

Independent Review of an Outbreak of
Salmonella enteritidis Phage Type 14b at
Heartlands Hospital, Heart of England, NHS,
Foundation Trust (HEFT) from May to June
2014.

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2. Executive Summary

Background

Between 25 May and 18 June 2014, 32 cases of *Salmonella enteritidis* O9g PT 14b in patients, staff and visitors were linked to the Birmingham Heartlands Hospital (BHH). Of the patients infected 17 had spent the whole incubation period of the disease in the hospital. The outbreak focused mainly on a cluster of cases on two related orthopaedic trauma wards (Beech and Rowan). A local Outbreak Control Committee (OCC) was formed to co-ordinate a multi-disciplinary investigation to understand the source of this outbreak and enable suitable control measures to be put in place to prevent further cases.

Investigations

A detailed epidemiological and clinical review of cases was conducted to identify cases that were hospital acquired or community acquired. There was a review and microbiological testing of the food supply chain and the potable drinking water supply to establish the safety of food and drink consumed by patients. Infection prevention control measures were implemented on all affected wards. A hand washing campaign and enhanced cleaning routines were implemented. All cases were diagnosed by microbiological testing of stools and/or blood. All *Salmonella* isolates were sent to the national reference laboratory for serotyping, phage typing and molecular typing. In addition whole genome sequencing (WGS) was undertaken early in the outbreak at Birmingham University and subsequently at Public Health England (PHE) Colindale.

Findings

Initially 36 cases were investigated of which 29 were patients and seven staff (six community acquired). Eight of the patients were deemed to be community acquired cases and 21 cases hospital acquired. Ten of these 21 cases occurred on Beech/Rowan wards, eight on other wards and three were identified as asymptomatic cases following ward screening. Six patients had a bacteraemia and five cases died. *Salmonella* infection was considered to be a contributory factor in the cause of death for one patient.

Conclusion

This report describes a review of the investigation and management of an outbreak of gastrointestinal illness caused by *Salmonella enteritidis* PT14b in Birmingham Heartlands Hospital. The outbreak investigation was thorough and timely interventions were put in place. Senior Trust executives and staff took leading roles during the outbreak. Unfortunately, despite the best efforts of the OCC and the Infection Prevention Control Team (IPCT) secondary cases occurred on Beech and Rowan wards. These cases were probably due to a breakdown in preventative control procedures or suboptimal cleaning.

Access to local, rapid characterisation by WGS proved to be invaluable during this outbreak. These results confirmed that isolates from cases in the hospital and community, and one environmental isolate from Beech ward were indistinguishable.

Main Recommendations

- The Trust should use the learning outcomes from this outbreak to review its infection control and cleaning services to ensure that they will meet the new requirements of the Department of Health's: The Health and Social Care Act 2008: Code of practice on the prevention and control of infections and related guidance.
- This Salmonella Outbreak review has identified a gap between the Policy for the Control of an Outbreak of Infection in Hospital and the Trust Major Incident plan. The Trust should review the need for a plan that deals with Major Internal Incidents or Outbreaks.
- In the light of this outbreak the Trust should regularly review major policies that relate to patient safety and infection control procedures as a number of these were overdue for review.
- This outbreak has demonstrated the impact of WGS when investigating outbreaks of hospital and community acquired infections. It is recommended that in future microbiology departments in large teaching hospitals, such as HEFT, and Public Health laboratories should provide access to WGS as part of their routine service.
- The Trust should review all of its high-risk, specialist wards in the light of the experience from this outbreak and ensure that the ward environment and equipment is fit for purpose.
- The Trust should ensure that all ward staff handling food undertake food hygiene training.
- The Trust should proceed with the implementation of the new Mortality review system.
- The Trust should ensure that there is adequate clinical involvement on the new Food Safety and Cleaning Environment Group Committee so that ward based issues and patient safety are kept at the forefront of any future decisions.
- The Trust should have an on-going review of the relationship with G4S to address any ward-based staff concerns about the service.
- The Trust should review the communications strategy for ward-based staff, who do not have daily access to email, especially when there are outbreaks on wards.

3. Background

3.1 Salmonella

Salmonella is a common cause of bacterial gastroenteritis in the United Kingdom. [1] *Salmonella* bacteria are widely distributed in domestic and wild animals. Human sporadic cases typically peak between July and September. However, outbreaks of infection associated with larger numbers of cases are not uncommon and since the mid 1980s *Salmonella enteritidis* has been the commonest salmonella associated with food poisoning.

Salmonella organisms are typed for epidemiological purposes by serology and by bacteriophage typing. This typing identified the organism causing the outbreak as *Salmonella enteritidis* O9g (serology) phage type 14b. In addition molecular techniques are used to differentiate between strains that appear identical by these methods.

3.2 Transmission of Salmonella infection

This can occur by several routes:

- Most commonly transmission is through the consumption of contaminated food items. Typical food sources include undercooked poultry or meat, raw or undercooked eggs and raw or inadequately pasteurised milk. Heating food to at least 70°C for 2 minutes is required to kill the organism.
- Person-to-person transmission through the faecal-oral route can also occur. This can be directly by contact with a food handler or carer (doctor, nurse, healthcare assistant) who is excreting the organism or indirectly by staff inadvertently spreading the organism from patient to patient resulting in secondary cases. The risk of person-to-person spread is highest during the acute diarrhoeal phase of the illness. Hence, inadequate infection control practices may prolong outbreaks.
- Transmission may also occur from a contaminated environmental source. *Salmonella*, unlike Norovirus and *Clostridium difficile*, can continue to multiply in the environment, especially when it is warm and humid, and this reservoir of organisms can lead to an on-going source of infection. This can be by direct contamination of food items or by staff transferring the organisms to patients.

3.3 Infective dose and onset of symptoms

The infective dose can be very low, with as few as 10 organisms able to initiate the infection. The infective dose can vary depending on the type of food consumed and also the immune status of the individual. The elderly, very young and those with predisposing medical conditions are at greater risk.

