigation and follow up of the children referred is to be commended alongside the work of all the other teams.

In future large outbreaks an NHS 24 helpline should be set up earlier, which can be scaled up and down depending on call volumes. Letters to parents/guardians and nurseries should include the phone number for this helpline from an early stage. This would free up HPT to investigate and manage the outbreak, including lifting exclusions after negative stool samples. Mutual aid from other HPTs is very important in scaling up and down HPT capacity, but this requires shared access to guidance, files and data. IT input to help with telephony and shared folder access between regions will be important in managing outbreaks that require mutual aid in the future.

During a large outbreak, external requests will be received from different sources (complaints, letters, Freedom of Information requests), including parents, Scottish Government, MSPs, journalists, and others. These requests are clearly very important, but responding is time consuming, at a point when HPT resource should be prioritised for investigating and managing the outbreak. A small number of families made repeated contact with HPT. Some of these families were very distressed and required a lot of support. A small number of families became abusive to HPT nurses. This meant that HPT nurses had less capacity to deal with other calls (see point 4 below).

2) Interdisciplinary and interagency working during an outbreak: Work to investigate and manage an outbreak is a team activity - multidisciplinary and multiagency. This outbreak required input from several local and national organisations, all of whom were essential in investigation, risk mitigation, communication and control measures. IMT work is detailed in national guidance and legislation; it is important that all members of the IMT are aware of the legal powers available, and associated guidance.

The independence of the IMT is important in advising the different organisations on the actions to take and resources required to control the outbreak and minimise the risks to public health. The IMT will involve different organisations and teams depending on context, some of whom may not have had direct experience of such work previously. Clarification about the roles and remit of the IMT would be helpful for all participants, including the different responsibilities of those who are full members, in attendance or observers. Training of senior management in partner agencies that are not often involved in such incidents, to help them understand the role and remit of the IMT, would be helpful. Ideally there should be continuity in representation and chairing at IMT meetings.

Gathering information from - and conveying and explaining decisions to - the nursery providers is important, but there should be clear separation between the IMT and nursery; nursery management should not be invited to attend IMTs or supporting meetings.

An Incident Management Support Team is sometimes required to support an IMT, for example when additional resources are required or strategic support to unblock issues. Additional consultant input could have helped communicate with parents and the community while HPT was managing other aspects of the outbreak. There are always lessons in a complex outbreak to learn about the deployment of resources and triggers for seeking senior support.

This outbreak required repeated multiagency nursery inspections. Understanding the different roles and responsibilities of the different officers and agencies is important, both in making decisions and conveying these to the nursery, and reporting findings to the IMT.

Thought should be given to simplifying IMT meeting agendas, and introducing a checklist for rapid consideration of environmental sources for an outbreak – e.g. water, swabs, food, animals, outside play areas. If a swabbing/sampling exercise is to be undertaken, this should be done as early as possible as any deep cleans undertaken may result in failure to pick up sources of contamination.

3) Epidemiology: For this outbreak, with its considerable complexity, earlier data scientist input would have helped with the epidemiology. Capacity for local communicable disease descriptive and analytical epidemiology is critical for local outbreak management, from the very start of an outbreak. The epidemiological information required to manage an outbreak is derived from local knowledge and locally held data, and expertise in local public health practice. These are specialist skills, which require access to accurate data and are difficult to obtain through mutual aid within or outwith the health board. The collection and management and curation of data was essential to the IMTs investigation. This is a large and complex task, which requires access to up-to-date software. This could be improved, with advances in digitised systems, updated IT, capacity of data management staff and appropriate training for data entry staff involved. The epidemiological analysis did not identify a source of infection,

but that is not unusual for an investigation of this complexity. Nonetheless, the investigation demonstrated high attack rates within (but not between) two of the nurseries (Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark). The investigation, which included network analysis, provided useful findings, but these could not be shared more widely because of the risk of deductive disclosure.

4) Impact of STEC outbreak, and IMT communication, on families: The level of disruption and distress experienced by parents, children and business is also predictable in an STEC outbreak, because affected members of the public are being asked to restrict their activities dramatically, even though many of these individuals may be asymptomatic. Some of that distress could be minimised by earlier engagement with families. That was challenging in this outbreak because of the large numbers of affected families, and also because of the evolving control measures and the difference in approaches between nurseries.

During an outbreak, communication with families aims to describe the nature of the infection, ways to minimise spread, when to seek further assessment, and how to minimise the impact of exclusion (e.g. through compensation). Much of the communication during an outbreak is by phone and letter. Additional information is made available in frequently asked questions (FAQs) and on the internet.

The different approaches to closure and testing used for the different nurseries made communication complex, with different information required for each nursery. The main focus of the IMT was to reduce the potential harm from an evolving STEC outbreak. It was challenging to keep parents informed with such a rapidly changing situation, when the main focus of the IMT was on gathering information, making decisions, and introducing control measures. In future outbreaks, there should be more focus on explaining decisions to families and nurseries early on, and providing regular updates. This would be expected to help build trust, help with implementation of control measures, and reduce parental distress.

The timing of written information to parents could also have been improved. On one occasion information was not relayed to families by one of the nurseries. On another occasion a letter to parents was delayed as information was checked for the different arrangements for the five nurseries, and this meant that the parent letter was sent out after a news bulletin was released. Information in the formal exclusion letters could have explained the meaning of “exclusion” in more detail. Pressure on HPT meant that exclusion letters were sometimes delayed, but these families had been verbally excluded from nursery/work.

Distressed families require additional support, and that needs to be adequately resourced in staff skills and time. In the absence of additional resource, this can be very time consuming for HPTs already under pressure to manage an outbreak and help return families back to normality. Families experiencing distress should have rapid lines of support - whether from the local authority (financial advice, education) or the NHS (e.g. support from HPT for enquiries about samples and exclusions, and the patient experience team when providing feedback/complaints). An HPT could request nurseries involved in outbreaks to share contact details of all parents and staff to allow direct communication from HPT to these groups.

5) Whole genome sequencing: The IMT was worried that links between the Haddington nurseries, and conditions in the first of these nurseries (Pear Tree Nursery Church Street), could have indicated a wider problem and might have meant that this was a single outbreak across multiple nurseries. However, WGS, coupled with epidemiological investigation,

identified that this was in fact two separate outbreaks in two nurseries, and some unrelated sporadic cases. The national spike in cases meant that there was additional pressure on the national reference laboratory, caused by the following challenges:

Surge in sample submission: Over a number of years, sample submission to the SERL has increased considerably, partly, but not entirely due to diagnostic laboratories responding to changes in national guidance for management of STEC infection. Between August and October 2021, 2188 samples were submitted to the SERL for testing, compared to 4548 samples between August and October 2022. There was a 464% increase in sample submission from NHS Lothian diagnostic laboratories comparing August-October 2021 (363 samples) and August-October 2022 (2047 samples). Although a small number of submitted samples were linked to other outbreaks, the majority were submitted in response to this incident.

Requirement for isolation of SF O157 & Non-O157 STEC: Whole genome sequencing plays a vital role in outbreaks, by identifying and characterising the organisms involved, identifying the transmission routes and helping to pinpoint the source of the infection. That was why every effort was made in this investigation to isolate an organism from each PCR positive patient (WGS is not currently performed directly on a faecal sample). However, isolation of SF O157 and non-O157 STEC is not straightforward and is a globally recognised bottleneck following the PCR detection stage, and can impact outbreak investigations if isolates cannot be cultured and WGS conducted. Most laboratories performing isolation from PCR positive faeces screen 10 colonies on a culture plate by PCR in order to identify the organism responsible for the original positive faecal PCR result. If the organism responsible cannot be identified by culture, the sample will be reported as PCR positive but not confirmed by culture and no further work will be conducted. At SERL, a large number of colonies on a plate may be screened in an attempt to isolate an organism for further characterisation and WGS. Although this process has been streamlined, it does incur extra time. However it has proved successful and isolation rate is currently 80%. In this incident, we managed to isolate organisms from the majority of PCR positive cases (44/53 cases – 83% isolation rate) meaning WGS results were available to assist with the outbreak investigation.

