NHS National Services Scotland

Guidance for the public health management of *Escherichia coli* O157 and other Shiga toxin-producing (STEC) infections.

Evidence-Based Guideline (EBG).

Scottish Health Protection Network

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Document Amendment Log

Version	Date	Page Number	Amendment Summary

The Scottish Health Protection Network (SHPN) is a network of existing professional organisations and networks in the health protection community across Scotland. It aims to promote, sustain, and coordinate good practice. The SHPN supports a systematic approach to development, appraisal and adaptation of guidelines, seeking excellence in health protection practice.

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Feedback on the guidance

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Abbreviations

APHA	Animal and Plant Health Agency – https://www.gov.uk/government/organisations/animal-and-plant-health-agency
DWQR	Drinking Water Quality Regulator – http://dwqr.scot/
EHD	Environmental Health Department
EHEC	Enterohaemorrhagic *E. coli*
EPEC	Enteropathogenic *E. coli*
FSS	Food Standards Scotland – http://www.foodstandards.gov.scot/
GBRU	Gastrointestinal Bacteria Reference Unit
HPS	Health Protection Scotland – http://www.hps.scot.nhs.uk/
HPT	Health Protection Team
HUS	Haemolytic Uraemic Syndrome
IMT	Incident Management Team
IQR	Interquartile range
MPHI	Scottish Government. Management of Public Health Incidents: Guidance on the Roles and Responsibilities of NHS led Incident Management Teams. Scottish Guidance No 12 (2017 edition). Scottish Health Protection Network. Available from: http://www.hps.scot.nhs.uk/guidelines/detail.aspx?id=1266
PAG	Problem Assessment Group
PCR	Polymerase Chain Reaction
SEPA	Scottish Environment Protection Agency - https://www.sepa.org.uk/
SERL	Scottish *E. coli* O157/STEC Reference Laboratory
SF	Sorbitol fermenting
STEC	Shiga toxin-producing *E. coli*
stx	Shiga toxin
TMA	Thrombotic microangiopathy
TTP	Thrombotic thrombocytopenic purpura
VTEC	Verocytotoxigenic *E. coli*
WGS	Whole Genome Sequencing

1. Introduction

Over a number of years, there has been a large amount of work to reduce the burden of disease from *E. coli* O157 through a host of interventions aimed at preventing, or minimising risk of, infection.

However, cases still occur, both sporadically and in outbreaks, and rapid response to these situations is necessary for protection of the public health. Additionally, there has been an increase in the number of non-O157 STEC, and increasing evidence of the disease burden of *E. coli* O157 Shiga-toxin negative organisms.

This guidance does not replace individual expert clinical judgement or local response arrangements, but is designed to support the development of those arrangements and assist in response to *E. coli* cases by health protection teams, environmental health departments and other stakeholders.

This document replaces the 2013 Guidance for Public Health Management of Infection with Verotoxigenic *Escherichia coli*. It is part of a suite of materials that has been produced in parallel, which also includes a clinical guideline and a template patient information leaflet.[i] In addition it should be used alongside the Scottish STEC Enhanced Surveillance Form.

Whilst reference is made in this document to outbreak/incident response, infection control, and water treatment and supply, detailed discussion of these topics is out with the remit of this guidance and can be found elsewhere.

1.1 Changes in this edition

- Updates to the current epidemiology of *E. coli* in Scotland, including the increase in non-O157 STEC.
- An expanded and more detailed guide to local diagnostic and reference laboratory testing procedures and services.
- Removal of sections on clinical management – now covered by the clinical guideline.[i]
- Refresh of text on public health action, including new, simplified algorithm. Clarification on the need for public health action for all *E. coli* O157 (*stx* positive and negative) and *stx* positive *E. coli* of other types.

i A link to the clinical guidance and the patient information leaflet will be added when they are published.

2. Case definitions

The case definitions are provided to assist in ensuring a co-ordinated and consistent approach, but cannot be comprehensive of all situations; notably, when outbreaks occur, Incident Management Teams (IMT) should agree a more appropriate case definition for each circumstance.

Possible case:

A case where STEC is considered in the differential diagnosis but another diagnosis is as, or more likely and where there is no known epidemiological link.

Probable case:

A case with gastrointestinal symptoms and a known epidemiological link to a confirmed case.

OR

A case with significant clinical illness, such as acute bloody diarrhoea, and no epidemiological link.

OR

A case with Haemolytic Uraemic Syndrome (HUS).

Presumptive positives: A positive *E. coli* O157 slide agglutination result is obtained on morphologically typical colonies, pending full identification of the organism as *E. coli*.

Confirmed case:

A case which has been microbiologically confirmed:

Locally confirmed case: Isolation of *E. coli* O157 from a clinical specimen OR detection of *E. coli* O157 nucleic acid or Shiga toxin genes in a clinical specimen.

Reference laboratory confirmed case: Isolation of *E. coli* O157 or non- O157 Shiga toxin-producing *E. coli* from a clinical specimen OR detection of IgM antibodies to Shiga toxin-producing *E. coli* in serum.

Terms such as ‘provisional’ should be avoided.

Close Contacts

- All household contacts. This includes those who shared a kitchen or toilet facilities with the case during the infectious period. This may include extended family members,

childminders and their families, as well as sexual contacts. It also includes occasions where the case has stayed overnight away from home.

- Any individual the case has regularly prepared food for, during the infectious period, or on a single occasion if there are concerns about hygiene practices.
- If appropriate, anyone involved in nappy changing, assisted toileting, or personal care of the index case during the infectious period.