The incubation period is usually 1-3 days, but ranges from 4 hours to 5 days. The majority of cases will present with diarrhoea and/or vomiting and in some cases the *Salmonella* may be invasive and patients may develop septicaemia

/ bacteraemia. Salmonellosis is diagnosed by culturing the organism from stool or blood specimens. In rare cases the infection may be systemic and spread to other organs. Some individuals may also become chronic carriers and continue to excrete the organism for weeks or months. In contrast other individuals have milder infections and some can be asymptomatic.

3.4 National Outbreak

At the beginning of June 2014, Public Health England (PHE) was alerted to an outbreak of *Salmonella enteritidis* phage type (PT) 14b in a hospital in central England (Birmingham Heartlands Hospital). Following this, outbreaks of *Salmonella enteritidis* PT14b and cases were detected in the North West and South of England. A national Outbreak Control Team (OCT) was formed to co-ordinate a multi-disciplinary investigation to understand the source of this outbreak and enable suitable control measures to be put in place to prevent further cases. Subsequent investigations confirmed that this was part of an international outbreak with infections reported in Austria, France, Germany and Luxemburg. The outbreak was eventually traced back to contaminated eggs produced in Bavaria, Germany. (Dr Paul Cleary, PHE, Personal Communication). During the first week of the outbreak the University of Birmingham undertook Whole Genome Sequencing (WGS) of the salmonella isolates from cases in Heartlands Hospital and the local community. The results confirmed that the outbreak strain responsible for infections in hospital and community cases was indistinguishable and hence the original source of the outbreak was most likely from a food source in the local community. This information was critical to understanding the acute epidemiology of the outbreak and was available before the PHE national reference laboratory's typing results. This sequencing information was shared with the national reference laboratory and other European centres and facilitated the national and international investigations.

Information provided by PHE (**Figure 1**) shows that the cases in the outbreak at Heartlands Hospital (pink columns) occurred at the beginning of what was later to be identified as a national outbreak. These hospital cases were part of a wider local community outbreak.

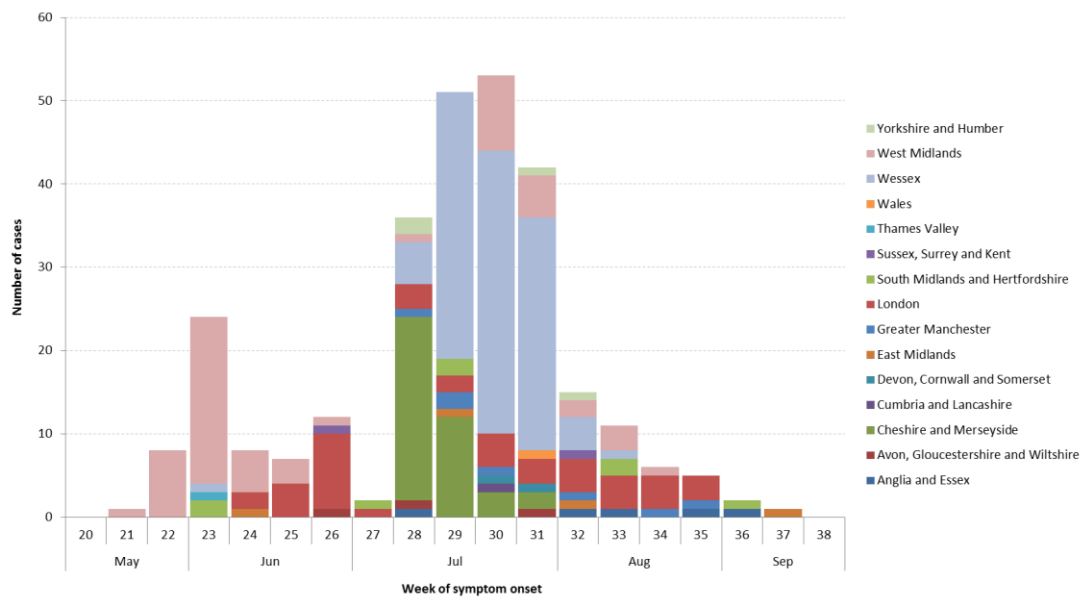


Figure 1. Epidemic curve showing onset date by ONS week (n=284)

3.5 Salmonella Outbreaks in Hospitals

From the beginning of the millennium Salmonella outbreaks in UK hospitals have been uncommon. However, severe cases of Salmonellosis acquired in the community are admitted to hospitals and hence, the risk of spreading infection must be dealt with by infection control teams. Failure to effectively manage these risks was demonstrated in a review of Hospital outbreaks during the 1980s and the early 1990s. [2] [3]

A total of 248 outbreaks of salmonellosis in hospitals affecting over 3000 patients and 110 associated deaths were ascertained in England and Wales between 1978-87. Fifty seven (24%) outbreaks were considered to be due to foodborne salmonellosis, and 70 (30%) were reported as person-to-person spread of the infection. [2] This period also included the largest salmonella outbreak in hospitals in the UK. This occurred in 1984 at the Stanley Royd Hospital, where there were over 400 cases and 19 deaths. This led to a public inquiry and recommendations for the investigation, control, and prevention of such outbreaks. Such is the outcome of these Salmonella outbreaks that even in modern NHS hospitals there is the potential for these investigations to lead to litigation and or to an enquiry.

A similar review of surveillance data in England and Wales described the epidemiology of outbreaks of salmonellosis in hospitals from 1992-1994. [3] Salmonella was the implicated pathogen in 22/189 (12%) outbreaks. The mode of transmission was described as mainly person-to-person in 12/22 (55%) of outbreaks, mainly foodborne in 8/22 (36.4%) and equal or unknown proportions of foodborne and person-to-person in two. The most common strain involved was Salmonella enteritidis Phage Type (PT) 4. This was the predominant Salmonella phage type at the time and infection was associated

with contaminated eggs and poultry. The mean duration of outbreaks was 16 days and illness was reported in 260 patients, of whom 130 had a laboratory confirmed infection. The salmonella infection was believed to have contributed to the deaths of five patients.

