Lessons learned from handling a large rural outbreak of Legionnaires’ disease: Hereford, UK 2003

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Summary
The outbreak of Legionnaires’ disease that occurred in Hereford, West Midlands UK in 2003 was the single largest outbreak of Legionnaires’ in Hereford and one of the first to challenge the newly formed Health Protection Agency. This was, de facto a ‘public health incident’ requiring not only the investigation and management of a community outbreak of infectious disease, but also one that had to take into account other issues including: uncertainty regarding roles and responsibilities, political considerations and communication needs including sustained media attention. The incident also demonstrated the ‘added value’ of an integrated health protection response. The practical lessons learned from outbreaks are rarely described, particularly operational aspects. This paper summarises the outbreak, outlines specific elements of the response and identifies some
Background

In late October 2003 the Consultant in Communicable Disease Control (CCDC) for Herefordshire was informed of a case of Legionnaires’ disease (LD) in an elderly man from Hereford City. Three days later, on 27 October the local laboratory reported a further case. On 6 November, as a result of active case-finding, two further cases were identified. A multidisciplinary Outbreak Control Team (OCT) was convened that day to formally declare an outbreak, define the magnitude of the outbreak, prevent further transmission and investigate the source of infection.

Intensive case finding, microbiological and environmental investigation and the use of a geographic information system (GIS) identified the likely source as one of two cooling towers at a local factory which was used on a seasonal basis. There were 28 associated cases and two deaths before cleansing and closure of the cooling towers on 12 November 2003. A condensed chronology of events is provided in Appendix A.

LD is an environmentally acquired bacterial pneumonia caused by Legionella species, which are widely distributed in man-made and natural environments.1,2 Transmission of the disease may, in susceptible people, follow inhalation of Legionella contaminated aerosol.3 Documented sources of contaminated aerosols include cooling towers, fountains, showers, water taps and whirlpool spas.4–9 Reports of LD can cause great alarm in the community and intense media attention with pressure on public health officials to identify the cause and institute remedial action. Indeed, previously published accounts of outbreaks of LD have focused on identifying the source of the outbreak and the control measures instituted.7,10,11 Although important, such reports rarely describe the practicalities involved in managing and coordinating a major outbreak, or the responses of the organisations involved.

The largest Legionnaires’ outbreak ever recorded in the UK occurred in the summer of 2002 with over 170 laboratory confirmed cases of LD and illustrates the need for sharing lessons identified from outbreak investigations.12,13 The outbreak was caused by a contaminated ventilation plant in the town centre and led to the hospitalisation of approximately 500 suspected cases over a 10-day period.12 This posed considerable clinical and public health challenges and placed a significant strain on healthcare services. Although a single organisation was not leading the outbreak response, local public health organisations retained overall control and responsibility while receiving significant support from local and national agencies.13 Valuable lessons identified from this outbreak included: the need for good surveillance and health intelligence; the limitations of major incident plans and the value of the multidisciplinary approach.13

In the UK responsibility for protecting the health of the population rests with Primary Care Trusts (PCTs). However in April 2003 the HPA was formed to provide advice and support to PCTs to deal with the surveillance and investigation of infectious and non-infectious environmental hazards. In effect, the specialist health protection teams that had resided within PCTs up to that date moved into and largely formed the local Health Protection Agency (HPA). This posed some organisational challenges as both the PCT and HPA clarified their roles and responsibilities.

The Hereford LD outbreak of November 2003 was one of the first large community outbreaks to challenge the newly formed HPA both in its expert role, and in the way local and regional HPA teams worked as part of the new ‘public health system’ in England and Wales.14,15 During a major incident, emergency, or large outbreak the formation of a multi-disciplinary incident or outbreak team is standard practice with the lead agency being determined by the nature of the incident. Where the incident is focussed on health the incident team is traditionally chaired by a Director of Public Health (DPH) from the PCT. However, in this incident the new health protection arrangements prompted a different management structure.

The scale of this outbreak and its impact on the economy of Hereford city centre not only stimulated debate about the role and responsibilities of the different agencies involved in the response but also about public expectations regarding health protection and the strategies to be adopted by the Agency for future outbreaks.