3. Background

3.1 The pathogen

Escherichia coli (*E. coli*) are gram negative, rod-shaped bacteria commonly found in the intestines of humans and animals making up part of the normal gut flora. Most are harmless; however, certain types of *E. coli* are harmful to humans.[1]

The enterohaemorrhagic *E. coli* (EHEC) are now generally referred to as Shiga toxin-producing *E. coli* (STEC). They are capable of producing the toxins Shiga toxin 1 (stx1) and Shiga toxin 2 (stx2) (named due to their similarity to the toxin produced by *Shigella dysenteriae* type 1). STEC replaces the previous terminology 'verocytotoxin-producing *E. coli* (VTEC)'.

Shiga toxin can be produced by both O157 and non-O157 serotypes. All O157 types (stx +ve and –ve) and non-O157 STEC (i.e. stx +ve) infections require urgent Public Health action.

3.2 Clinical features

Symptoms of STEC infection range from asymptomatic infection, to mild non-bloody diarrhoea, through to bloody diarrhoea (around half of people infected will have bloody diarrhoea), abdominal pain and occasionally fever.

Some people may go on to develop very serious complications such as haemolytic uraemic syndrome (HUS),[2] and in a small number of cases infection may prove fatal.

Approximately, 10-15% of people infected with STEC go onto develop HUS.[3]

Children under 15 years old and older adults over the age of 65 years[4] are more likely than other age groups to develop STEC-related HUS, particularly children under 5 years. In England between 2009 and 2012, three quarters of HUS cases occurred in children (0-14 years).[5]

For more information on the clinical aspects of STEC infection, see clinical guidelines.[ii]

Incubation period

The incubation period for diarrhoeal illness caused by STEC O157 infection is usually three to four days, with a range of one day to ten days, but has been occasionally recorded as long as 14 days.[6,7,8,9] However, even longer incubation periods have also been noted.[10] It can be difficult to distinguish co-primary cases with longer incubation periods from secondary cases with shorter ones.

ii A link to the clinical guidance and the patient information leaflet will be added when they are published.

3.2.1 Infectious period

Infectivity is generally seen to be greater whilst symptomatic.[11] However, as cases are infectious even if asymptomatic the possibility of being infectious before symptoms start cannot be ruled out[12] and cases remain infectious until they have 'cleared' the infection, i.e. until STEC can no longer be detected in the faeces.[13-14]

STEC can be 'shed' in faeces intermittently[15] and shedding times vary, but are typically from 2-62 days with varying means/medians in different studies – 13,17 or 30 days.[16-17] A small number of individuals have been reported to shed STEC for over six months,[18] which is consistent with findings from Scotland (personal communication). There is some evidence to suggest that the shedding times for patients with HUS might be longer at 5-124 days with an average of 21 days[19-20]

The shedding time of young children is of particular interest due to the necessity to exclude them from childcare facilities. A paper from Ireland analysed 10 years of data on the number of days children under the age of six years took to microbiologically clear STEC infection. The median clearance time for all the children was 39 days, interquartile range (IQR) 27-56 days, longest clearance time 283 days. At 70 days from onset of infection, 90% of children had cleared the infection. There is some evidence that asymptomatic children cleared STEC infection faster than symptomatic children. Symptomatic children older than 1 year of age cleared STEC infection faster (than symptomatic children under 1 year of age).[21]

3.2.2 Transmission

STEC are found in the intestines of farmed[22-23] and wild ruminant animals,[24] mainly cattle,[25] sheep and goats including calves,[26] lambs[27] and kids. Other animals have been shown to be colonised with STEC, such as deer. Most animals carrying STEC will show no signs of illness.[28]

The fact that STEC can be found in the intestines of these animals means that STEC can also be present in their faeces[29] and hence anywhere their faeces may come into contact with, such as:

- The animals themselves, even if they look clean and well;
- Land where they have been grazing;
- Fences, gates and surfaces around the farm or grazing land;
- Petting farms where these animals are kept;
- Anywhere where the animal faeces may have spread through contact with vehicles, footwear, clothing worn on farms, pushchair wheels etc;
- Rivers, streams, lochs and inadequately treated water supplies where the faeces may have washed into from the land;
- Raw meats and undercooked animal products and unpasteurised milk and other dairy products made from unpasteurised milk;

- Other food stuffs which may have become contaminated by animal faeces or contaminated irrigation water, such as raw vegetables and salad.

Secondary transmission also occurs within households and other close settings such as nurseries-. The highest proportion of secondary cases are as a result of child to child transmission, and secondary cases are more common when the age of cases is <6 years-.

3.3 Sources

3.3.1 Food borne

STEC was initially associated with minced beef products, for example, beef burgers.[34,35,38] Minced meat products are higher risk due to the fact that any bacteria present on the surface of the meat will have been mixed throughout the product after mincing.[37]

However, STEC has also been associated with a range of other foods.[38-39].

Other meat products that are documented to have caused STEC outbreaks include venison,[40] pork,[41-42] mutton[43] and cooked meats.[44]

Unpasteurised milk and milk products, such as cheese, are another source of STEC[45-46] Pasteurised products have also been traced as the probable source of outbreaks where pasteurisation failure or post-pasteurisation contamination has occurred.[47-48]

Food products not immediately identified as being linked to animals such as lettuce,[49-50] including bagged lettuce[51-52] sprouted seeds,[53] watercress,[54] leeks,[55] potatoes,[56] berries[57] and raw cookie dough[58] have also been identified as the source of outbreaks. Modes of contamination identified include direct contamination with animal faeces, manures and slurries,[59] irrigation with contaminated water[60] and cross-contamination with animal products in food preparation areas.[61,62,63]

Infected food handlers have also been traced as the probable source of STEC outbreaks.[64]

3.3.2 Non-food borne

The fact that STEC is found in the intestines of some animals, and hence anywhere their faeces may come into contact with, means that STEC is likely to be present on farms, petting farms and grazing land; and may also be found in untreated water from lochs, rivers and streams, or from private water supplies that have not been adequately treated.