As part of these outbreak investigations 31/826 (3.8%) of asymptomatic patients tested were positive, 68/115 (59.1%) of staff with symptoms tested were positive and 33/1508 (2.2%) of asymptomatic staff tested were positive.

These findings demonstrate that attack rates can be high and outbreaks are often prolonged (several weeks), with high morbidity and associated disruption of hospital services. These studies also highlight the importance of hospitals providing safe food for patients. Since the 1990s hospital catering and food safety has improved mainly due to the introduction of Hazard Analysis Critical Control Point (HACCP) systems, the need for ISO accreditation and adoption of modern food production methods.

These studies also demonstrate that person-to-person transmission is a major problem in hospital outbreaks. In a more recent outbreak on a paediatric ward in a South African Hospital person-to-person transmission was identified as the most likely mechanism for the spread of infection expedited due to a breakdown in hand-washing and hygiene, suboptimal infection control practices, overcrowding of hospital wards, and an undesirable nurse-to-patient ratio. [4]

Outbreaks of salmonellosis in hospitals are preventable and there is a need for effective infection control policies, appropriate training of staff, simple surveillance systems and readily available expert advice to ensure outbreaks are rapidly controlled. [3] Since this recommendation many of these issues have been addressed in UK hospitals with the establishment of Infection Control teams and the Director of Infection, Prevention and Control (DIPC) role. Regardless hospitals must be vigilant and as demonstrated in the outbreak in South Africa any breakdown in preventative infection control procedures can lead to these infections occurring in vulnerable groups of patients, who require close and frequent contact with clinical staff and other healthcare workers.

4. Heartlands Hospital Outbreak - Investigation and Management

4.1 Epidemiological Information

Between 25 May and 18 June 2014, 32 cases of *Salmonella enteritidis* O9g PT 14b in patients, staff and visitors were linked to the Birmingham Heartlands Hospital (BHH). (Data from PHE) Of the patients infected 17 had spent the whole incubation period of the disease in the hospital. The DIPC for HEFT reported that there were 36 cases. This difference is explained later in this section of the report.

The normal background level of Salmonella infection reported by NHS laboratories in the West Midlands each week is a few cases (2-6) and these are usually all community acquired. At the time the first few cases of the Heartlands outbreak were detected there was some uncertainty about the source of the infection and it was not known if this was within the hospital or was from a community source. For this reason it was important for the Outbreak Committee to agree working definitions for cases that either acquired infection in the hospital or in the community. Cases that entered Birmingham Heartlands Hospital with symptoms of salmonella infection or developed symptoms within 24 hours of admission were classed as community acquired. Cases with onset of symptoms more than 120 hours after admission to hospital were considered to be hospital acquired. These definitions were used to review all cases clinically and epidemiologically.

The DIPC has produced a comprehensive report of the outbreak for submission to the Coroner's court and there is an excellent epidemiological review of the outbreak detailed in a report by epidemiologists from the PHE Centre, Birmingham. It is not the intention of this review to reproduce all of this data but to highlight the essential information.

The DIPC in his report to the coroner stated that: this strain of salmonella (Salmonella enteritidis O9g PT 14b) was isolated from specimens of 36 individuals. This is slightly different than the 32 cases reported by PHE. This is probably due to later re-assignment of some hospital cases as community acquired cases by the epidemiologists in PHE. However, the following breakdown of cases by the DIPC is a useful guide to the situation that developed at BHH. In the early stage of the outbreak there were Salmonella infected patients on nine different hospital wards. However, the three cases on three of these wards were subsequently designated as community acquired infections. The main part of the outbreak was the cluster of cases on Beech and Rowan wards.

Community acquired	8
BHH Staff	7* (4 associated with Rowan ward)
Patients-Beech/Rowan wards	10
Patients- other wards	8**
Patients screened for carriage	3***
Total	36

* Likely to be community-acquired, apart from one individual.

**Epidemiological investigation indicates that four of these cases are possibly community-acquired.

***Asymptomatic patients on Beech and BHH 9 (ex Rowan ward) were screened for salmonella carriage.

Note that Rowan ward was moved to BHH Ward 9 on 5th and 6th June.

4.2 Infection, Prevention and Control

HEFT has a long established structure for infection, prevention and control.

There is a designated Consultant Microbiologist as the DIPC. The DIPC at the time of the outbreak has since retired and has been replaced by another senior Consultant Microbiologist. The Infection Prevention Control Team (IPCT) at HEFT is led by a Lead Infection Prevention Control Nurse and supported by an experienced group of professionally trained nurses. The Trust has an established Trust Infection Committee for oversight of infection related issues. There is an established, excellent working relationship between the IPCT and the Consultant Microbiologists in the Trust. There are several documented policies and procedures in place. Those relevant to this outbreak are: The Policy for Control of an Outbreak of Infection in Hospital (Review date December 2012) and a document describing Standard Infection Control Precautions which was reviewed in January 2013.

The Trust's IPCT has procedures and on-going auditing that were in place before the Salmonella outbreak. For example, all wards and departments undertake monthly auditing for environmental cleanliness and hand hygiene practice. Both Beech and Rowan wards achieved satisfactory results during April and May 2014 with scores of over 85%. In addition the annual infection control audit was carried out on Beech Ward in January 2014 with the ward achieving an overall score of 89%.

4.3 Recognition of and Response to the Outbreak.

The first outbreak meeting (internal to the Trust) was called by the DIPC on the 5th June the same day that the first two cases were diagnosed in the laboratory. These cases were on two different wards (ward 2 and ward 19). The IPCT team was also been informed of an increase in gastro-enteric symptoms in patients on Beech and Rowan wards. This is part of the standard response to syndromic surveillance in place for early warning of potential outbreaks of infection.