During the acute outbreak investigation, SERL reviewed its testing protocol to assess whether further streamlining of laboratory testing was possible and, as a consequence, Phage Typing was suspended following agreement by PHS and National Services Division of NHS National Services Scotland. By this point, Phage Typing had been performed on all *E. coli* O157:H7 strains in this incident. *E. coli* O157/STEC are Hazard Group 3 pathogens, requiring extra levels of containment and highly trained staff therefore it was not possible to train other users to work in Containment Level (CL) 3 laboratories, where all work on live organisms is conducted. However, SERL received assistance from the other Scottish Microbiology Reference Laboratories (Edinburgh) and the Department of Laboratory Medicine, NHS Lothian for various non-CL3 related work. This enabled SERL to focus on conducting the maximum number of WGS runs per week (n=3).

The Turnaround Time for whole-genome sequencing is dictated by the time taken to isolate an organism for sequencing and the time each WGS run takes (~45h) using current Illumina technology.

6) Lessons for local and national testing protocols: Current evidence and national guidance does not describe the role that asymptomatic carriage plays in disease transmission. In this outbreak, half of the identified cases were asymptomatic. Furthermore, some of the cases with milder symptoms, particularly in the absence of bloody diarrhoea, would not have met the threshold for STEC testing had there not already been concern about an outbreak in a connected nursery. While some children from Pear Tree Nursery Church Street became unwell and required hospital assessment and treatment, affected children in the other nurseries typically had a self-limiting infection. With the prompt control measures put in place, we cannot know how many cases of STEC infection, significant morbidity and hospitalisation might have occurred if the outbreak had been left unchecked. One scenario would be that the "48-hour rule", where children and staff are asked to remain away from nursery for 48 hours after symptoms have stopped, would have minimised further harm. However, another scenario would be that without control measures a much larger number of children would have become infected and some of them could have become very unwell. The whole nursery testing and detailed results available from this outbreak might have lessons for management of future outbreaks.

Current Scottish guidance is for exclusion of children under 5 years of age. UKHSA guidance excludes children up to their 6th birthday. Both guidelines have risk group A for those with dubious hand hygiene, which will include some primary school age children. The Scottish guidance recommends an individualised risk assessment. During a large and complex outbreak individualised risk assessment is not feasible. In the future, guidelines should be clear about age – the UKHSA rule of excluding up to the 6th birthday is clear. Risk assessment for 6-10 year olds could potentially be the responsibility of the primary school, working with HPT and EHOs.

7) Microbiology testing pathways: The flow of samples from the patient to the laboratories, via the GP, was complicated by a number of factors including the number of samples submitted and subsequently by the different organisms identified. This was the first Scottish outbreak where *E. coli* O157 (both NSF and SF) and non-O157 organisms were identified in the same incident. This had implications both for testing symptomatic patients and clearance samples during this outbreak. Additionally, some cases and contacts reported that their samples had gone missing. There is potential to streamline this process. This was reviewed subsequently as part of a quality improvement project in HPT, working with GPs and both laboratories.

8) Enforcement: The nurseries involved in the investigation and management of this outbreak closed voluntarily and promptly. This was extremely helpful. This is likely to have limited the number of cases of STEC infection and complications. The circumstances might have been very different if the nurseries had not agreed to voluntary closure. The legal powers that HPTs, EH and IMTs have in relation to the Public Health etc. (Scotland) Act 2008 need to be better understood and strengthened, particularly around the powers to compel premises to close. This is an area for further exploration at a national level.

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14 Recommendations

1. **IMTs managing complex incidents must be resourced to work over long periods of time (weeks or months).**

   This applies across all organisations and teams working on the incident. The teams most affected by the incident (e.g. HPT, labs, clinical teams) need to rota staff (where possible) so that there is capacity throughout the incident. For some very specialist teams, however, such as SERL, it is not possible to pull in staff from other sections.

   HPT administrative support is essential to ensure effective inter-agency coordination, accuracy in document management, rapid turnaround time of meeting notes and confirmation of follow up of actions.

   A pool of business support assistants trained specifically in supporting IMTs is required to ensure accurate and timely production of minutes, action logs and decision logs.

   Action: NHS Lothian HPT/Health Boards and Chairs of IMT.

2. **The process of requesting mutual aid should involve assessment of resources that are required and how they will be deployed and managed.**

   Staff from other health boards who were providing mutual aid needed to be briefed and updated about the situation, which took time. IT access - particularly HPZone (the HPT records system) and network drives (that contain SOPs and line listings) – was difficult to obtain (and in some cases was not possible).

   Before calling for mutual aid in such a complex incident, the HPT should consider how the logistics will work and the tasks to be performed, and assess the best way to involve these staff in managing the outbreak.

   Action: NHS Lothian HPT/Health Board.

3. **Options for improving communication between organisations involved in IMTs should be explored.**

   Secure communication between the different organisations – e.g. in providing regular updates, or collaborating on reports and analysis – was challenging, with inboxes filling up very quickly. Options for simpler communication processes should be explored.

   Action: NHS Lothian HPT/Health Board/ Local Authority/ other agencies.

4. **In a major outbreak, a fully constituted incident management support team needs to be put in place as per national guidance.**

   Resources required for an outbreak should be directed by the IMT Chair as per national IMT guidance. The Incident Management Support Team supports the IMT and, with senior management support, can free up resources within the wider team (e.g. consultants in public health, data scientist support), and make the case for other help (e.g. IT issues, mutual aid, involvement of Patient Experience Team to support families in distress). The arrangements for IMT and Incident Management Support Team to manage a longer outbreak, and manage resources accordingly, should be considered further and tested in exercises.

   Action: NHS Lothian HPT and NHS Public Health and Health Policy Directorate

5. **Roles and responsibilities of each IMT member should be clarified at each IMT meeting to ensure that members understand each agency's roles.**

   A clear understanding of the role of the IMT and its members is essential for effective functioning of the IMT. The chairs of the IMT should guide all members of the IMT, at the very beginning, on their roles and responsibilities and signpost them to national guidance.[13] Members of the IMT must also be empowered by their parent agency to make an effective contribution to the group. The national guidance could be appended to the standard IMT agenda for awareness.
   Action: NHS boards (Chairs of IMTs) and all partner agencies in the IMT

6. **Joint training and exercising by partners and familiarisation with each other's methods of work is recommended to improve the effective working of IMTs.**

   Understanding of the legislation and rationale for IMT formation is essential. Good collaborative working between agencies helped with joint risk assessment and decision making. Training and exercising on incident management will further promote the good working relationships. This training should stress the importance of good communication, openness and transparency. Pre-recorded accessible training resources in video format may be useful.

   Action: NHS Boards (Chairs of IMTs) and IMT partners.

7. **The communication teams of all agencies represented on an IMT need to work closely with each other to ensure consistency in message content and in the timely release of messages for the public.**

   Action: IMT partners from all relevant agencies involved in managing outbreaks (NHS boards, local authorities, PHS and Care Inspectorate).

8. **A public health scientist with expertise in communicable disease epidemiology should be involved in the outbreak investigation at a very early stage.**

   Epidemiological analysis is required by the HPT and IMT at all stages of outbreak investigation for effective risk assessment and timely intervention.

   Action: NHS Lothian HPT/Health Board

9. **HPTs should have data collection tools which align with surveillance forms.**

   The rapid collection of data, ideally pre-populated with information from other databases, is important in describing the incident and planning control measures. As per recommendation 2 (mutual aid) it is important that these forms can be used across NHS Board boundaries. It is also important that different team members can work on forms at the same time. One option might be use of Microsoft Forms, but that would require exploration of information governance, and training and testing of systems within the team and across borders.

   Action: NHS Lothian HPT/Public Health Scotland

10. **Establish more direct routes of communicating with families, rather than relaying messages through the nurseries. Schedule regular meetings (virtual or in person) as an additional means of providing parents and guardians with updates; give them a chance to ask questions and be reassured.**

    Effective and regular, consistent communication with relatives and guardians is essential during a major outbreak. There was great demand for information by parents and guardians which could not be fully met by the methods of information provision used by the IMT, such as Inform and Advise letters relayed via the nursery, press releases and FAQs. HPTs should request that nurseries involved in outbreaks share contact details of all parents and staff to allow direct communication with these groups. As recommended in the SAGE SPI-B report on the Covid pandemic[31] community champions should be identified and engaged to act as regular points of contact with the community.