Outbreaks have occurred from non-food borne sources involving direct or indirect contact with animals including farms,[65-66] petting farms / zoos,[67,68,69] country fairs,[70] camps, music festivals,[71] recreational water activities[72-73] and private water supplies.[74]

4. Epidemiology in Scotland

4.1 Incidence

Health Protection Scotland (HPS) has an established enhanced surveillance system, in close collaboration with the Scottish *E. coli* O157/STEC Reference Laboratory (SERL).

Reports of STEC O157 infection in Scotland increased markedly in the mid 1990s and rates remain high when compared with other UK and European countries.[75]

The number of STEC O157 infections in Scotland has remained reasonably steady over the last 10 years, with an average of 220 per year.

However, the number of non-O157 STEC infections has steadily increased, partially driven by a change in referral pattern for diagnostic testing. Over the past five years, the non-O157 infections reported have accounted for an average of 20% of STEC cases.

Phage type (PT) 21/28 and PT 8 are the most commonly occurring in Scotland accounting for an average of 39% and 23% respectively of STEC O157 cases over the past five years.

Geographical distribution of incidence varies in Health Board areas around Scotland. However, interpreting the rates in smaller Health Board areas is difficult as the small numbers disproportionately affect the incident rates, and all Boards' rates can be affected by large outbreaks.

4.2 Age

For cases occurring between 2012 and 2016, the age of cases ranged from under 1 to over 90 years with a mean age of 31.9 years, median 28 years. Children under 16 accounted for 33% of infections with the highest rate of infection being in the 0-4 year old age group.

4.3 Seasonality

Case numbers tend to be higher in the summer months. Approximately 60% of the cases in Scotland (2012-2016) were reported between weeks 21 and 40. This equates to mid May to the end of September. Numerous reasons for this fluctuation have been suggested such as travel, environmental factors, cattle shedding patterns, differences in food handling and recreational activities in the summer months and housefly populations.[76]

Travel

Of the STEC cases in 2016, 15% were reported to have travelled outside the UK in the 14 days prior to the onset of symptoms.

4.4 Morbidity/Mortality

Overall in 2015 and 2016, 36% of STEC cases were admitted to hospital for at least one night during their illness. In terms of symptoms, 5% of STEC cases were asymptomatic, 21% had diarrhoea without blood and 71% had bloody diarrhoea.

Approximately, 9% cases of STEC in Scotland developed Haemolytic Uraemic Syndrome between 1999 and 2008.[77] Similar proportions have been observed in more recent years.

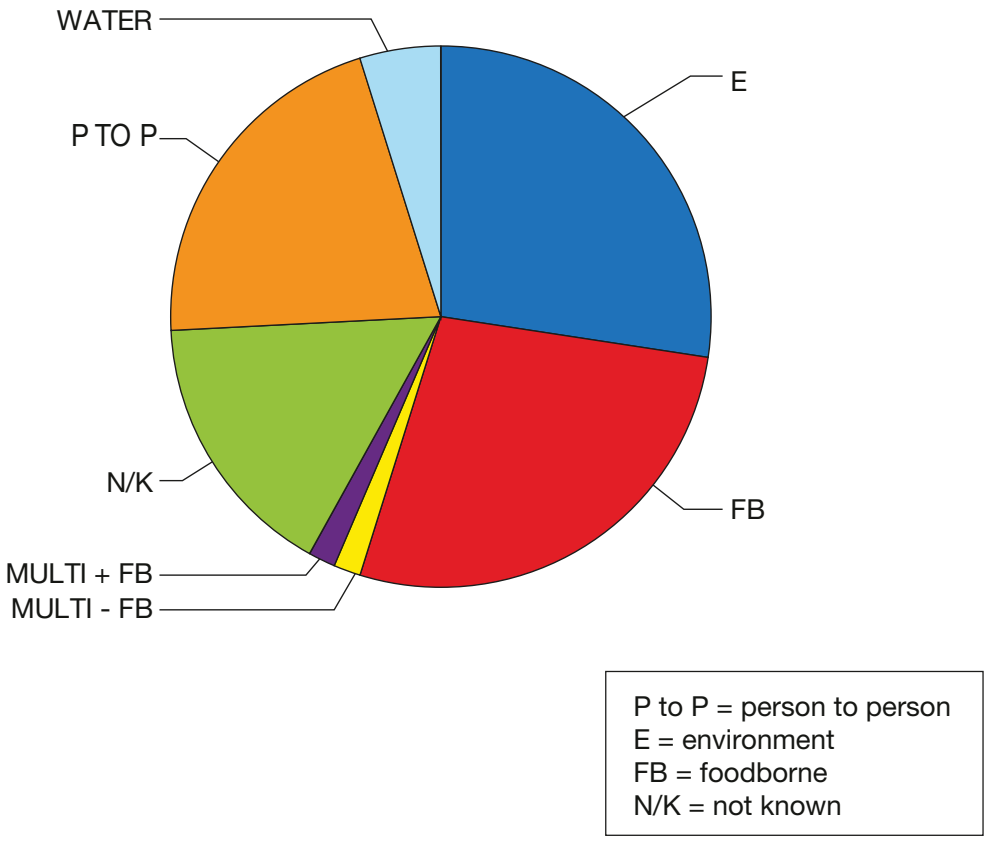
The mortality rate in children with HUS is reported in the literature to be between 3% and 5% with most deaths being due to severe extrarenal complications including central nervous system involvement.[78]

4.5 Sporadic/outbreak

The majority of cases in Scotland are sporadic. However, a number of general outbreaks (defined as affecting more than one household) do occur. In the ten years between 2008 and 2017, there was an average of six STEC general outbreaks a year.