On the 6th of June a full Outbreak Control Committee (OCC) was formed This comprised the Medical Director, Executive Directors, with senior officers of nursing, infection control, microbiology, occupational health, hotel services, food and catering, estates, communications and Clinical Commissioning Group (CCG) infection control leads. In addition, officers from the West Midlands Health Protection Team of Public Health England, and Environmental Health Officers from Birmingham City Council were in attendance. It had also become evident that there were possibly five more cases with a cluster on Beech and Rowan wards.

At this time the purpose of the OCC was defined: It was to determine the extent of the outbreak and control it, to identify the source of the organism, and eliminate this source, to identify any breaches in practices that needed immediate address, and to ensure that all processes for patient, staff and visitor safety were reviewed, and that correct practices were in place to protect these groups.

Subsequently there were regular OCC meetings scheduled throughout the period of the outbreak.

4.4 Actions Taken

1. The Trust policy and management plan “Control of an Outbreak of Infection in Hospital” was instigated which included cohorting of staff with staff changing into scrub suits, remaining on the ward for breaks and not being relocated to work in other clinical areas. Visiting was restricted for five days and patients were not transferred to other healthcare facilities but could be discharged to their own home. Enhanced cleaning with hypochlorite solution and hand hygiene education was carried out on the wards.
2. The Birmingham Health Protection Unit of Public Health England and the Environmental Health Department of Birmingham City Council conducted a detailed epidemiological investigation of the outbreak. This involved obtaining food histories from affected individuals (or family members), including staff.
3. A review of the food handling process on arrival of the cook-chill food at the BHH site through to ward distribution.
4. Testing of available residual food samples still retained in the PHE Food Water & Environmental Laboratory (Good Hope), and on an on-going basis, a range of food from the cook-chill facility for salmonella.
5. The holding of cake and food sales and raffles, and the practice of families, visitors and commercial representatives bringing food into hospital were stopped.
6. Testing of potable and non-potable water samples on key wards.
7. Environmental sampling in ward kitchens, and regeneration (food heated to required temperature) trolleys on Beech ward and ward 2.
8. All consumable food items were removed from ward kitchen areas at the BHH site and restocked after cleaning.
9. The ward kitchen areas were deep cleaned, with hydrogen peroxide fogging. This was implemented as a preventative measure by the IPCT based on the syndromic evidence of infection from Beech and Rowan wards.
10. Beech ward was closed and roll-cleaned, with enhanced cleaning of bath/shower rooms, toilets and sluices each day.
11. Bottled water was dispensed for use until the water supply had been confirmed as microbiologically safe.
12. A review of the ward processes involved with food preparation and serving, and cleaning duties, were done, with separation of these duties for relevant staff.

13. A review of the security of ward kitchen areas and appropriate storage of regeneration trolleys.

14. Increased IPCT activity on affected hospital wards.

15. Following the OCC meeting on Monday the 9th June 2014, 16 isolates of *Salmonella enteritidis* were available. Professor Peter Hawkey and Dr Nick Loman, in co-operation with scientists at the University of Birmingham, undertook rapid DNA extraction and WGS using the Oxford Nanopore WGS system.

4.5 Outcome of the Initial Actions

From the initial epidemiological investigations there was no clear association with any food type or any association with consumption of food provided at the Prince of Wales, Amigo and Cafe 1 facilities at BHH and food services provided by external contractors.

A total of 56 food samples, 45 mains water samples and 20 environmental samples collected in the Trust were tested. All samples of food and water were negative for salmonella. These results and the epidemiological information allowed the OCC to rule out the Hospital Cook Chill food supply (see **Section 7** for more detail) and the potable drinking water supply as the source of infection.

One of the 20 environmental swabs was positive for salmonella. This was highly significant because the swab was taken from the seal edge of the food regeneration (re-heating) trolley on Beech ward. The trolley was therefore replaced.

The WGS data was available for review at the OCC meeting on Wednesday 11th June 2014. This sequencing information confirmed that all of the outbreak isolates were closely related and the hypothesis that this was a community outbreak with a number of cases admitted to Heartlands followed by local spread on Beech and Rowan wards was formulated. This information was critical to directing infection control and community epidemiological investigations.

The OCC was then able to concentrate on the other potential routes of transmission i.e. the person-to-person route and the potential for indirect transmission from a contaminated environmental source.

In an attempt to reduce person-to-person spread a major hand washing and personal hygiene campaign was implemented across the Trust (Section 9) and daily visits were made by the IPCT to affected wards. To reduce further secondary cases Beech ward was closed to new admissions.

To reduce the risk from an environmental source and /or cross contamination of food for patients several approaches were introduced. These were:

introduction of enhanced cleaning regimes on affected wards (Section 8), improved security and access to ward kitchens, access to and storage of food regeneration trolleys and segregation of duties for G4S staff involved in food service.

The initial cases on Beech/Rowan wards may have been caused by a patient bringing the infection onto the ward, a member of staff with symptoms infecting patients, cross contamination of food by a food handler or from environmental contamination.

Despite the infection control interventions put into place secondary cases occurred on Beech ward. The reasons for these infections are most likely multi-factorial and due to a combination of:

- A breakdown in infection prevention and control procedures, particularly personal hygiene and hand washing standards by staff
- Inadequate isolation rooms with en-suite toilets meaning that infected patients shared communal toilets and showers, which may have led to recontamination of the environment
- Possibly a failure of the cleaning regime or its frequency.

5. Ward Issues

5.1 Ward Structure

The outbreak strain of Salmonella was found in cases on nine different wards in the hospital but cases on three of these wards were considered to be community acquired and hence six wards had cases that were hospital acquired. In the main these remained as single cases without any further spread to other patients. The exceptions were Beech and Rowan wards, the two wards that were most affected and showed evidence of secondary cases. The following comments relate to these two wards.