Lessons learned

Media, political and public interest was intense for several weeks following declaration of the outbreak on 6 November and required vigorous and sustained handling. The resource and expertise to achieve this, and to manage the outbreak needed a collaborative effort between the local and neighbouring Health Protection Unit (HPU) teams, the HPA Regional Surveillance Unit (RSU), the PCT, the Strategic Health Authority (SHA), the Regional DPH (RDPH), the Local Authority (LA), and two central HPA divisions (Centre for Infections (CFI) and Porton Down). This incident served to illustrate that outbreaks can be complex, unpredictable events and that while existing structures are fundamentally sound they need to be flexible enough to cope with sudden and unexpectedly large events.

The methodology used in this paper to describe the lessons learned is based upon the observations, personal experiences and perspectives of local personnel directly involved in the outbreak. Once the outbreak was concluded a formal lessons learned exercise was conducted in addition to the standard debrief within the OCT. This employed root cause analysis16 to systematically collect and map information and involved a questionnaire survey of those who managed the outbreak, the company at the source of the outbreak, local businesses politicians and the media.

Although general guidelines on the management of outbreaks are available, as are LD outbreak reports,10,11,17–20
practical lessons learned, particularly from the operational perspective are rarely described.

The purpose of this paper is to summarise the outbreak, outline specific elements of the response and identify the main learning points for the new agency and its partners. A number of these lessons have a generic applicability to the handling of public health incidents and are summarised under the following topic headings (these are not in order of priority):

- Organisation and coordination.
- Surveillance.
- Investigation.
- Control and prevention.
- Roles and responsibilities.
- Engagement with partners.
- Communications.
- Political considerations.
- Intelligence and information management.
- Surge capacity.

**Organisation and coordination**

In an outbreak situation the chain of command must be clear to all concerned and is of particular importance where many agencies are involved. For this incident, command structure and responsibilities followed the 'Gold-Silver-Bronze' arrangement for dealing with significant incidents. In this hierarchical structure, control of an incident on the ground is dealt with operationally by the 'Bronze' team. The 'Silver' team provide tactical guidance and ensure adequate resourcing for the 'Bronze' team. Over the 'Silver' level of command lies 'Gold' command which exercises strategic control over the incident.

In this outbreak a management system was rapidly established that partly copied this command structure and, with modifications in response to the developing situation, provided the management framework throughout the outbreak.

During the outbreak it rapidly became apparent that two teams were needed. One responsible for the investigation (tactical and operational aspects) of the outbreak, and the other taking responsibility for strategic management of the outbreak. This was achieved by separating the investigation ('Bronze' and 'Silver') and strategic management ('Gold') arms of the response, with agreed terms of reference and streams of work for both. The 'Gold' team met twice daily and dealt principally with the media response. The 'Silver' team met once daily. The 'Gold' team signed off the daily ministerial briefing and also the media bulletins, which were issued at regular times twice daily.

This structure and organisation encouraged swift exchange of information, allowing the rapid solution of problems as, or before, they developed. Regular briefings kept all members informed and ensured rapid and integrated action on operational issues. This approach to tackling the outbreak was considered a success and is recommended as a model to be used in future outbreaks.

**Surveillance**

The CCDC was contacted directly by the microbiologist once the cause of atypical pneumonia had been established in the early cases, as the potential wider public health significance of this diagnosis is generally well known. Thereafter a programme of active surveillance was set up such that all hospital admissions for pneumonia were tested for *Legionella* specific urinary antigen. This surveillance was extended to the community and local general practitioners (GPs) were also asked to test patients with signs of atypical pneumonia. Retrospective serum testing for *Legionella* antibody was conducted for all patients hospitalised with pneumonia three months prior to the date of the first case of Legionnaires'.

**Investigation**

The investigation of the outbreak was co-ordinated by the OCT and comprised microbiological, environmental, and epidemiological methods. These were carried out contemporaneously and the results fed into the OCT.

The microbiological investigation consisted of the rapid processing of urine and serum samples from suspected cases to confirm the diagnosis. Clinical isolates and environmental samples were also sent to reference laboratories to allow DNA typing to take place with the aim of defining more closely the exposure pathway.