In the ten years 2008-2017 (Figure 1), 18 STEC general outbreaks were reported in Scotland where the main mode of transmission was foodborne or multiple modes, including a foodborne component. Suspected foods were identified in 10 of these outbreaks; meat/meat products in five, salad leaves in two, vegetables in one, and other foods in two.

Figure 1: outbreaks of STEC 2008-2017 in Scotland



5. Microbiology

Definitive diagnosis of STEC infection in diagnostic (local) laboratories is obtained by culture of STEC from stool samples or detection of antibodies in a serum sample.

5.1 Local Laboratory Diagnosis

Scottish diagnostic laboratories routinely test all submitted stool specimens for the presence of non-sorbitol-fermenting *E. coli* O157 but not for non-O157 STEC or sorbitol-fermenting *E. coli* O157.

Clinical history of bloody diarrhoea, HUS or other relevant presenting feature should be noted on the laboratory request form.

Culture confirmation of *E. coli* O157 at the diagnostic laboratory will take 24-48 hours from receipt of the sample (local confirmation).

In general, this is obtained by the following steps:

1. Examination of colonial morphology on selective media (day 1);
2. Performing a slide agglutination test on single colonies (this is usually an *E. coli* O157 kit- based test) (day 1);
3. Confirmation of the identity of slide agglutination positive colonies as *E. coli* (usually day 2).

When all 3 steps have been carried out, the isolation of *E. coli* O157 from the sample is `locally confirmed`.

Most diagnostic laboratories employ kit- based slide agglutination tests which have a very low rate of false positive results. The diagnostic laboratories will therefore usually inform the clinician and the local Health Protection Team immediately if a positive *E. coli* O157 slide agglutination result is obtained on morphologically typical colonies, pending full identification of the organism as *E. coli*. These are termed “presumptive positives”.

Urgent notification to the Health Board of possible, presumptive or confirmed STEC infection is required under the Public Health etc. (Scotland) Act 2008.[79]

Written or electronic notification of the result is issued within 3 days.

Isolates should then be sent to the Reference Laboratory for final confirmation of identity and typing. The appropriate clinical and public health management of potential STEC infection should not be delayed whilst awaiting Reference Laboratory results.

Microbiological confirmation of infection with non- O157 STEC, or atypical *E. coli* O157 strains is more difficult.

If enteric pathogen molecular diagnostic methods are in use at the local laboratory, it is possible to obtain a rapid local positive PCR result, which will be immediately reported to

the clinician and the local Health Protection Team. It is important to assess the significance of a positive PCR result, taking account of the clinical and public health information on the case. Appropriate clinical and public health management should not be delayed pending culture confirmation, which may take several days. In some cases, culture confirmation is not possible.

More detailed guidance on the interpretation of PCR assays for STEC is available on the Health Protection Scotland Website: http://www.hps.scot.nhs.uk/guidelines/detail.aspx?id=1561.

5.2 Reference Laboratory Diagnosis

The Scottish *E. coli* O157/STEC Reference Laboratory accepts stool samples for molecular testing from cases that meet the following criteria:

- Cases of suspected HUS or cases of bloody diarrhoea in whom conventional laboratory testing has failed to yield a pathogen;
- All symptomatic contacts of non-sorbitol-fermenting *E. coli* O157, sorbitol-fermenting *E. coli* O157 and non- O157 STEC in whom conventional laboratory testing has failed to yield a pathogen;
- Any outbreak- associated case in whom conventional laboratory testing has failed to identify a pathogen.

The Reference Laboratory will carry out molecular testing by PCR, followed by culture if the stool sample is PCR positive. Positive PCR results will be telephoned, immediately, to the referring diagnostic laboratory.

5.2.1 Role of the Reference Laboratory

For Scotland, the Reference Laboratory is the Scottish *E. coli* O157/STEC Reference Laboratory (SERL).

A variety of services is provided, including the following:

- Confirmation of identity and relevant typing e g serotyping, phage typing, molecular typing including whole genome sequencing
- Detection of virulence genes, and other genes as appropriate
- Antimicrobial resistance data for national surveillance (not routinely reported to clinicians or Health Protection Teams)
- Provision of advice to clinicians, public health and epidemiology colleagues at NHS Board level and national level
- Provision of advice to Local Authority scientific services, and other bodies in relation to food, water and environmental isolates as required

In addition to human isolates, the SERL accepts isolates of STEC from food, water or environmental sources by arrangement by telephone. Isolates submitted in the course of

outbreak investigations are routinely processed by SERL and will be prioritized along with human isolates.

The SERL User Manual can be accessed at the following site: http://www.edinburghlabmed.co.uk/Specialities/reflab/ecoli/Pages/default.aspx.