    Action: NHS Lothian HPT/All IMT members

11. **The accessibility and readability of communications that are issued as part of outbreak management (e.g. letters to parents) should be reviewed.**

    Health Protection Teams have template letters for many situations, which have been developed and revised over many years. Some of these resources are now rather long, or have information that needs to be updated. These letters and resources should be reviewed, considering health literacy principles and accessibility legislation.

    Action: NHS Lothian HPT

12. **During a large outbreak the IMT requires additional support to deal with complaints, enquiries and Freedom of Information requests.**

    This was a complex outbreak involving hundreds of individuals and families with considerable disruption to their lives. This led to requests for further information from a range of different sources. Some families reported considerable distress, for example resulting from exclusion from nursery or work and the clearance process. Early involvement of the health board Patient Experience Team to deal with complaints and concerns would be beneficial. HPT staff would benefit from training about managing calls when callers show signs of distress. Most HPT work is done by phone or email. Updating information on the recorded phone message played at the start of each call to HPT could be useful, but such changes incur a charge, and may need to change a number of times during an outbreak. Opportunities should be taken to reinforce NHS Lothian policy that the organisation will not tolerate abusive treatment of staff.

    Action: NHS Lothian HPT

13. **Feedback should be gathered from those affected by the incident (parents, organisations (e.g. nurseries).**

    In future incidents there should be mechanisms for assessing the impact of the incident. This should be as soon after the incident as possible, either in a debrief exercise with stakeholders, focus groups or questionnaires.
    Action: NHS Lothian HPT

14. **Explore the use of different sequencing technologies, for example Oxford Nanopore, for more rapid WGS results.**

    Although Nanopore sequencing is currently used for Sars-CoV-2 sequencing, its utility in foodborne outbreaks of infection is uncertain, although some international groups are conducting evaluations. SERL will explore opportunities to evaluate this technology and assess its utility in proving more rapid results, particularly during outbreaks of infection.

    Action: SERL

15. **There should be a review of evidence nationally, and update of guidance on the interpretation of STEC results in relation to clearance and asymptomatic carriage.**

    Universal testing of the affected nurseries, the availability of whole genome sequencing, and the high proportion of asymptomatic cases identified during this outbreak have potentially important lessons for future national guidance.

    Action: SHPN GIZ group

16. **Cases and contacts aged 6-10 years should be risk assessed when considering their exclusion.**

    A clear exclusion criterion is required for all cases and contacts for timely and effective intervention. The Scottish guidance recommends exclusion of children under 5 and a risk assessment of children aged 6 to 10 years, while the UKHSA guidance recommends exclusion of children up to their 6th birthday. On the other hand, at the time of this outbreak NHS Lothian SOP recommended blanket exclusion of children under 10. Given the experience of risk assessment of families experiencing long mandatory isolation, cases and contacts aged 6 -10 years should be risk assessed when considering their exclusion.

    Action: NHS Lothian HPT and PHS GIZ team

17. **A clear pathway and flow of samples to the laboratories and results to NHS Lothian HPT is required for efficient investigation and management of outbreaks.**

    Future IMTs should consider convening a Laboratory-Working group at the outset of an incident, to focus on a workable, scalable solution to the flow of samples from patients, via GP surgeries, to the laboratories, and between laboratories (depending on what organisms are detected), and the flow of results from laboratories to the HPTs. This should include decisions on labelling and which samples should be tested in which laboratories.

    Action: NHS Lothian HPT, NHS Lothian Microbiology and SERL

18. **The legal powers that HPTs, EH and IMTs have in relation to the Public Health etc. (Scotland) Act 2008 need to be better understood and strengthened.**

    It was extremely helpful that the nurseries involved in this outbreak opted to close voluntarily. The Public Health etc. (Scotland) Act 2008 should be strengthened, particularly around the powers to compel premises to close.

    Action: Public Health Scotland, Scottish Government

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16 Appendices

16.1 Appendix 1: Membership of IMT

***E. coli* Incident Management Team membership**

Please note, on occasion, meetings were attended by junior and trainee staff for training purposes.

Co-Chairs of the IMT

Name	Role	Organisation
Dr Graham Mackenzie	Chair, Consultant in Public Health	NHS Lothian
Josie Murray	Chair, Consultant in Public Health	NHS Lothian
Dr Richard Othieno	Chair, Consultant in Public Health	NHS Lothian

Membership of the IMT

Name	Role	Organisation
Alison Cameron	Quality Improvement for Early Years	East Lothian Council
Amie Borge	Advanced Health Protection Nurse	NHS Lothian
Andrew Douglas	Environmental Health Team Manager	East Lothian Council
Arlene Reynolds	Senior Professional Adviser in Public Health	Scottish Government - observer
Cara Lewis	Infectious Disease	Scottish Government - observer
Carol Calder	Lead Nurse, Edinburgh Infection Control Team	NHS Lothian
Cath Agnew	Care Inspectorate	Care Inspectorate
Cath Morrison	Advanced Health Protection Nurse	NHS Lothian
Chris Tracey	Health Protection Nurse	NHS Lothian
Dr Donald Inverarity	Consultant Microbiologist	NHS Lothian
Dr Ewan Olson	Microbiology Consultant	NHS Lothian
Fiona Smith	Business Support Officer/PH HPT	NHS Lothian
Genna Leckenby	Healthcare Scientist Advanced (Epidemiology)	Public Health Scotland
Dr Geoff Foster	Microbiologist, Veterinary Services	Scottish Rural College
Dr Gill Hawkins	Senior Medical Officer	Scottish Government - observer

Name	Role	Organisation
Holly Macdonald	Environmental Health	East Lothian Council
Jacky Gillan	Service Manager	Care Inspectorate
Jacqueline Dennis	Senior Improvement Advisor	Care Inspectorate
Dr Janine Thoulass	Consultant Public Health Medicine, Clinical Health Protection	Public Health Scotland
Jean Harper	Geographical Lead, Sick Children's hospital	NHS Lothian
Jeni Armstrong	Advanced Health Protection Nurse	NHS Lothian
Jill McKay	Environmental Health Comms Lead	East Lothian Council
Joanne Allen	Communication Lead, Early Years	East Lothian Council
Dr John Cowden	Consultant Epidemiologist	Public Health Scotland
Karen Quinn	Team Manager, Care Inspectorate	Care Inspectorate
Kizzy Taylor	Communications Manager	NHS Lothian
Laura Jones	Consultant Paediatrician	NHS Lothian
Dr Lesley Allison	Principal Scientist/ Deputy Director	Scottish *E. coli* O157/STEC Reference Laboratory (SERL)
Linda Mulhern	Operations Manager, Microbiology Laboratories	NHS Lothian
Lindsay Guthrie	Associate Director, Infection Prevention and Control	NHS Lothian
Louise Wellington	Health Protection Clinical Nurse Manager	NHS Lothian
Lynda Browning	Principal Healthcare Scientist (Epidemiology)	Public Health Scotland
Lynn Crothers	Protective Services Manager, Chief EHO	East Lothian Council
Lynne Ziarelli	Communication Manager	NHS Lothian
Marion Muir	Environmental Health	East Lothian Council
Prof. Matt Holden	Professor of Pathogen Genomics	Public Health Scotland
Nicola McDowell	Head of Education	East Lothian Council
Peter Harrison	Nurse Consultant, HPT	NHS Lothian
Dr Pota Kalima	Clinical Lead, *E. coli* ref lab	NHS Lothian
Sharon Saunders	Head of Place	East Lothian Council
Shonagh Szwedowska	Business Support Officer/PH HPT	NHS Lothian
Sinead Donnelly	Senior Communications Office	NHS Lothian
Susan Brownlie	Healthcare Scientist	Public Health Scotland

16.2 Appendix 2: Public Health Scotland Alert

Public Health Scotland

PHS Health Protection Alert

Title	Description
Event	Exceedance of STEC activity in the UK since August 2022
Alert reference number	2022/29
Recipients of this alert	PHS Senior Leads Team, NHS Board Health Protection Teams, Directors of Public Health, ARHAI, CMO Office (CMO and DCMO), SG Health Protection, SMVN, Scottish Ambulance Service, Infection Prevention Control
Alert status	4. for action - monitoring, wider dissemination and specific measures to be taken by recipient
Action required of initial recipients	Cascade to other members of Health Protection Team and Microbiology/Virology and Environmental Health colleagues for information and action as appropriate (see recommendations below).
Date of issue	12th September 2022
Source of event information	UKHSA & Scottish *E. coli* O157/STEC Reference Laboratory
Contact	Hazel Henderson
Authorised by	Nick Phin
HPZone context	STEC increase August 2022

Situation
Cases of Shiga-toxin producing *E. coli* (STEC) notified to UKHSA surveillance systems have increased over the last four weeks, with significant escalation since the end of August. In particular an increase in *E.coli* O157 PT14 has been reported. All four nations are reporting this increase.