Both wards have the same patient population, which is a mixture of orthopaedic trauma and surgical patients. Some patients may be elderly and by the nature of their medical problems they require a more frequent contact with nurses, healthcare assistants and allied medical professionals. This of course increases the risk of spreading Salmonella infection and probably accounted for some of the cases.

The two wards were adjacent and because of the clinical similarities there was at times movement of patients from one ward to the other. This was usually done for clinical reasons so that same-gender patients with similar conditions could be given the best clinical care. Similarly at times of staff shortage the wards would share some staff.

The layout of the two wards was very similar and not optimal for this category of patients. There was insufficient ward space to segregate patients on clinical

grounds, there were insufficient toilet facilities for male and female patients, especially when they are suffering with an enteric infection, there were only three side wards on each ward and only one of each had an en-suite toilet. Hence, from an infection control point of view it is difficult to effectively isolate infected patients and some patients have to use the communal ward toilets. This could have led to environmental contamination and the risk of infection to other patients.

Prior to the outbreak the Trust had recognised the deficiencies on Beech and Rowan wards and was in progress with moving the two wards to wards 8 and 9 respectively. Unfortunately the outbreak came prior to the move but Rowan ward was moved within the first week of the outbreak. It was not possible to move Beech Ward because of the number of patients infected with Salmonella. This left the ward isolated and closed to new admissions.

Orthopaedic patients need a range of specialist equipment, i.e. for lifting, supporting limbs, walking etc. Storage of such bulky equipment can be a problem and this can lead to cluttering of ward space. This equipment is also difficult to keep clean. From my visit to Beech ward and discussions with infection control staff it is evident that this was a problem in May and June 2014 and may have contributed to the outbreak.

5.2 Staff issues

During the outbreak it was decided to open ward 8 (old Beech ward) with new admissions and hence staff had to be shared between Beech and ward 8. This created an obvious staff pressure and further isolated staff on Beech ward. On reflection these staff were taking the brunt of the salmonella infection issues and became a little demoralised during the outbreak. The lack of direct communication to the ward also created a feeling of blame and isolation.

The Trust's Occupational Health department has a policy for staff with symptoms of gastrointestinal infection. There is also a poster with guidance from the Infection Prevention and Control Team. This clearly states that staff should not come to work until symptoms have ceased for 48h hours. There was evidence of a member of staff on Rowan ward who had salmonellosis and who may have been at work whilst infected.

5.3 Ward Food Service

A review of the food service on wards that were affected indicated a number of issues. Ward kitchens were not secure, they should have limited access and food should not be stored longer than recommended. Since the outbreak the Trust has implemented a system of security locks on the doors and checking of refrigerators in ward kitchens.

The food regeneration trolley on Beech ward was located in a busy corridor on the ward near to communal patient toilet. This meant that staff and patients had access to the trolley. Environmental swabbing of this trolley showed it to be contaminated with salmonella. This may have occurred by placing of soiled items on the trolley, staff or patients touching the trolley with contaminated hands or from a contaminated food source. This finding also demonstrated the failure to keep this equipment clean. During the time of the outbreak the regeneration trolley on Beech ward was removed and replaced with a new one to eliminate any further environmental risk. The Trust's catering department have since instigated an on-going process of relocating the food regeneration trolleys into non-clinical areas, wherever possible this is into the ward kitchens.

A member of the G4S staff is designated to provide hostess service from these trolleys. All hospital catering and G4S hostess staff have the appropriate level of food hygiene training and certification. Basic food hygiene training for nurses and healthcare assistant staff was mandatory but had ceased within the Trust. Clearly all staff handling food and feeding patients should have the necessary training.

6. Patient Safety

6.1 Morbidity and Mortality

Patient safety is paramount in hospitals and it is incumbent on all hospitals and staff that they should not put their patients at unnecessary risk. Trusts now have a designated medical Patient Safety Director or Lead. This is also the case at HEFT and the Director of Medical Safety attended and chaired several of the outbreak meetings.

It is clear from the literature that Salmonella outbreaks in hospitals cause significant morbidity and mortality. The Trust data indicates that there were hospital acquired Salmonella cases on wards 7,11,19, AMU, Beech and Rowan (including ward 9) and so infection was quite widespread. Even though these cases were followed up clinically and epidemiologically it was not possible to link cases on the different wards.

Trust figures indicate that there were 21 patients on wards with Salmonella infection. Eighteen patients were symptomatic (diarrhoea with or without vomiting) although it is possible that four of these cases acquired their infection in the community. Ten of these symptomatic patients were on Beech and Rowan wards. Several patients on these wards were elderly and confused, and their personal care, and increased demands on nursing and other ward staff, could have been a contributing factor in the spread of the organism. Three other patients on Beech and Rowan (later ward 9) were asymptomatic and were identified by microbiological screening.

According to PHE data, of the patients infected 17 had spent the whole incubation period of the disease in the hospital indicating hospital acquired infections and secondary cases, which should be preventable.

Six patients had a bacteraemia, with the organism detected by blood culture. This is considered a high rate of invasive disease, which is not usually a feature of *Salmonella enteritidis*. This might indicate that the organism was more pathogenic and possibly was more transmissible than other salmonellas. Both of these factors could have contributed to the spread of the organism during the outbreak.

Many of the Salmonella patients had co-morbidities and five patients died. However, *Salmonella* infection was considered to be a contributory factor in the cause of death for one patient. This patient was subsequently the subject of a Coroner's inquiry.

In discussion with the Trust's Director of Medical Safety it is evident that each of the five cases that died was reviewed. At the time, specialist medical staff in the designated Directorate undertook these reviews. The trust is now introducing an enhanced mortality review system that will collect Trust wide data and provide executive oversight.