5.2.2 Detection of antibodies in serum samples

Diagnostic laboratories should submit a sample of serum (not clotted blood) if stool samples are negative or no stool sample is available in cases where HUS is a likely diagnosis. This is a referred test (GBRU, Colindale) and the turnaround time is 10 days if samples are referred via the SERL. Serum samples may also be sent directly from the diagnostic laboratory to GBRU, Colindale.

5.2.3 Interpretation of PCR positive stool sample results not confirmed by culture

Reference Laboratory data has shown that approximately 16% of stool samples which are positive for Shiga toxin genes at SERL fail to yield a STEC organism on culture.

Interpretation of these results should be based on the clinical presentation and the detection of other enteric pathogens.

5.2.4 Shiga toxin (stx) gene negative *E. coli* O157

E. coli O157 strains testing negative for stx genes are isolated as a result of referral of faecal samples from cases of bloody diarrhoea which are locally culture negative to the Reference Laboratory. These isolates are frequently sorbitol- fermenting and are more difficult to detect by current diagnostic laboratory methodologies. In Scotland in 2015, 6.5% of *E. coli* O157 strains tested negative for stx genes (HPS Weekly Report 18 October 2016).

A proportion of these strains are descendents of enterohaemorrhagic *E. coli* O157 that have lost the stx gene during infection but have caused significant disease, including HUS.[80,81,82]

Therefore the initial assumption should be that Public Health actions such as screening and exclusion should be carried out. Advice on the potential pathogenicity of individual strains may be obtained from the Reference Laboratory, but clinical and epidemiological features of the case should also be taken into account. A risk assessment may be required if a case continues to excrete a stx gene negative *E. coli* O157, taking account of the clinical presentation and circumstances of the case.

Non- bloody diarrhoea may be caused by *E. coli* strains (non- O157 serotype) designated Enteropathogenic *E. coli* (EPEC). These are also stx gene negative. Diagnostic laboratories do not investigate faecal samples for these organisms as illness is usually mild and self-limiting.

5.2.5 Whole Genome Sequencing (WGS)

Additional information provided by whole genome sequencing of STEC organisms may inform risk assessment for Public Health purposes – e. g. possession of *eae*, *aggR* and *aaiC* genes –, which are involved in adherence of the organisms to the gut. Isolates of *E. coli* O157 are eae positive but possession of eae genes in non- O157 STEC is variable.[83] However, possession of eae gene is usually, but not always, an additional requirement for the organism to cause severe disease.[84]

Genetic elements involved in the pathogenicity of STEC are mobile and new pathogenic strains emerge in the human and cattle population and in foodstuffs e.g. the eae gene negative, stx and aggR positive *E. coli* O104 which caused a large outbreak of HUS in Germany.[85]

WGS also provides information on stx subtype and some subtypes e.g. stx 2a and stx 2d are associated with more severe disease.[86-92]

5.2.6 Microbiological clearance testing

Microbiological clearance for non-sorbitol-fermenting *E. coli* O157

Microbiological clearance: for non- sorbitol- fermenting (NSF) *E. coli* O157 with or without stx genes is confirmed by conventional laboratory testing (culture) at the local diagnostic laboratory; this is irrespective of whether or not the local diagnostic laboratory initially cultured the STEC.

Microbiological clearance for sorbitol-fermenting *E. coli* O157 and non-O157 STEC

Microbiological clearance for sorbitol-fermenting *E. coli* O157 is confirmed at SERL by PCR for detection of *stx*1, *stx*2, and *rfb*O157 genes.

Microbiological clearance for non- O157 STEC is confirmed at SERL by PCR for detection of *stx*1 and *stx*2 genes.

Samples are reported by SERL as positive or negative based on interpretation of the PCR result.

Diagnostic laboratories employing PCR methodology for STEC detection may be able to locally confirm microbiological clearance of SF and non- O157 STEC.

5.2.7 Reference Laboratory Reporting

Reports are issued electronically. Important or urgent results are telephoned to the referring diagnostic laboratory – e.g. new positive results on faecal samples. See the SERL User Manual - http://www.edinburghlabmed.co.uk/Specialities/reflab/ecoli/Pages/default.aspx - for further information.

6. Public Health Action for STEC

STEC infection can cause significant and potentially severe disease, hence the need for rapid public health intervention. The key to public health action for STEC is detailed risk assessment to ascertain a) the likely source of infection b) the likelihood of further primary or secondary cases, and c) to inform the subsequent implementation of measures to remove or mitigate those risks.

Public health response to an STEC case must start on the day of notification, and as a minimum standard, the risk assessment should be completed and subsequent public heath actions initiated within 24 hours of notification.

6.1 Local planning

Whilst this guidance provides general information on risk assessment, case management and outbreak control, and can be used as the basis for local planning, it does not replace the need for such planning. The implementation of this guidance at local level will be influenced by factors including, but not limited to, geography and demography, available resources, and accessibility of other services.

To assist effective working arrangements, a specific standard operating procedure, service level agreement or similar – which meet or exceed the minimum standard above, should be agreed between public health teams and local environmental health departments. Arrangements with other agencies should be detailed in local or national plans. Other agencies who may be involved dependent on the scenario include: Health Protection Scotland (HPS); the Animal and Plant Health Agency (APHA), Scottish Environment Protection Agency (SEPA); Scottish Water; Drinking Water Quality Regulator (DWQR), and Food Standards Scotland (FSS). Implementation of this guidance, and post-action reviews (lessons learned) should form part of the work plan of the Board health protection liaison groups.

6.1.1 Surveillance

Since 1999, *E. coli* O157 and other STEC have been subject to an enhanced surveillance system in Scotland. The enhanced surveillance form was fully revised and updated in 2016, and is approved for use as part of the data sharing arrangements between HPS and territorial Boards.