Background
The UKHSA Gastrointestinal Bacteria Reference Unit (GBRU) has reported that more than double the number of presumptive STEC isolates were received in August 2022 compared to August 2019 (the most recent pre-pandemic year). Data from the Scottish *E. coli* O157/ STEC Reference Laboratory indicates a similar increase in STEC cases recorded since August 2022, with 31 cases reported (compared to around 10 in previous years). Whole-genome sequencing is underway to better characterise the affected population, though a relative preponderance of females and ages 20-39 year olds has been noted in preliminary findings.

To date, there have been no known deaths where STEC infection was reported during this time period. Analysis of available exposure data, including food sources is underway.

Assessment
STEC infection can cause more severe clinical outcomes than many other GI pathogens. Up to 10% of cases with STEC develop haemolytic uraemic syndrome (HUS) following the initial gastrointestinal infection symptoms. The number of HUS cases can be expected to increase in line with the overall reporting rate. STEC infection results in relatively high hospitalisation rates of up to 30–40%.

Available data suggest that within this increase in cases, there is one outbreak strain of O157, and multiple small clusters. Investigations are underway to identify a common exposure. An enhanced surveillance questionnaire is being developed to help investigate specific exposures.This is being managed as an Enhanced National Incident, led by UKHSA with full participation of Public Health Scotland and colleagues in Wales and Northern Ireland.

Recommendations for Health Protection Teams
Health Protection Teams are asked to support and follow up cases notified to them and return enhanced surveillance questionnaires to Public Health Scotland (phs.giz@phs.scot) as soon as possible.

HPTs are also asked to share this PHS Alert as appropriate with their Local Authority Environmental Health Teams. Please direct any enquiries regarding this incident to phs.giz@phs.scot.

Recommendations for Local Authorities
Local authorities and Environmental Health Teams may be asked to follow up and/or interview cases linked to this incident, should they occur in their area. Local authorities may also be asked to contact businesses to trace products if those businesses are located in their area.

Recommendations to diagnostic laboratories
PHS asks that NHS diagnostic laboratories continue to promptly refer STEC isolates/faecal samples to the Scottish *E. coli* /STEC Reference Laboratory in Edinburgh for confirmation and typing.

16.3 Appendix 3: Timeline of key events in the management of the outbreak

Date	Event
29 July 2022	• NHS Lothian Health Protection team notified by the duty Consultant Microbiologist of a case of STEC in a child attending Pear Tree Nursery Church Street.
1 August 2022	• NHS Lothian HPT notified by another Public Health Agency of a second case of STEC in a child attending the same room at the same nursery • Problem Assessment Group held, chaired by Public Health Consultant • NHS Lothian HPT notified of further probable case by Pear Tree Nursery Church Street
2 August 2022	• NHS Lothian HPT notified of further symptomatic staff and children by Pear Tree Nursery Church Street – at this point there were 2 confirmed cases and 12 probable cases, including 4 staff (subsequent results identified no STEC infection in staff at this nursery) • Public Health Incident declared: Incident Management Team meeting held • HPT updated the reference laboratory to allow them to prepare for surge in workload • Nursery management agreed to close Pear Tree Nursery Church Street voluntarily following communication between the Pear Tree Nurseries Ltd's management and Care Inspectorate • Initial visit to the nursery by HPT and EH after which Pear Tree Nursery Church Street was advised to carry out a deep clean and to look at other Infection Control improvements • First private water supply sample taken from house of confirmed case
2-5 August 2022	• Senior colleagues within NHS Lothian (including the Deputy Director of Public Health, and Emergency Departments), Scottish Government Health protection division and NHS24 were contacted to make them aware of situation
3 August 2022	• IMT held • Inform and Advise letter issued to parents/guardians/staff at Pear Tree Nursery Church Street • Letter issued to Lothian GPs
5 August 2022	• IMT held • IMT agreed NHS Lothian would be the lead agency for communications
9 August 2022	• Joint inspection of Pear Tree Nursery Church Street by HPT, EHO, Care Inspectorate and Education Department of ELC

Date	Event
10 August 2022	• HPT notified of cases of GI illness at Pear Tree Nursery Meadowpark • EH visit to Pear Tree Nursery Church Street, taking environmental swabs • EH visit to Pear Tree Meadowpark for initial assessment • IMT held
11 August 2022	• Meeting with Pear Tree Nursery Church Street provider (Pear Tree Nurseries Ltd) • Further letter issued to Lothian GPs • Second private water supply sample taken from house of confirmed case
12 August 2022	• IMT held: discussed Pear Tree Nursery Church Street and Pear Tree Nursery Meadowpark • Inform and Advise letter and proactive statement sent to Pear Tree Nursery Church Street to share with parents/guardians prior to media statement • Media statement released by NHS Lothian • Pear Tree Nursery Meadowpark closed voluntarily as a precautionary measure due to GI symptoms • Inform and Advise letter issued to parents/guardians at Pear Tree Nursery Meadowpark regarding nursery closure • Pear Tree Nursery West Road visited by EH: Included menu discussion and kitchen assessment. Kitchen was deemed generally compliant[23] with no foods available in freezer from previous meals for sampling.
12-16 August 2022	• NHS Lothian HPT received high level of calls reporting GI illness in staff and parents at Pear Tree Nursery Meadowpark and Pear Tree Nursery West Road
13 August 2022	• NHS Lothian media interview with BBC and STV news journalists, both of which were used in their respective bulletins
15 August 2022	• PAG held to discuss gastroenteritis outbreak at Pear Tree Nursery Meadowpark. • Compliance meeting with Pear Tree Nursery Meadowpark management
16 August 2022	• IMT held • Inform and Advise update letter sent to parents/guardians at Pear Tree Nursery Meadowpark • Pear Tree Nursery West Road closed voluntarily by Pear Tree Nurseries Ltd, due to GI illness • Inform and Advise letter sent to parents/guardians at Pear Tree Nursery West Road informing them of closure
17 August 2022	• Visit by Care Inspectorate to Pear Tree Nursery Meadowpark