Environmental investigation was extensive. Firstly, all known registered cooling towers were visually inspected and where appropriate. Secondly, all other potential sources were identified across Hereford by applying local knowledge as well as some innovative methods such as the use of thermal imaging by police helicopter to detect unregistered cooling systems.

The epidemiological investigation consisted of analysing the daily travel patterns of identified cases around Hereford in the two weeks prior to onset of illness. This information was used to target areas of the city for environmental investigation. Information derived from a literature search about sources implicated in other outbreaks was also used to guide the epidemiological investigation.

A key factor in the successful investigation of this incident was the ability of the OCT to utilise the resources of local organisations and the wider HPA.

**Control and prevention**

Potential sites identified by environmental and epidemiological investigations were inspected. These sites were sampled, and where appropriate, control measures instituted immediately following sampling. The control methods consisted of cleaning and 'shock dosing' by hyperchlorination. Typically this involved shutting down the cooling systems to carry out the necessary work.

**Roles and responsibilities**

The OCT aimed to adopt clear and consistent policies, however, it was unclear at times what the 'correct' procedure was as the evidence base was not robust enough to answer several questions. Indeed, early on there was some hesitancy about the respective roles, responsibilities and decision-making accountabilities of the various agencies involved in the investigation. For example, whose
and undertake all press interviews. Additionally, the SHA outbreak. The PCT DPH agreed to act as media spokesperson than leading the investigation and management of the ad hoc responding to spend considerable time in the initial phase of the outbreak. This meant that the Director of the local HPU team had to capacity and no communications strategy for the outbreak. outburst there was no regional HPA communications national news media for several days. At the time of the extremely quickly and the outbreak was a lead item on result in enquiries 24 h a day. The media reacted result in intense media coverage that at one stage Communication was a key task from the outset, not only with partner agencies and organisations, not only those in the health community but also the media, police, NHS Direct and the National Meteorological Office. The benefit of good local and regional working relationships between key personnel that had been built up previously over time through regular meetings and joint training exercises was particularly noticeable, and resulted in significant resources being quickly made available to the OCT. Effective communication with representatives of partner and other organisations involved in the investigation and management of an outbreak is crucial to the success of any OCT and this outbreak illustrated that importance. Partners actively participated in the organisational, logistical, financial and communications effort required to investigate and manage the outbreak. This resulted in the development of a common strategy and purpose based on a mutual understanding of the issues involved and knowledge of the local situation. The shared experience of the outbreak has further facilitated the engagement of partner organisations in planning and preparedness activities.

Engagement with partners

One of the main lessons learned and acted upon early in the outbreak was the importance of engaging fully with other agencies and organisations, not only those in the health community but also the media, police, NHS Direct and the National Meteorological Office. The benefit of good local and regional working relationships between key personnel that had been built up previously over time through regular meetings and joint training exercises was particularly noticeable, and resulted in significant resources being quickly made available to the OCT. Effective communication with representatives of partner and other organisations involved in the investigation and management of an outbreak is crucial to the success of any OCT and this outbreak illustrated that importance. Partners actively participated in the organisational, logistical, financial and communications effort required to investigate and manage the outbreak. This resulted in the development of a common strategy and purpose based on a mutual understanding of the issues involved and knowledge of the local situation. The shared experience of the outbreak has further facilitated the engagement of partner organisations in planning and preparedness activities.

Communication

Communication was a key task from the outset, not only with the affected community and the wider public, but also with partner agencies and the wider health community. In an outbreak situation, a communication strategy should be in place from the beginning to avoid confusion and ensure that consistent information is shared in a timely manner both internally and externally. The first carefully drafted press statement was released to the media on 7 November and resulted in intense media coverage that at one stage resulted in enquiries 24 h a day. The media reacted extremely quickly and the outbreak was a lead item on national news media for several days. At the time of the outbreak there was no regional HPA communications capacity and no communications strategy for the outbreak. This meant that the Director of the local HPU team had to spend considerable time in the initial phase of the outbreak responding to ad hoc media requests for interviews rather than leading the investigation and management of the outbreak. The PCT DPH agreed to act as media spokesperson and undertake all press interviews. Additionally, the SHA provided an experienced communications officer and administrative support to deal with media enquiries. A joint NHS, LA and HPA press office was established, led by the SHA communications lead and supported by other SHA communications officers so that someone was available to respond to media enquiries 12 h a day.