6.1.2 Identification

Cases will usually be notified by either local microbiology laboratories, or SERL. Cases may also be reported by clinical staff where there is suspicion of STEC, for example cases with acute bloody diarrhoea, or in cases of haemolytic uraemic syndrome (HUS).

Further guidance on diagnosis is contained in the microbiology section and in the clinical guideline.[iii]

iii A link to the clinical guidance and the patient information leaflet will be added when they are published.

6.2 Risk assessment

The investigation should begin with the collection of the information necessary to make the risk assessment. The HPS enhanced surveillance form must be used to ensure complete collection of this information about every case. The information may come from the case, contacts, or other informants.

Key areas to consider during the risk assessment are based on the known epidemiology of the disease, including source and transmission factors, which are described in the first section of this guidance. These include:

- Case details, including age, occupation, and underlying medical conditions.
- Details of workplace (including health, care or food handling responsibilities) or educational establishment, including nurseries or other care settings.
- Food history, especially any history of eating out, takeaways, handling of produce contaminated with soil, and handling or consumption of raw, unpasteurised, unusual, or imported foods.
- Contact with animals. Careful questioning, including specific questions on household pets, is required as individuals may have differing definitions of domestic v wild animals.
- Use of water. There is a higher risk from private water supplies, and contact with surface water such as lochs or streams. Risk from public water supply is very low unless there has been a failure of treatment or significant works on the water network.
- Travel history should include not just foreign travel, but any overnight stays elsewhere in the United Kingdom, as STEC is endemic to the UK.
- Consideration of other activities, day trips or hobbies, such as hillwalking or rural sports, which may bring the individual into close contact with animal faeces.

The risk assessment should also include gathering of details of all close contacts, including sufficient information to assess if they fall into risk categories. Close contacts (Section 2) can be defined as follows:

- All household contacts, including those made through overnight stays. This includes those who shared a kitchen or toilet facilities with the case, during the infectious period. This may include extended family members, childminders and their families, as well as sexual contacts.
- Any individual the case has regularly prepared food for, during the infectious period, or on a single occasion if there are concerns about hygiene practices.
- If relevant, anyone involved in nappy changing, assisted toileting, or personal care of the index case during infectious period.

Contacts who are symptomatic should be treated as a probable case, with appropriate clinical and public health management.

Further investigations to identify or confirm the source may be necessary. These may include case finding, additional microbiology testing, environmental inspection, and food or water testing. The Health Protection Team (HPT) and Environmental Health Department

(EHD), with HPS and other agencies as necessary, should discuss and agree what, if any, further investigation is required for single cases. It is expected that in clusters/outbreaks this decision would be taken by the IMT. In the event that a case(s) used private water supplies in the incubation period, it would be expected that sampling of the supply would occur, and alternative temporary water supplies utilised, pending results.

6.3 Control measures

Working with Environmental Health Departments and other agencies as appropriate, the local public health team should initiate actions to mitigate the risk from any identified source, and to reduce the risk of future transmission. These should be proportionate to the risk and may invoke use of the precautionary principle.

Cases and contacts should be provided with information and advice on reducing the risk of further spread. Advice should be given both verbally and in writing. Local public health teams should give consideration to use of standardised patient information leaflets.[iv]

As with all GI pathogens, the key intervention is good infection-control practice, in particular hand hygiene. The importance of washing hands with liquid soap and running warm water, as well as drying thoroughly with a separate towel, every time after using the toilet and before food preparation should be stressed.

Hand washing should also be performed after any other activity where faecal contamination is a possibility, for example the handling of soiled linen, contact with animals, and before and after assisting younger children with toileting, including nappy changing.

Symptomatic individuals should not, if possible, prepare food for others, or share towels, and should be discouraged from swimming until 48 hours after symptoms cease. They should also refrain from sexual contact during this time.

Environmental cleaning should be reinforced, with special attention paid to toilets and surrounding areas, food preparation areas, and other hard surfaces such as sinks taps and door handles. Cleaning in nondomestic settings such as healthcare, daycare, or food businesses is detailed elsewhere.[93-96] In particular food businesses should discuss their needs with the local environmental health department.

6.3.1 Exclusion and clearance

All cases should be advised to refrain from attending work or educational establishment (including nurseries, schools and universities or colleges) until 48 hours after diarrhoea and/or vomiting have resolved. This exclusion should also extend to other group settings such as playgroups and sports clubs.

Cases and close contacts who fall into one or more of the risk groups A to D (Table 1) should be, under the Public Health Act , formally excluded or restricted, in writing, from work or school until microbiological clearance has been achieved (see flowcart, page 20).

iv A link to the patient information leaflet will be added when they are published.

Table 1: Risk Groups (cases and close contacts) adapted from Food Standards Agency Scotland (2006, Review) Guidance on the investigation and control of outbreaks of foodborne disease in Scotland (Cairns Smith Report). Available at: http://www.hps.scot.nhs.uk/giz/resourcedetail.aspx?id=187.

RISK GROUP	DEFINITION
Group A	Any person of doubtful 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 subject to further heating.
Group D	Clinical and social care staff who have direct contact with highly susceptible patients or persons in whom a gastrointestinal infection would have particularly serious consequences

Children attending preschool/nursery should be excluded under risk group B. In general, children under 5, not attending nursery/preschool fall under risk group A. 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.[97] Group D may also include those working in early years care and education.