Date	Event
	• Letters sent to parents/guardians at Pear Tree Nursery Meadowpark and Pear Tree Nursery West Road to clarify what to do if child symptomatic
18 August 2022	• First confirmed STEC case at Pear Tree Nursery Meadowpark • Third private water sample taken from house of confirmed case for PCR testing • Care Inspectorate visit to Pear Tree Nursery West Road
19 August 2022	• IMT held • GPs, out of hours GPs and A&Es updated on Pear Tree Nursery Meadowpark via email • Musselburgh Private Nursery Bridge Street closed voluntarily due to diarrhoea and vomiting cases and possible links to Pear Tree Nursery Meadowpark • Inform and Advise letters (Appendix 6 and 7) issued to Musselburgh Private Nursery Bridge Street (parents and staff respectively) advising people to submit stool samples if they were symptomatic • Inform and Advise letters sent via email on the evening of 19th August to parents/guardians at Pear Tree Nursery Meadowpark to stay at home and submit clearance samples
21 August 2022	• A further letter was sent out to parents/guardians of children at Musselburgh Private Nursery Bridge Street advising them not to send children to new nursery or school on 22nd August 2022
22 August 2022	• Official exclusion letters sent to parents/guardians at Pear Tree Nursery Meadowpark by post
23 August 2022	• Third joint visit to Pear Tree Nursery Church Street by HPT, EH, Care Inspectorate and Education Department of ELC • IMT held • Scottish Government representative joined the IMT
24 August 2022	• NHS24 helpline opened • Musselburgh Private Nursery Stoneybank Terrace reported diarrhoea and vomiting – links to Musselburgh Private Nursery Bridge Street • SRUC invited to join IMT
25 August 2022	• GPs, out of hours GPs and A&Es updated on Musselburgh Private Nursery Bridge Street via email
26 August 2022	• IMT held • EH advised IMT that there were no EH issues to prevent Pear Tree Nursery Church Street from reopening • IMT advised Pear Tree Nurseries Ltd that no objections to Pear Tree Nursery Meadowpark reopening

Date	Event
	• Inform and Advise letters were sent to staff and parents/guardians at Musselburgh Private Nursery Bridge Street and Musselburgh Private Nursery Stoneybank Terrace • Press release and FAQs issued • Media interview with STV, which was used in evening news bulletin • Musselburgh Private Nursery Stoneybank Terrace closed voluntarily
29 August 2022	• Pear Tree Nursery Church Street reopened • GPs, out of hours GPs and A&Es updated on Musselburgh Private Nursery Stoneybank Terrace via email
30 August 2022	• HPT/EH/ Education visit to Pear Tree Nursery West Road nursery • IMT held
31 August 2022	• Pear Tree Nursery Meadowpark reopened
2 September 2022	• IMT held • IMT agreed Pear Tree Nursery West Road could be reopened following commercial clean • EH/CI/HPT/Education visited Musselburgh Private Nursery Bridge Street and Musselburgh Private Nursery Stoneybank Terrace
6 September 2022	• IMT held • IMT agreed that Musselburgh Private Nursery Bridge Street and Musselburgh Private Nursery Stoneybank Terrace could reopen after deep clean, improvements and re-inspection • Scottish Water asked for information about mains water testing for Pear Tree Nursery Church Street, before the outbreak
8 September 2022	• IMT held • Update letter sent out to parents/guardians affected by nursery closures • Scottish Water reported no issues from mains water testing for Pear Tree Nursery Church Street, before the outbreak
9 September 2022	• HPT and Care Inspectorate visit, Pear Tree Nursery West Road. EH advised HPT they had no objections to the premises reopening
12 September 2022	• Pear Tree Nursery West Road reopened • Revisit Musselburgh Private Nursery Stoneybank Terrace by HPT/EH/Care Inspectorate/ELC Education.
13 September 2022	• Revisit to Musselburgh Private Nursery Bridge Street EH/HPT/Care Inspectorate/ ELC Education • IMT held

Date	Event
	• IMT agreed that Musselburgh Private Nursery Stoneybank Terrace could reopen
14 September 2022	• IMT held • IMT agreed that Musselburgh Private Nursery Bridge Street could reopen
19 September 2022	• NHS24 helpline stood down
20 September 2022	• IMT held – agreed criteria for outbreak to be over
28 September 2022	• IMT held
13 October 2022	• IMT held – agreed outbreak can be declared over and IMT stood down
14 October 2022	• Public announcement that IMT stood down

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16.4 Appendix 4: STEC questionnaire

SCOTTISH HEALTH PROTECTION NETWORK
Promoting and Supporting Good Practice

NHS SCOTLAND

E. coli O157 / VTEC questionnaire

The information collected in this form will be used to gain a better understanding of the causes and risk factors for *E. coli* O157 and other VTEC infections. The information will be shared, in strict medical confidence, with NHS public health agencies, locally and nationally in Scotland to help inform measures to reduce the risk of these infections. If you have any concerns about this, please tell me.

SECTION A: QUESTIONNAIRE DETAILS					
Interviewer name:				Interview date (dd/mm/yyyy):	/ /
Interviewer office:				Interviewer telephone:	
EHO Ref No :		HPZone No:		Diagnosis: ☐ O157 ☐ Non O157	
Case status :	☐ Confirmed ☐ Provisional				
Notified: ☐ Yes ☐ No		Notified by:		Date Notified (dd/mm/yyyy):	/ /
Person interviewed name:					
Details from:	☐ Case ☐ Case's Parent ☐ Other (specify):				
Can the Case be contacted again?	Yes No				

SECTION B: PERSONAL DETAILS					
First name:		Family name:			
Address:					
Postcode:		Tel (home):		Tel (mobile):	
Email:					
Sex:	☐ M ☐ F	Date of birth (dd/mm/yyyy):	/ /	Age:	
CHI No:		GP Name:		GP tel:	
GP address:					
Are there any children living in the household? (other than the case):	☐ Yes ☐ No ☐ Unknown				

SECTION C: WORK / SCHOOL / CHILDCARE	
Occupation (include part time work; volunteering; etc):	
Name of work / school / nursery / volunteer centre etc – include multiple locations if relevant:	

Address:					
Postcode:		Tel:		Date last attended (dd/mm/yyyy):	/ /

Did Case attend whilst symptomatic? ☐ Yes ☐ No ☐ Unknown

Additional information related to work / nursery etc:

Is Case in Risk Group? ☐ Y ☐ N ☐ Unknown Indicate Risk Group*: ☐ A ☐ B ☐ C ☐ D

***Group A:** Any person with doubtful personal hygiene or with unsatisfactory toilet, hand washing or hand drying facilities at home, work or school.

***Group B**: Pre-school children.

***Group C:** People whose work involves, preparing or serving unwrapped foods that is not subjected to further heating.

***Group D**: Clinical and social care staff in high risk facilities who have direct contact with highly susceptible patients or persons in whom a gastrointestinal infection would have particularly serious consequences.

Exclusion required: ☐ Yes ☐ No			
Has Case been in contact with another person(s) suffering from diarrhoea or similar illness?	Yes No	No	Unknown

Record details on Page **9**.

SECTION D: SYMPTOMS OF ILLNESS

Onset date (dd/mm/yyyy):	/ /	Stool sample submitted:	☐ Yes ☐ No	Date submitted (dd/mm/yyyy):	/ /
Still ill:	Yes No	Duration of illness (days):			

Symptoms experienced:	**Yes**	**No**	**Unknown**	**Ongoing**	**Duration (d)**	**Date of onset**
Diarrhoea (3 or more loose stools in 24hrs)	☐	☐	☐	☐		/ /
Bloody stools	☐	☐	☐	☐		/ /
Nausea	☐	☐	☐	☐		/ /
Vomiting	☐	☐	☐	☐		/ /
Abdominal pain	☐	☐	☐	☐		/ /
Fever	☐	☐	☐	☐		/ /
Other (specify):						/ /

Sought healthcare:	NHS 24 GP visit A&E Other (specify):		
Date first healthcare contact (dd/mm/yyyy):	/ /		
Admitted to hospital for this illness:	☐ Yes ☐ No	Admission date (dd/mm/yyyy):	/ /
Hospital name:		Duration of stay (days)	

SECTION E: TRAVEL IN THE 14 DAYS PRIOR TO ILLNESS

Outside the UK: ☐ Yes ☐ No Unknown (if yes, please complete below)

Country and Resort / Town or Area	Date departed (dd/mm/yyyy)	Date returned (dd/mm/yyyy)	Name & address of accommodation	Type of accommodation e.g. hotel; campsite; B&B	Name of airline; ferry; rail company; tour operator	Board basis e.g. self-catering (SC); all inclusive (AL)

Any other details:

WITHIN Scotland or OTHER UK countries: ☐ Yes ☐ No ☐ Unknown (if yes, please complete below)

Country and Resort / Town or Area	Date departed (dd/mm/yyyy)	Date returned (dd/mm/yyyy)	Name & address of accommodation	Type of accommodation e.g. hotel; campsite; B&B	Name of airline; ferry; rail company; tour operator	Board basis e.g. self-catering (SC); all inclusive (AL)

Any other details:

SECTION F: FOOD HISTORY IN THE 14 DAYS PRIOR TO ILLNESS

Did Case **eat outside the home** during the **14 days** prior to illness e.g. restaurant, takeaway, hotel, school / work canteen, functions, parties, BBQ etc?