6.2 Serious Untoward Incident (SUI)

The Trust has a Serious Untoward Incident (SUI) Policy and Procedure. The current version of the document was released in 2010 with a review date of 2012, which has not yet been completed.

An untoward incident report was logged on the Trust's internal Datix system on the 06/06/2014 by the lead IPCT nurse. As a result Beech ward was closed to new admissions.

Following an increase in the number of cases and the deaths of two patients It is recorded, in the minutes of the OCC meeting of 09/06/2014 and in subsequent action lists, that the Director of Medical Safety should raise a formal SUI on the Strategic Executive Information System (STEIS). These actions confirm that the Trust has effective systems for recording potentially serious incidents and that executive staff recognised the possible impact and seriousness of the outbreak at an early stage.

7. Hospital Catering and Food Supplies

7.1 Hospital Food Production

As Salmonella is a major cause of bacterial food poisoning it was important to establish the safety of the hospital food supply and drinking water supply very early in the outbreak investigation.

It is clear from the minutes of the outbreak meetings and the action lists that this was recognized as a potential problem. (Section 4) The Central Processing Unit (CPU) at Solihull provides food for patients in all three hospitals in the Trust. The OCC and the specialist environmental health officers ruled out the CPU as the source of the outbreak for the following reasons:

- The food is supplied to all three sites but cases were only occurring at the Heartlands site. If the CPU was the source then there would be more cases and these would be more widespread.
- This unit makes and delivers cook chill foods to all wards in the hospitals. The unit is operated to the highest standards and has an excellent Quality Management System (QMS), which meets the requirements of ISO 2001, This system covers all aspects of the food production, transportation and to the point of regeneration (reheating) of food at the ward level. This system is externally audited to ensure compliance with the ISO standard. The QMS also includes systematic auditing of the whole process and there is evidence that this is embedded in the culture of the organisation.
- The CPU also has a Hazard Analysis Critical Control Point (HACCP) system in place covering the whole food service. HACCP is a requirement for food producers so that they can identify the critical control points, which must be addressed to eliminate or mitigate risks.
- The CPU food service is audited on a frequent basis by the environmental health officers from Birmingham City Council and has a 5 star rating for food safety and hygiene.

Regardless of this information the OCC reviewed the evidence from the Catering department and the results of past microbiological tests on food samples were checked. All were consistent with a clean bill of health for the unit and the food service. The PHE Food Microbiology Laboratory based at Good Hope Hospital carried out additional microbiological testing of the CPU food and the hospital drinking water supply. All samples were shown to be negative for Salmonella and met the appropriate /designated microbiological standards.

The Catering department is responsible for the ward regeneration trolleys and the ward kitchens. The Catering department has implemented several improvements to these ward based functions. As stated previously the hostess staff at Heartlands are employed by G4S and these staff are responsible for receiving food from the Catering Department transport drivers and then to plate out food from the regeneration trolleys before ward staff take it to the patients. For assurance purposes there is active documented auditing of this system.

7.2 Other Sources of Food at Heartlands Hospital

During the investigations it emerged that there are other sources of food on the Heartlands site that are not covered by the Trust's policies and systems and these may have contributed to some cases of infection.

- A third party contracted by the PFI operates Café 1 at the front entrance to the hospital. Some patients, staff and hospital visitors use this facility. It came to light that this food service had been given a 3 star rating by the EHO department but this information was not passed on to the Trust. There is also the Arriva shop in the front entrance, which sells sandwiches and takeaway food.
- The Prince of Wales Post Graduate centre has its own external food provider and once again this is outside of the responsibility of the Trust
- Food is brought in from outside of the Trust by patient's relatives and also by staff for local fundraising events or staff celebrations.

It was clear that these potential areas of infection were recognised by the Outbreak Committee and preventative action taken during the outbreak.

Although these areas of potential source of infection were known to the Trust prior to the outbreak there was no mechanism for reviewing the situation, alerting to and addressing issues and problems. For many years the Trust had a Food Hygiene Committee that had oversight of the food chain and ward service in the hospital, unfortunately this had been disbanded and was no longer in operation.

7.3 Recommendations Made During the Outbreak

To improve the food safety for patients the following local changes were implemented:

- Staff preparing/serving food should only be involved in light cleaning duties.
- Staff preparing/serving food must change clothes prior to food preparation/food service.
- Staff preparing/serving food should not do a supper service if they have undertaken heavy cleaning duties without showering and changing first.
- Oven gloves must be changed for each food service.
- All kitchens to be locked
- All regeneration trolleys to be stored off the ward if possible.

The Infection Prevention and Control Team have recently audited these recommendations on several wards across HEFT. These audits have highlighted that the food safety standards required are not being maintained by both Trust and G4S ward staff.

8. Hospital Cleaning

8.1 A Safe Environment

Contamination of the hospital environment with pathogenic microorganisms can lead to transmission of infections and long-term problems. High-risk areas such as wards and operating theatres are at greater risk of spreading infection. This is well understood by Trust management and infection control teams and systematic and regular cleaning is paramount to providing a safe environment for patients. It may also be necessary to carry out a deep clean and/or a sterilising process of some areas following incidents with norovirus, *Clostridium difficile* and antibiotic resistance bacteria.

8.2 Cleaning Arrangements

The HEFT has policy and standards for these procedures on each of the three sites. At Solihull and Good Hope cleaning services are provided by on site Trust employed cleaning staff but at Heartlands this service is subcontracted to G4S. There was no evidence that this difference in service provision contributed in anyway to the Salmonella outbreak.

The contract with G4S clearly states the services to be provided and there was no evidence that G4S was not meeting the Trust's requirements.

Following discussions with the senior G4S staff on the Heartlands site it is clear that they are committed to providing the best service possible, within their resources, and that they fully understand the patient population they are trying to protect. G4S has a system of monitoring staff performance and the Trust has access to these records. In addition senior facilities management staff audit the cleaning and work closely in partnership with G4S.