Key elements of the external communications response during the outbreak included: press releases timed to coincide with copy deadlines; a press hotline; press material on the web; someone available to do live interviews 12 h a day and a dedicated phone line to the incident room for GPs and other health staff.

Communication on all aspects of an outbreak and its impact must be timely. This can be difficult in a rapidly changing and escalating outbreak situation. Although much was achieved during this outbreak the HPA is striving to improve public communications and this has resulted in the appointment of HPA regional communications managers.

Political considerations

This outbreak led to widespread local anxiety, as well as social disruption, economic losses and high-level political attention. As a result, the investigation and control of this outbreak was very much conducted in public and had to meet a constant demand for accurate, detailed and timely information on all aspects of the investigation from a wide range of interested groups including those within Government. It is particularly important that Government spokes persons providing information to the public, including ministers, local politicians and the Chief Medical Officer are kept well informed and able to explain actions being taken at the local level during high-profile outbreaks. However, a significant amount of time and resource was required to provide ministers and the DoH with adequate reassurance about the robustness of the local response. This situation could have been prevented if the strategy for media and political handling had been agreed at the outset.

Intelligence and information management

Identification of cases relied on active case-finding and the collection of epidemiological information directly from patients or a proxy. The HPA RSU established and developed linked databases and a data management system to keep track of epidemiological, environmental and laboratory information. This required considerable time and effort and successful application of the systems was hindered by several deficiencies including inadequate capture of laboratory data and lack of local information systems support and resources.

The interpretation of large amounts of travel data was made possible by the use of GIS software by experienced personnel from the LA. This was extremely helpful to the investigation of the outbreak and allowed separate databases to be combined to provide graphical representation of the location of suspect sites, case movements and residences. The production of high quality maps greatly aided the effort to deal with the outbreak and to explain to others the distribution of cases in relation to suspect sites. GIS is a useful tool in outbreak investigation and resources are being
provided to ensure its availability within the region. The availability of GIS expertise and plume dispersal modelling at HPA Porton Down was unknown until late in the investigation. This illustrated the need to ensure that all local HPU teams are aware of the resources available centrally and how they may be accessed.

**Surge capacity**

All levels of the HPA were involved in the response to this outbreak. HPA staff as well as those from other organisations worked long hours, including weekends. The experience in Hereford has demonstrated that during the acute phase of an outbreak organisations should think about their ability to rapidly expand the availability of appropriately skilled human resources. To deal with future outbreaks this would include ensuring that staff working in various organisations have specialist training in risk communication, epidemiology, public health and the use of GIS. There should also be consideration of the need to ensure sufficient media, laboratory, financial, administrative and hospital bed capacity.

**Key messages**

- Organisation and coordination
  - Primary Care Trusts need to have resources for major incident response including a large room to act as an ‘incident centre’ and support staff;
  - Separate teams to manage the incident and conduct the investigation;
  - Use of a running log enables rapid update for members of Outbreak Control Team.

- Investigation
  - Expertise from the wider Health Protection Agency resources should be accessed early.

- Roles and responsibilities
  - These should be agreed at the outset by agencies forming the Outbreak Control Team.

- Communications
  - Management of the media is crucial to successful handling of an incident. A dedicated communications officer is helpful.

- Intelligence and information management
  - GIS software is necessary to process detailed travel information from a large numbers of cases.

**Conclusions**

Despite statutory control measures LD remains a potential risk to the health of the public and proactive initiatives are essential for prevention and control. Outbreaks and even sporadic cases can place a strain on local social, economic, and health resources and attract media attention. The investigation and management of this outbreak identified a number of important lessons that are described in this paper, including the ‘added value’ of an integrated health protection response and the value of high quality working relationships with other agencies.

Based on our experience we consider that it is better to over react at the beginning of an incident and scale back as catching up is more difficult. This will require a coordinated, structured and flexible approach that takes into account delineating roles and responsibilities, political considerations and communication needs. The outbreak of LD that occurred in Hereford, West Midlands UK in 2003 was the single largest outbreak of LD in Hereford and one of the first to challenge the newly formed HPA. The lessons learned from this particular outbreak have been shared within the HPA and externally in order to inform and improve practice.