Name / Location of place	Type of venue e.g. restaurant; takeaway; BBQ	Date (dd/mm/yyyy):	Food eaten	Others ill? (Yes (Y) / No (N) / Unknown (Unk))	How many ill?
		/ /		☐ Y ☐ N ☐ Unk	
		/ /		☐ Y ☐ N ☐ Unk	
		/ /		☐ Y ☐ N ☐ Unk	
		/ /		☐ Y ☐ N ☐ Unk	
		/ /		☐ Y ☐ N ☐ Unk	
		/ /		☐ Y ☐ N ☐ Unk	

In the **14** days prior to illness did Case **handle** or **prepare** any of the following?

	Yes (Y) / No (N)	**Product (e.g. steak, burger, chicken breast etc.)**	**Where Purchased? Name and Location (include whether supermarket, farmers' market, butcher etc.)**
Raw beef	☐ Yes ☐ No		
Raw poultry	☐ Yes ☐ No		
Raw lamb	☐ Yes ☐ No		
Raw pork / gammon	☐ Yes ☐ No		
Venison	☐ Yes ☐ No		
Other raw meat (e.g. game, goat)	☐ Yes ☐ No		
Raw vegetables	☐ Yes ☐ No		
Eggs	☐ Yes ☐ No		
Pet / animal feed	☐ Yes ☐ No		

In the **14** days prior to illness did Case **consume** any of the following?			
	Yes (Y) / No (N)	**Product (e.g. mince, chicken breast) Include how prepared e.g. rare etc. and brand if known**	**Where Purchased? Name and Location (include whether supermarket, farmers' market, butcher etc.)**
Meat, Poultry & Fish			
Beef	☐ Yes ☐ No		
Poultry	☐ Yes ☐ No		
Lamb	☐ Yes ☐ No		
Pork / gammon	☐ Yes ☐ No		
Venison	☐ Yes ☐ No		
Other meat e.g. pheasant, goat, etc.	☐ Yes ☐ No		
Pre-cooked cold meat e.g ham	☐ Yes ☐ No		
Cured meats, chorizo, salami etc.	☐ Yes ☐ No		
Other processed meat, pies etc.	☐ Yes ☐ No		
Fish	☐ Yes ☐ No		
Shellfish	☐ Yes ☐ No		
	Yes (Y) / No (N)	**Product (e.g. carrots; bagged salad etc. Include brand name where known)**	**Where Purchased? Name and Location (include whether supermarket, farmers' market, butcher etc.)**
Dairy			
Pasteurised milk	☐ Yes ☐ No		
Unpasteurised milk	☐ Yes ☐ No		
Hard cheese	☐ Yes ☐ No		
Soft cheese	☐ Yes ☐ No		
Unpasteurised cheese or other produce	☐ Yes ☐ No		

Yoghurt / fromage frais	☐ Yes ☐ No		
Cream	☐ Yes ☐ No		
Ice cream	☐ Yes ☐ No		
Eggs	☐ Yes ☐ No		
Fruit & Veg			
Pre-washed / ready to eat salad	☐ Yes ☐ No		
Other salad	☐ Yes ☐ No		
Raw vegetables	☐ Yes ☐ No		
Soft fruit / berries	☐ Yes ☐ No		
Pre washed / ready-to-eat fruits	☐ Yes ☐ No		
Other raw fruits	☐ Yes ☐ No		
Sprouted seeds / beansprouts	☐ Yes ☐ No		
Fresh herbs	☐ Yes ☐ No		
Other Food Items			
Fruit juices, smoothies	☐ Yes ☐ No		
Ready-to-eat sandwiches etc.	☐ Yes ☐ No		
Chutneys; pickles; preserves	☐ Yes ☐ No		
Other foods (e.g.nuts, confectionery, etc)	☐ Yes ☐ No		

SECTION G: WATER EXPOSURE IN THE 14 DAYS PRIOR TO ILLNESS			
Any issues with household water supply eg. drainage/plumbing?	Yes No Unknown	If yes, details:	
Drank water from any of the following (include water used for brushing teeth):			

Water supply	**Yes**	**No**	**Details**

Mains (municipal) water	☐	☐	
Private water supply (spring /well / borehole)	☐	☐	
Bottled water	☐	☐	
River / stream / lake wa-ter	☐	☐	

Did the Case **do any of the following** in the **14** days prior to illness?

Activity	Yes / No / Unknown	If yes, details including location	Date (dd/mm/yyyy):	Water Swallowed Yes (Y) / No (N) / Unknown (Unk)		
Swimming; water play; paddling	Yes / No / Unknown		/ /	☐ Y	☐ N	Unk
Sailing; canoeing; fishing; water sport	Yes / No / Unknown		/ /	☐ Y	☐ N	Unk

Was the Case **exposed to other raw water** in the **14** days prior to illness?						
Exposure	Yes / No / Unknown	If yes, details including location	Date (dd/mm/yyyy) :	Water Swallowed Yes (Y) / No (N) / Unknown (Unk)		
Raw water; flood-water; trough; pond; garden tap	Yes / No / Unknown		/ /	☐ Y	☐ N	Unk

SECTION H: ANIMAL CONTACT IN THE 14 DAYS PRIOR TO ILLNESS			
Contact with domestic animals / pets:	☐ Yes	☐ No	☐ Unknown
If yes, tick all that apply	☐ Dog	☐ Rodents	☐ Fish
	☐ Cat	☐ Reptiles	☐ Other (specify):……
	☐ Rabbit	☐ Birds	
Contact with non domestic animals:	☐ Yes	☐ No	☐ Unknown
If yes, tick all that apply	☐ Cattle	☐ Horses	☐ Deer
	☐ Calves	☐ Pigs	☐ Birds
	☐ Sheep	☐ Reptiles	☐ Fish
	☐ Lambs	☐ Poultry	☐ Rodents
	☐ Goats	☐ Rabbits	☐ Other (specify): ……..

Visits / activities	Yes / No / Unknown	Details (include dates where applicable)
Lives / works / access to private farm	☐ Yes ☐ No ☐ Unknown	
Visited farm park / petting zoo	☐ Yes ☐ No ☐ Unknown	
Any other event / venue with animals' e.g. agricultural show, highland games, wildlife reserve etc.	☐ Yes ☐ No ☐ Unknown	
Any other animal contact not captured above?	☐ Yes ☐ No ☐ Unknown	
Petting / handling any of the animals	☐ Yes ☐ No ☐ Unknown	
Feeding animals: bottle feeding lambs; hand feeding etc.	☐ Yes ☐ No ☐ Unknown	
Was hand washing facilities available at any of the above?	☐ Yes ☐ No ☐ Unknown	
If yes, please indicate if it was running water or gel handwash?	Running water Gel	

Did Case wash hands after contact with animals or environment?	☐ Yes	☐ No	☐ Unknown	
Did Case eat at any of above?	☐ Yes	☐ No	☐ Unknown	

If yes, was the food (tick all that apply):			
☐	Purchased on premises	☐	Brought from home / elsewhere
☐	Eaten in separate area	☐	Eaten whilst in contact with the animals
☐	Eaten at a picnic table	☐	Eaten whilst sitting on the grass / soil

Details:			
If yes, did they wash hands before eating?	☐ Yes	☐ No	☐ Unknown

SECTION I: ENVIRONMENTAL EXPOSURE IN THE 14 DAYS PRIOR TO ILLNESS

Walked in a paddock / field where farm animals graze?	☐ Yes	☐ No	☐ Unknown
If yes, specify:			
Taken any day trips (beach, countryside etc.):	☐ Yes	☐ No	☐ Unknown
If yes, specify:			
In contact with wildlife species or their droppings:	☐ Yes	☐ No	☐ Unknown
If yes, specify:			
Had contact with soil, manure or sewage:	☐ Yes	☐ No	☐ Unknown
If yes, specify:			