G4S have demonstrated a willingness to be flexible to the Trust's demands and an ability to respond to the changing needs during the Salmonella outbreak:

- The Trust historically employed a specialist team for sterilization of side rooms and wards, a service that is now provided by G4S.
- At the time of the outbreak all G4S staff had the same uniform and there was some concern that hostess staff were being asked to provide cleaning of higher risk (clinically soiled) areas. To clearly segregate the duties of different G4S staff and to help hospital ward staff to identify the two groups of staff G4S introduced a new uniform for all hostess staff.
- G4S responded to the pressure for additional cleaning during the outbreak and all ward kitchens on every ward at Heartlands were steam cleaned to eliminate any possible sources of infection.

Cleaning of the PFI areas in the Trust is subcontracted to a third party provider. There is no evidence that these contractors are working to the same standards and specification that the Trust would expect of its own providers.

This lack of understanding has also led to some confusion about who is responsible for cleaning clinical spillages (body fluids) in the PFI areas of the Trust.

9. Communications

9.1 Internal Communications

From the outset of the outbreak at Heartlands Hospital a designated communication officer attended the outbreak meetings. A comprehensive internal communications campaign was developed and started following the first outbreak meeting on the 5th June 2014.

This campaign included:

- Daily position updates in the Trust daily bulletin email that is sent to the email addresses of staff.
- Hand hygiene policy promoted on the Trust intranet
- A Trust wide hand washing campaign that reinforced the need to maintain high standards of personal hygiene. New posters and door stickers were sent out to all wards
- Infection control/site teams issued clinical outbreak packs that included relevant information for clinical staff on affected wards.
- A staff sickness message was developed and promoted by site teams. This outlined the Trust guidance and reminded staff that they should not come to work if they developed gastrointestinal symptoms and that they should remain at home until they have been symptom free for 48 hours.
- An infection control protocol for dealing with newly diagnosed cases.

On the 5th of June 2014 the Communications department issued a Trust wide email entitled “Salmonella Infection identified.” This was for staff dealing with patients with symptoms and reminded them of strict hand hygiene and hand washing, importance of thorough cleaning, isolation of patients with symptoms, to send a stool specimen for testing, to complete a medical review of each patient and to refer to all relevant trust Infection Control policies. These messages were restated on the 6th June 2014. They were then reinforced in the Trust daily briefing email through out the period of the outbreak.

The Trust daily briefing on the 23 June 2014 also included a ban on food/cake sales, or bake-off events in the Trust for the duration of the investigation. From the week commencing 9th June the CEO also set up a blog specifically about the Salmonella outbreak.

9.2 External Communications

During the course of the outbreak the Trust issued regular updates on the Salmonella investigation in the weekly Primary Care Support bulletin to GP's.

Joint press statements were agreed and issued by the Trust and Public Health England

A news release was issued on the 12th June targeted at visitors. This was aimed at:

- Raising awareness about hand washing
- Advising visitors who have had symptoms within the last 48 hours not to visit patients
- Telling patients that they should not bring food into the hospital

The Trust also issued a PHE Salmonella fact sheet on “Frequently Asked Questions”.

From 12 June to 18 June 2014 the outbreak was also covered in local and national press. These included newspapers, online newspapers, local and national television and radio.

10. Review of the Trust Response to the Outbreak

10.1 Background

To assess HEFT’s response to this outbreak it is important to understand the nature of the infecting microorganism and the epidemiological factors associated with the timing of the hospital outbreak.

The following Trust documents relating to the outbreak investigation have been reviewed: The Outbreak Plan, Agendas, Minutes of the Outbreak meetings, Action Plans, the Trust Major Incident Plan, epidemiological reports and the report to the Coroner.

The conduct of the investigation and management of the outbreak was discussed with several key staff members of the Trust and also individuals from the external agencies that were involved.

10.2 Comments Relating to Outbreak Management

- Recognition of the outbreak by the DIPC and the IPCT was rapid and the Trust’s “Control of an Outbreak of Infection in Hospital” plan was implemented on the 5th June 2014
- There is good evidence that the OCC, on behalf of the Trust, implemented a systematic approach to dealing with this outbreak and had developed a clear sense of purpose.
- The support from the Trust departments involved and the external agencies meant that the OCC was able to review the situation and introduce appropriate infection control procedures quickly.

- The Medical Director chaired most of the OCC meetings, which confirms that the Trust recognised the seriousness of the developing situation.
- This high level involvement provided the leadership necessary to respond to the situation and ensured that both investigative and corrective actions were implemented.
- The view from external representatives was that the OCC meetings were run professionally and effectively.
- A working definition of a hospital acquired case, a Community acquired case and a possible Community case was established by the OCC. This was essential for the team to be able to concentrate on the follow up of patients.
- A SUI was instigated.
- During the early phase of the outbreak the major potential sources of infection were identified and investigated. Actions were implemented to reduce the scale of the outbreak. For example, it was confirmed at these early meetings that the source was unlikely to be the Trust's cook chill food supply.
- The infection control team had clear leadership, implemented a ward closure and introduced enhanced infection control practices. These procedures were continually re-enforced by the IPCT team until the outbreak was over.
- There was clear evidence that the DIPC, other consultant microbiologists and the laboratory scientists worked effectively to diagnose the cases in the most rapid way possible. The microbiology laboratory at Heartlands tests all stool specimens from the hospital and the community cases for the presence of Salmonella. This good practice allowed the early recognition of cases in the hospital and the community. Note: Some hospitals do not test specimens for Salmonella from patients who have been in hospital for three days or more.
- The links with the PHE reference laboratories and the PHE Centre in Birmingham contributed significantly to establishing that the hospital outbreak strain was also causing cases in the local community.
- The networking with Birmingham University and access to the latest whole genome sequencing techniques produced invaluable evidence that the hospital outbreak strain was indistinguishable from that in cases in the community. Furthermore, this information was shared with the national reference laboratory and other European centres and was invaluable in unravelling the epidemiology of an international outbreak. This is the first time that WGS has been used in real time to explain the epidemiology of an outbreak of salmonellosis in a hospital.
- Catering and facilities staff were fully engaged with the OCC and provided invaluable support.
- G4S staff supported the OCC and IPCT by responding to changing needs during the Salmonella outbreak by a) segregating work duties of ward based staff to reduce potential cross contamination of food b) performing additional and deep cleaning.