**Acknowledgements**

We gratefully acknowledge the contribution of all those who participated in bringing this outbreak under control.

**Appendix A. Chronology of events associated with an outbreak of Legionnaires’ disease in Hereford UK, 2003**

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>8 October</td>
<td>76 year-old man (Case 1) develops symptoms</td>
</tr>
<tr>
<td>13 October</td>
<td>Case 1 admitted to hospital</td>
</tr>
<tr>
<td>24 October</td>
<td>Consultant in Communicable Disease Control informed of Case 1</td>
</tr>
<tr>
<td>25 October</td>
<td>Case 1 dies</td>
</tr>
<tr>
<td>4 November</td>
<td>Case 2 admitted to hospital</td>
</tr>
<tr>
<td>6 November</td>
<td>Two further cases identified through active case finding</td>
</tr>
<tr>
<td>6 November</td>
<td>Outbreak Control Team convened</td>
</tr>
<tr>
<td>6 November</td>
<td>Strategic Health Agency and Regional HPA informed</td>
</tr>
<tr>
<td>6 November</td>
<td>Feature fax to local General Practitioners</td>
</tr>
<tr>
<td>6 November</td>
<td>Environmental Health Officers inspect and revisit all known potential sources</td>
</tr>
<tr>
<td>7 November</td>
<td>Detailed history taking and ascertainment of further cases—no clues about source</td>
</tr>
<tr>
<td>7 November</td>
<td>Press release</td>
</tr>
<tr>
<td>7 November</td>
<td>Samples taken from factory tower and tower “shock chlorinated”</td>
</tr>
<tr>
<td>8–9 November</td>
<td>Review of hospital admissions, preparation of further press statements, and media (TV, radio, and newspaper) interviews</td>
</tr>
<tr>
<td>9 November</td>
<td>Briefing for MP at his constituency office</td>
</tr>
<tr>
<td>9 November</td>
<td>Continued high media interest</td>
</tr>
<tr>
<td>11 November</td>
<td>Preparations made for use of boardroom and extra facilities required for next day</td>
</tr>
<tr>
<td>11 November</td>
<td>Formal press conference at local hotel 'Gold/Silver' control structure set up with separation of outbreak</td>
</tr>
</tbody>
</table>
Appendix B. Roles and responsibilities of the organisations involved in responding to the Legionnaires’ disease outbreak in Hereford in 2003

Primary Care Trust

- Chaired the ‘Gold’ group.
- Led the management of the incident.
- Provided local facilities.
- Provided local administrative support to the Outbreak Control Team (OCT).
- Provided local public health and political background/advice to other bodies.
- Provided the “face” of the collective response to the media, and of the local National Health Service (NHS).

Health Protection Agency

- Chaired the ‘Silver’ group (OCT).
- Investigated and managed the outbreak together with ‘Bronze’ group.
- Marshalled adequate specialist expertise (local Health Protection Unit and central divisions involved) or procured it from other bodies.
- Represented on the ‘Gold’ group by the chair of OCT.

Strategic Health Authority

- Oversaw the handling of the whole incident.
- Negotiated the ‘Gold–Silver–Bronze’ model of control and escalation triggers.
- Liaised with the Regional Director of Public Health (RDPH) and Department of Health (performance and media lines).
- Ensured that all necessary media, management/administrative support was available.

Local Authority

- Undertook environmental inspections, sampling etc., and provision of expert environmental advice as part of the ‘Bronze’ group.
- Provided GIS modelling expertise.
- Provided advice and support on the political and commercial dimensions.

References


*These roles and responsibilities were specific to the Hereford 2003 outbreak and may vary in other areas depending upon local arrangements.
Lessons learned: Legionnaires' outbreak

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Glossary

‘Bronze’: Operational level
CCDC: Consultant in Communicable Disease Control
DoH: Department of Health
DPH: Director of Public Health
GIS: Geographic Information System
‘Gold’: Strategic level
HPU: Health Protection Unit
LA: Local Authority
LD: Legionnaires’ disease
NHS: National Health Service
OCT: Outbreak Control Team
PCT: Primary Care Trust
RDPH: Regional Director of Public Health
RSU: Regional Surveillance Unit
SHA: Strategic Health Authority
‘Silver’: Tactical level