THIS PAGE TO BE COMPLETED BY HEALTH PROTECTION TEAM PRIOR TO SUBMISSION TO HPS

SECTION J: CASE CLASSIFICATION					
Is this Case*:	☐ Primary	Co-primary	☐ Secondary	☐ Asymptomatic	
If co-primary, name of other co-primary case(s):					
If secondary, name of primary case:					
Investigation is:	Ongoing	Complete			
Outcome: Select all that apply	Recovered	Still ill	HUS/TTP	Died	Date of death: / /
Is case part of a household outbreak?	Yes	☐ No	☐ Unknown		
Is case part of a general outbreak?**	Yes	No	☐ Unknown		
Any medication taken for this illness?	Yes	No	☐ Unknown		
If yes, specify:	☐ Antibiotics	☐ Antidiarrhoeals	☐ Other - specify below:		
Detail any relevant past medical history:					

*Secondary cases are defined as those symptomatic cases from whose onset date and an assumed incubation period (≤14 days) local investigators have judged that contact with a confirmed case was more likely than any other exposure to be the source of infection.

**General outbreaks are defined as those affecting members of more than one household, or residents of institutions.

Please send the form to Health.Protection@nhslothian.scot.nhs.uk within 7 days of notification to the health board

CASE NAME:_____ **For local use only – not required by HPS**

HOUSEHOLD AND OTHER CLOSE CONTACTS OF THE CASE

Record contacts from the **14 days prior** to case's symptom onset **until the present day**

Name	Address	D.O.B	Sex (M/F)	Relationship to case (e.g. household member; close friend; school / workmate; other)	Sample re-quested? (Y/N)	Symptoms **D**=Diarrhoea **N**=Nausea **V**=Vomiting **AB**=Abdo Pain **None**	Occupation	Risk group* (A/B/C/D)	Exclusion required? (Y/N)

*__Group A:__ Any person with doubtful personal hygiene or with unsatisfactory toilet, hand washing or hand drying facilities at home, work or school;
__*Group B__: Pre-school children;
*__Group C:__ People whose work involves preparing or serving unwrapped foods not subjected to further heating;
__*Group D__: Clinical and social care staff in high risk facilities who have direct contact with highly susceptible patients or persons in whom a gastrointestinal infection would have particularly serious consequences.

For local use only – not required by HPS

Case name: _____

Any other information relevant to investigation:

Prevention and Advice

Case has been given *E. coli* O157 / VTEC information leaflet	☐ Yes ☐ No
Case has been advised on measures to prevent spread of infection, including kitchen hygiene; hand hygiene; personal hygiene; etc.	☐ Yes ☐ No
Case has been given information on return to work / school	☐ Yes ☐ No

Name: _____ Job Title: _____

Signature: _____ Date _____

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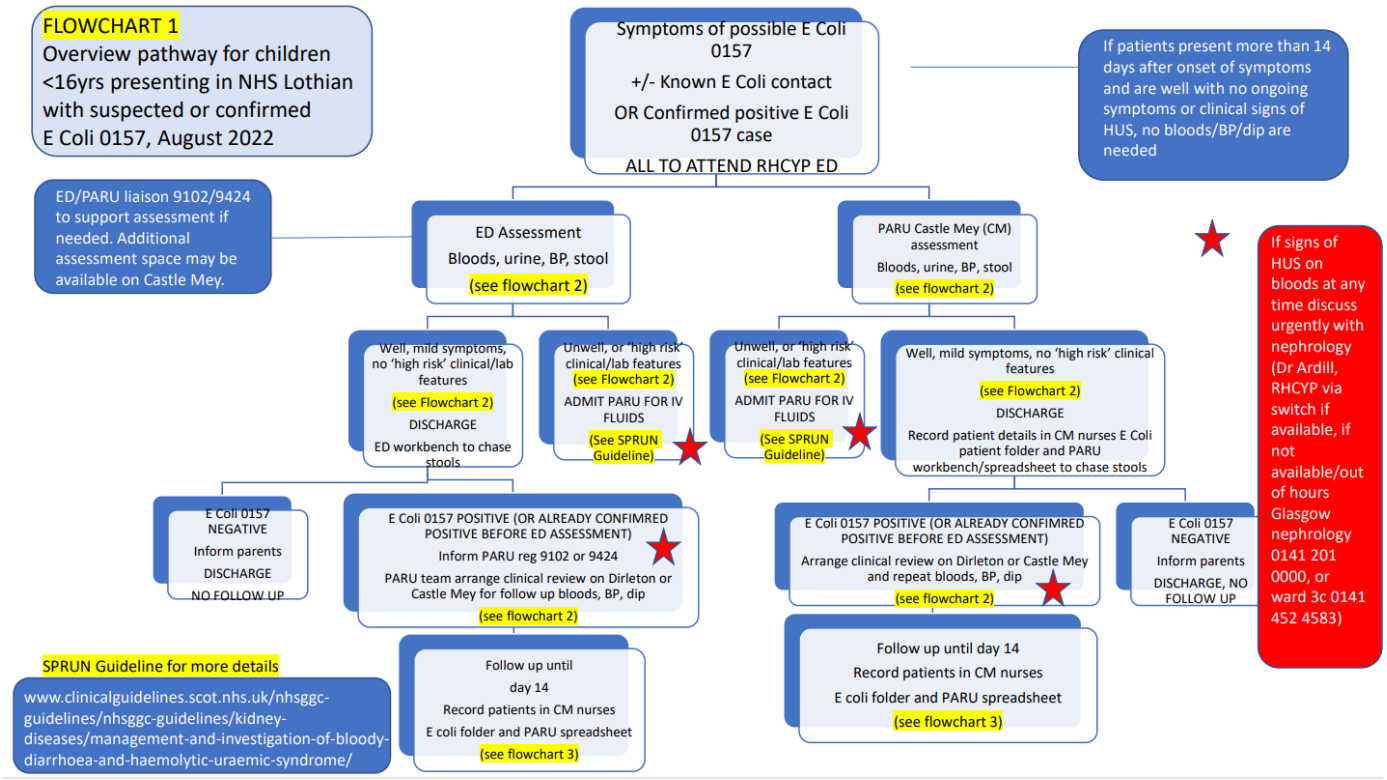
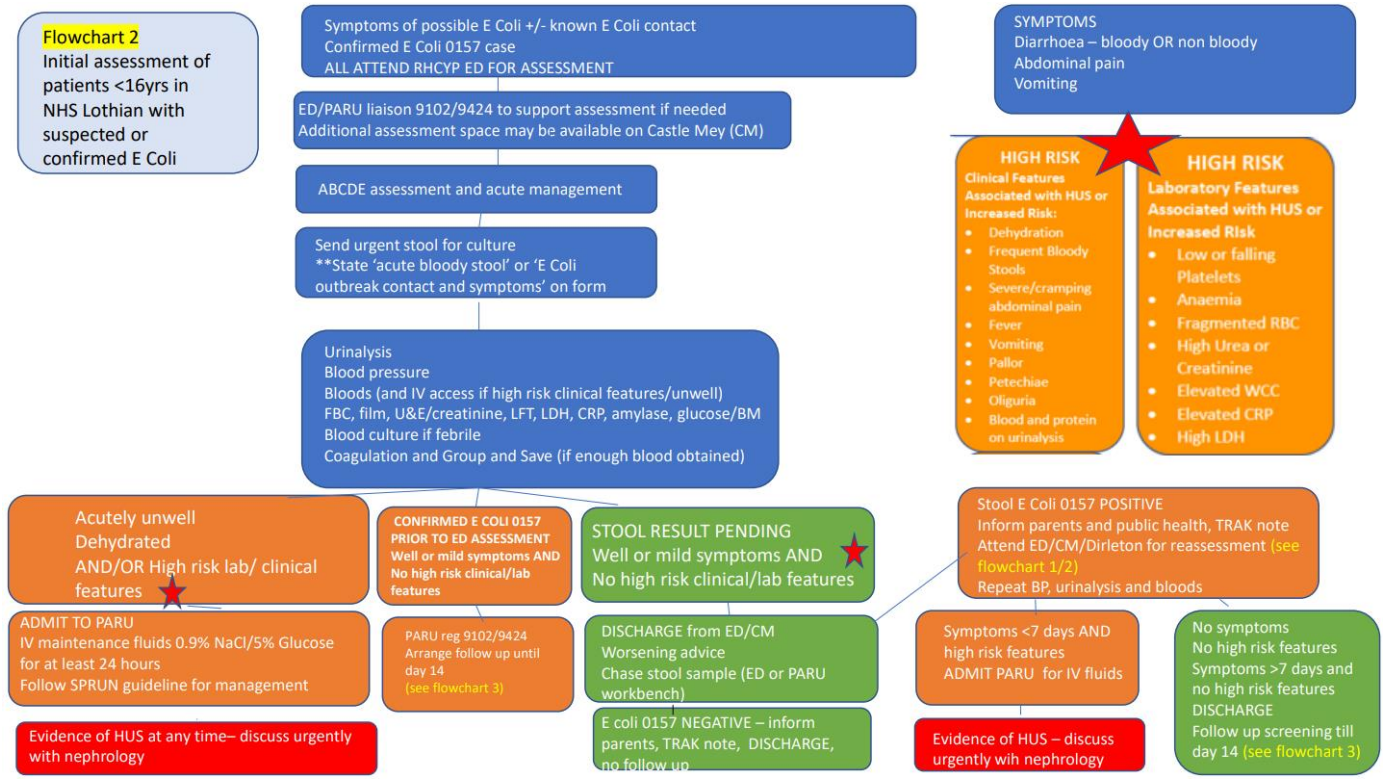
16.5 Appendix 5: Clinical pathway for suspected case of E. coli O157/ STEC, Royal Hospital for Children and Young People