The Scottish CPHM Good Practice Statement[98] remains a reasonable standard for microbiological clearance, when compared to the global literature.[99-102] The risk group categories included in the table are currently under review by the SHPN as part of the Cairns Smith guidance review, and may be updated during the life of this document.

Microbiological clearance consists of two consecutive negative samples taken at least 24 hours apart. To ensure this gap, it may be appropriate to ask cases to take samples on 'alternate days'. Samples should be submitted as soon as possible after being taken, and to minimise potential sample errors, on different days. Samples should be also labelled with the time they were taken, as *per* the local laboratory protocol. The first clearance sample for the case should be taken no earlier than 48 hours after symptoms resolved.

Public health teams should decide on the timing of clearance samples in contacts in risk groups on an individual basis. Theoretically if clearance samples are taken from the close contact whilst the index case is still infectious, later cross infection may be missed. However the use of good personal hygiene and environmental cleaning would make transmission between competent adults very unlikely. The cross infection scenario is less likely with risk groups C and D as the nature of their work means they should have greater understanding of, and compliance to necessary hygiene measures, and as such clearance sampling could potentially begin at the same time as the case. For other contacts consideration should be given to delaying the start of clearance sampling, especially if either case or contact is in risk groups A or B.

The frequency of sampling should be discussed with the case. Sampling should not be too frequent, as multiple samples may result in difficult to interpret results, and are not an efficient use of lab resource.

Although exclusion will be the appropriate control measure for many cases, it should not be considered as the default option, and the least restrictive intervention necessary to protect

public health should be used. Consideration should always be given in the risk assessment to the use of restriction orders, for example limiting the types or locations of duties. Although still requiring some change to day-to-day activities, restriction orders are ultimately less disruptive to the individual and employer/school.

When using exclusion or restriction orders it is vital to follow the guidance published by the Scottish Government including ensuring the individual is aware of their rights to claim for loss of income.[103]

Exclusion and restriction orders must be reviewed at least every 3 weeks.[104] Any decision on exclusion/restriction, and the risk assessment it is based on should be clearly documented.

6.3.2 Compliance

Control measures are only effective if there is a high level of compliance with strictly followed procedures. It is therefore important to ensure that control measures are understood and acceptable to those being asked to undertake them.[105]

Teams responding to cases and outbreaks should consider audit of compliance with control measures as a means of both measuring performance, and informing future actions.

6.3.3 Chronic shedding

Individuals, especially young children, can continue to shed *E. coli* O157 / STEC in the stool for some time after the symptomatic infection has passed (see Clinical features). It is important that cases and/or parents are aware that clearance can be a lengthy process.

In some individuals, shedding can continue for a significantly longer time than the expected range. In these cases, it is appropriate to review the risk assessment, including any restrictions that have been placed on the individual. The public health benefit of any continued exclusion needs to be balanced against the potential harm from prolonged periods away from work or educational settings. Further risk assessment and consideration of alternative control measures (such as supervised hand washing) if necessary should occur for these cases.[106-108] The timing of such a review will depend on the individual circumstances of the case, but six to eight weeks after notification is likely to be reasonable. In chronic shedding, reduction in the frequency of sampling should be considered. Where shedding continues for many months, consideration should be given to referral to the local infectious diseases team.

6.4 Outbreak management

Outbreaks should be managed in accordance with the HPS / Scottish Government Framework on Management of Public Health Incidents and the local outbreak control plan and other situation-specific national guidance.

Given the low infectious dose[109] and potential severity of STEC infection, a low threshold for action is appropriate. This includes the setting up of a problem assessment group (PAG) or an IMT. The initial PAG (if necessary) or IMT should be held on the same day as the outbreak

is detected or as soon as is practicable after. The first IMT meeting should specifically assess the ongoing risk to the public, consider what control measures are available, decide which activities should be prohibited or improved, and should identify who is responsible for completing each action.[110]

All outbreaks should be discussed with HPS and SERL. The Scottish Government Health Department should be informed, as in the Management of Public Health Incidents Guidance (2017).[111]

6.4.1 Special circumstances

Whilst outbreaks of STEC should be managed to the same principles as any other outbreak investigation, there are certain circumstances where special considerations should be given. In these circumstances consideration should be given to widening the membership of the IMT to include other relevant stakeholders.

Outbreak control is more difficult in closed and semi-closed communities such as prisons, care homes, and other residential premises (including boarding schools) because of both the increased risk of spread, and potential barriers to implementation of control measures. Outdoor/rural events, such organised camping/expeditions or charity and commercial events, require detailed risk assessment, and are beyond the scope of this guidance. Public health teams should follow any relevant plans and consider the need for early discussion and access to additional expertise and advice.

6.4.2 Nurseries and other early years establishments

All children attending these facilities will fall into risk group B, and many of the staff will carry out nappy changing or assisted toileting. Consideration should be given to how the infection was introduced and has spread around the setting. This should include assessment of the size, scope, layout, and operating procedures of the facility.

Aggressive control measures have been shown to stop school outbreaks.[112-113] Control measures should include exclusion and testing of all symptomatic children and staff, reinforcement of rigorous hand hygiene measures, written information for parents and staff and enhanced environmental cleaning as detailed in the relevant HPS guidance.[114]

In certain circumstances the IMT may wish to consider screening asymptomatic individuals, or complete closure of the facility.[115-117] If there are significant numbers of children excluded awaiting clearance who are now asymptomatic, it may be appropriate to consider cohorting if that is feasible given the design of the facility.[118]

These considerations can also be relevant in some adult day care settings.