- The communications campaign worked very well and was an important mechanism for informing staff of the developing situation and the actions that had been implemented.
- The external communications and liaison with external agencies was a valuable mechanism for updating stakeholders and providing reassurance to patients and visitors attending the hospital.

11. Recommendations

11.1 Relating to Outbreak Management

- The Trust should use the learning outcomes from this outbreak to review its infection control and cleaning services. In future they will need to meet the new requirements of the Department of Health's: The Health and Social Care Act 2008: Code of practice on the prevention and control of infections and related guidance. This is currently under consultation but will include 10 criteria that the Care Quality Commission (CQC) will use to assess healthcare providers.
- This Salmonella Outbreak review has identified a gap between the Policy for the Control of an Outbreak of Infection in Hospital and the Trust Major Incident plan. Neither covered all of the aspects required for dealing with this type of incident. Hence, the Trust should review the need for a plan that deals with Major Internal Incidents or Outbreaks.
- In the light of this outbreak the Trust should regularly review major policies that relate to patient safety and infection control procedures as a number of these were overdue for review.
- From the minutes of the meetings there are several issues that should be addressed:
 - The attendees were named but there was no indication of their professional status. Hence it was difficult to know why they were there.
 - During a major incident, like this, the Trust should ensure that there is dedicated, experienced clerical resources for organizing the meetings and taking minutes. For example there is variation in the quality of the minutes and it is not always clearly recorded when key decisions were made and approved.
 - As the outbreak continued the number of attendees at the OCC meetings increased and there was evidence of significant duplication. The Trust should review which key people should attend these meetings.
 - In contrast it was surprising that the two ward managers from Beech and Rowan were excluded from the meetings. Their attendance could have facilitated understanding and improved communication at ward level.

- This outbreak has demonstrated the important impact of WGS when investigating hospital and/or community acquired infections. Although outbreaks with Salmonella in hospitals are uncommon, in the future there are more likely to be outbreaks associated with multi-drug resistant bacteria. To be able to meet these challenges it is recommended that microbiology departments in large teaching hospitals such as HEFT and Public Health laboratories should provide access to WGS as part of their routine service.

11.2 Relating to Ward Issues

- The Trust should review all of its high-risk, specialist wards in the light of the experience from this outbreak and ensure that the ward environment and equipment is fit for purpose.
- Ensure that all ward staff handling food undertake food hygiene training.
- The staff on Beech ward became isolated and demoralised. The Trust should reflect on how this can be prevented in such incidents. It appears that there was a lack of personal communication to ward staff and perhaps there is a need to recognise the pressure on staff and implement some increased pastoral support.
- There is a clear policy on staff coming to work with gastrointestinal symptoms. Perhaps there is a need to determine how this message can be strengthened.

11.3 Relating to Patient Safety Issues

- The Trust should proceed with the implementation of the new enhanced Mortality review system.
- Unfortunately representatives from the Governance team were not included at the early OCC meetings. This may be due to the absence of a Major Internal Incident Plan and the Trust should review the need for this in the light of this outbreak.
- The Trust SUI policy and other policies should be reviewed at the appropriate date in accordance with the document control procedures.

11.4 Relating to the Food Service

- The Trust should build on the high quality catering service provided by the CPU to ensure that all food suppliers on site are operating to the highest food safety standards.
- Since the outbreak the Trust has introduced a new committee; the Food Safety and Cleaning Environment Group Committee. The Terms of Reference for this group includes catering, estates, IPCT and microbiology representation. The Trust should ensure that there is

adequate clinical involvement and focus so that ward based issues and patient safety are kept at the forefront of any future decisions. The committee must have a clear line of reporting to the Trust management Board.

- The new committee in conjunction with the IPCT should review the issue of food for patients brought in by visitors from outside. This is a sensitive issue but a Trust policy would provide the necessary guidance for visitors and ward-based staff.
- The Trust should develop agreed standards of food safety with external food providers on site to ensure safety of the Trust's patients, staff and visitors.
- The Trust should continue to audit the implementation and on-going adoption by wards of the recommendations made by the outbreak committee.

11.5 Relating to the Cleaning Service

- Some hospital staff raised concerns about the line management of ward based G4S staff. All other staff on wards report to the Ward Manager but the G4S staff report to their own managers. This in theory should not be a problem. The Trust should review the relationship with G4S to address any staff issues about the service, to give confidence to ward staff that this model of service meets the Trust's requirements and delivers a safe environment for patients.
- The Trust should audit that the segregation of G4S staff duties and the introduction of a new uniform for the hostess staff process is still fit for purpose.
- There was some feedback that the deep cleaning undertaken during the outbreak was not done to the highest standard. The Trust should review these comments and ensure that G4S continue to meet the Trust's specification.
- There should be an audit of the cleaning of regeneration trolleys.

11.6 Relating to Communications

- Most of the communications were electronic and it is clear that many ward-based staff either do not have access to email or do not have the time to access a computer on a daily basis because they are so busy caring for patients. There was no evidence of a verbal cascade system for these communications. Ward based team briefings could have included these updates. Senior staff on Beech and Rowan wards felt that they were not informed directly of decisions that affected their wards even though they were a major part of the outbreak. In light of these comments the Trust should review the communications strategy for ward-based staff, who do not have daily access to email, to ensure that all staff are updated, especially during a major incident.

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