Reference Management and investigation of bloody diarrhoea and haemolytic uraemic syndrome. Scottish Paediatric Renal Urology Network (SPRUN) guidance. www.clinicalguidelines.scot.nhs.uk/nhsggc-guidelines/nhsggc-guidelines/kidney-diseases/management-and-investigation-of-bloody-diarrhoea-and-haemolytic-uraemic-syndrome/

16.6 Appendix 6: Inform and Advise letters for parents of nursery children

The following files are available on the NHS Lothian website: Appendix 6: Inform and Advise letters for parents of nursery children – Public Health and Health Policy (nhslothian.scot)

Pear Tree Nursery Church Street / 3 August 2022 / Inform & advise letter to Parents

Pear Tree Nursery Church Street / 12 August 2022 / Inform & advise letter to Parents

Pear Tree Nursery Meadowpark / 12 August 2022 / Inform and advise letter to Parents

Pear Tree Nursery Meadowpark / 16 August 2022 / Inform and advise letter / Parents update

Pear Tree Nursery Meadowpark / 17 August 2022 / Inform and advise letter to Parents & Carers

Pear Tree Nursery Meadowpark / 19 August 2022 / Inform and advise letter to Parents

Pear Tree Nursery West Road / 16 August 2022 / Inform and advise letter to Parents & Staff

Pear Tree Nursery West Road / 17 August 2022 / Inform and advise letter to Parents & Carers

Musselburgh Private Nursery Bridge Street / 19 August 2022 / Inform and advise letter to Parents and Carers

Musselburgh Private Nursery Bridge Street / 21 August 2022 / Further inform and advise letter to Parents and Carers

Musselburgh Private Nursery Bridge Street / 25 August 2022 / Inform and advise letter to Parents

Musselburgh Private Nursery Stoneybank Terrace / 26 August 2022 / Inform and advise letter to Parents

Children attending party / 2 September 2022 / Letter to parents/carers of children attending party

All affected nurseries / 8 September 2022 / Letter to parents affected by nursery outbreaks East Lothian

See also lists of FAQs for parents and carers in Appendix 8.

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16.7 Appendix 7: Inform and Advise letters for staff

The following files are available on the NHS Lothian website: Appendix 7: Inform and Advise letters for staff – Public Health and Health Policy (nhslothian.scot)

Pear Tree Nursery Church Street Staff / 3 August 2022 / Inform & Advise letter to Staff

Letter to headteachers of primary schools / 16 August 2022 / Letter to Head Teacher via ELC

Pear Tree Nursery Meadowpark Staff / 19 August 2022 / Inform and advise letter to Staff

Musselburgh Private Nursery Bridge Street / 25 August 2022 / Inform and advise letter to Staff

Musselburgh Private Nursery Stoneybank Terrace / 26 August 2022 / Inform and advise letter to Staff

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16.8 Appendix 8: GP and A&E alert letters with advice on testing

Inform and Advise letters were also sent to Lothian GPs, out of hours GP service, and hospital teams.

The following files are available on the NHS Lothian website: Appendix 8: GP and A&E alert letters with advice on testing – Public Health and Health Policy (nhslothian.scot)

Pear Tree Nursery Church Street / 3 August 2022 / Inform and advise letter to GPs

Pear Tree Nursery Church Street / 11 August 2022 / Inform and advise letter to GPs up-dating about testing process

Pear Tree Nursery Meadowpark / 19 August 2022 / Inform and advise letter to GPs

Pear Tree Nursery Meadowpark / 19 August 2022 / Inform and advise letter to A&Es and GP Out of Hours / Hospital E.coli

Musselburgh Private Nursery Bridge Street / 25 August 2022 / Inform and advise letter to GPs

Musselburgh Private Nursery Bridge Street / 25 August 2022 / Inform and advise letter to A&Es and GP Out of Hours service / Hospital E.coli

Musselburgh Private Nursery Stoneybank Terrace / 29 August 2022 / Inform and advise letter to GPs (letter and covering email provided summary of the outbreak explaining the different arrangements by nursery)

Musselburgh Private Nursery Stoneybank Terrace / 29 August 2022 / Inform and advise letter to A&Es and GP Out of Hours service / Hospital E.coli (letter and covering email provided summary of the outbreak explaining the different arrangements by nursery)

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16.9 Appendix 9: Press Releases and other public facing communication

Press release 13 August 2022 https://news.nhslothian.scot/2022/08/13/nhs-lothian-update-e-coli-investigations-in-east-lothian/

Press release 17 August 2022 https://news.nhslothian.scot/2022/08/17/investigations-into-e-coli-continue-in-east-lothian/

Press release 24 August 2022 https://news.nhslothian.scot/2022/08/24/information-update-around-e-coli-investigations-in-east-lothian/

Frequently Asked Questions (FAQs) 26 August 2022 https://news.nhslothian.scot/2022/08/26/faqs-further-update-on-ecoli/

Press release 26 August 2022 https://news.nhslothian.scot/2022/08/26/appeal-to-families-during-e-coli-investigations/

Press release 2 September 2022 https://news.nhslothian.scot/2022/09/02/two-nurseries-at-the-centre-of-an-e-coli-outbreak-in-east-lothian-have-re-opened/

Press release 9 September 2022 https://news.nhslothian.scot/2022/09/09/third-east-lothian-nursery-prepares-for-re-opening/

Press release 14 September 2022 https://news.nhslothian.scot/2022/09/14/all-nurseries-affected-by-e-coli-outbreak-in-east-lothian-given-green-light-to-re-open/

FAQs 27 September 2022 https://news.nhslothian.scot/2022/09/27/updated-frequently-asked-questions-relating-to-e-coli-cases/

Press release 14 October 2022 https://news.nhslothian.scot/2022/10/14/health-officials-have-declared-the-e-coli-outbreak-in-east-lothian-as-being-officially-over/

Compensation form https://news.nhslothian.scot/wp-content/uploads/2022/09/Public-Health-Act-Compensation-Claim-form-Final-12-01-2022.pdf

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Report published 25 September 2024

Contact: eos.eastregionhpt@nhs.scot or 0300 790 6264

Report can also be downloaded from the NHS Lothian Health Protection Team website

https://services.nhslothian.scot/publichealth/health-protection-team/