6.4.3 Open farms or petting zoos

Attractions that bring about closer interactions with humans and farm or other animals have been associated with significant STEC outbreaks previously. In these settings there may be multiple zoonotic transmissions at the same time. As they are popular tourist attractions,

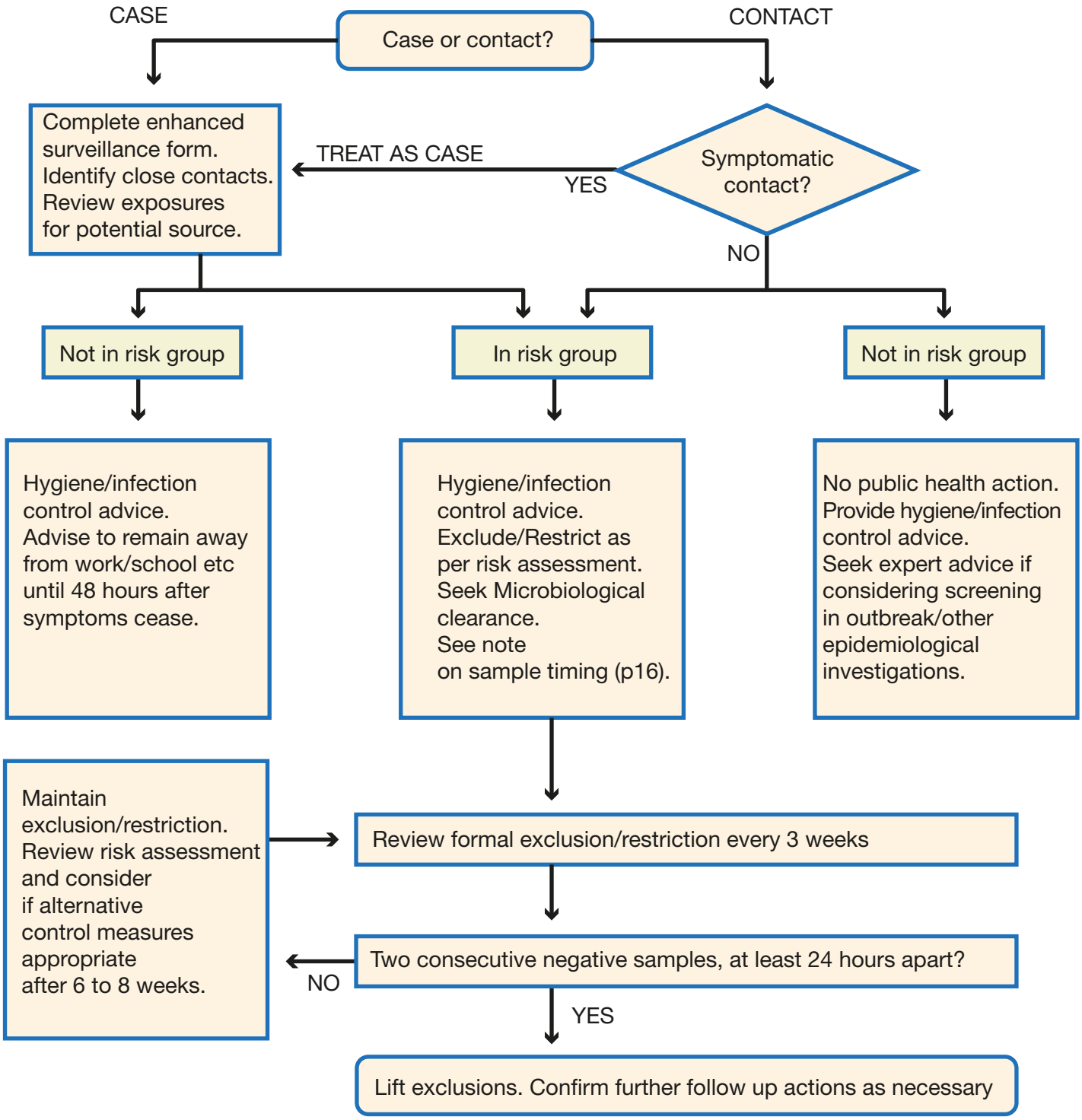
cases and contacts may be highly geographically dispersed making outbreak detection more difficult, and subsequently require an increased effort in case finding.

Urgent action to limit the possible further transmission including stopping all public access to the animals, and taking action to reduce possible contact between the public and animal faeces should be taken. Consideration should be given to closing the whole facility. HPT/EHD joint visits may be considered.[119]

The industry code of practice 'Preventing or controlling ill health from animal contact at visitor attractions or open farms,[120-121] which replaces HSE AIS 23,[122] provides standards[123] that open farms and similar attractions should follow to minimise risks to visitors.[124-125] Best practice guidance on planning events with animal-human interactions is also available.[126] In particular, keeping younger children out of animal pens/direct contact will help reduce risk.[127-128]

7. Flowchart

Exclusion / Restriction Criteria for Cases and Contacts



8. Guidelines Review Group (Membership)

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9. Guidelines Review Process

This guidance was developed using a standard methodology based on a systematic review of the evidence, in line with protocols supported by the Scottish Health Protection Network (SHPN). The evidence review and the appraisal process applied to the development of this guidelines, complies with the SHPN requirements for the production of evidence-based guidelines (EBG) type A. Further details can be found at: https://hpsmicrosites.scot.nhs.uk/scottish-health-protection-network.aspx

Keeping up to date

This guideline was published in 2018 and will be considered for review in three years. The review history, and any updates to the guideline in the interim period, will be noted in the review report.

9.1 Acknowledgements

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