



# National Confidential Study of Deaths Following Healthcare-Associated Infection & HPA/ONS Data Linkage Study

Year 1 report (01/08/05 – 31/07/06)

September 2006

## Project Team

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## Project Board

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## Steering Group

**Georgia Duckworth** Director, Dept Healthcare Associated  
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**Peter Goldblatt** Chief Medical Statistician for England and  
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**Joy Dobbs** Director, Social and Health Analysis and  
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**Theresa Lamagni/Richard Pebody** Grant co-applicants  
**Nicola Potz** *Ex-officio* member  
**David Bridger** *Ex-officio* member  
**David Powell** Secretariat

## **Overview**

The Health Protection Agency (HPA) and Office for National Statistics (ONS) are carrying out a project in response to the audit of deaths referred to in the Chief Medical Officer's report *Winning Ways: working together to reduce healthcare associated infection in England*.<sup>1</sup> This builds on previous joint work comparing trends in mortality and morbidity from MRSA.<sup>2</sup> The project is in two parts - a confidential study and a data linkage study.

The confidential study involves investigating a small sample of hospital deaths related to MRSA to identify patient and healthcare factors that may have contributed to these deaths. Potential risk factors will be considered for future quantitative studies to assess whether they are associated with an increased risk of mortality. In parallel, the data linkage study is developing a method for use in estimating the proportion of patients who have had an invasive MRSA infection and subsequently died within a defined period, and the proportion of these deaths for which the infection was recorded on the death certificate. The studies do not involve any statistical or epidemiological analysis of whether there is a causal relationship between MRSA infection and death. This work has been made possible through the collaboration of the Health Protection Agency and the Office for National Statistics with funding provided by the Department of Health.

## **Aims and Objectives**

The aim of the confidential study is to undertake a qualitative investigation of a small sample of deaths occurring in hospitals in England to which MRSA infection may have contributed.

Specifically the aims of the confidential study are to:

- Attempt to identify and explore potentially avoidable or amenable factors that may be associated with acquisition of, or death from, MRSA infection
- Disseminate anonymised key findings of use in improving general understanding of the circumstances surrounding deaths following MRSA infection

This will be achieved through the following objectives

- develop an acceptable mechanism for investigating a small number of deaths in hospitals to which healthcare associated infections (HCAI) may have contributed
- develop tools for investigating a small number of hospital deaths to which MRSA infection may have contributed
- on a case-by-case basis, attempt to establish where the infection is likely to have been acquired and whether it may have had any contributory role in the patient's death
- undertake a qualitative evaluation of the circumstances surrounding death, including exposure to known factors, that may have contributed to the death
- use these findings to generate hypotheses on any new factors potentially associated with increased mortality or increased risk of infection that could be tested in quantitative studies

The aim of the data linkage study is to improve understanding of mortality following invasive MRSA infection through the linkage of infection surveillance records and death registrations.

This will be achieved through the following objectives:

- develop a mechanism for the linkage of infection surveillance records and death registrations
- estimate case fatality ratios in hospital patients following laboratory confirmed invasive MRSA infection
- use linked data to examine the relationship between laboratory confirmed invasive MRSA infection prior to death and routine reporting of infection on death certificates

## **Statement of progress**

### ***Ethical approval and recruitment of staff***

On receipt of funding confirmation in March 2005, ethical approval for the study was sought through application to the London NHS Multi-Centre Research Ethics Committee (MREC). Final MREC approval was received in June 2005, after which the three study personnel were successfully recruited.

Dates of appointment at HPA:

- David Powell            Database Manager            20<sup>th</sup> June 2005
- David Bridger           Research Nurse            18<sup>th</sup> July 2005
- Nicola Potz            Senior Scientist            1<sup>st</sup> August 2005

### ***Steering Group***

A Steering Group was formed to provide expert advice regarding the study designs, methods and conduct of the data linkage study and the confidential study, ensuring that they are appropriate to meet the agreed aims and objectives and to produce the agreed qualitative and quantitative outputs. Membership comprises individuals with expertise in Clinical Microbiology, Epidemiology and Statistics. It includes representatives from HPA, ONS and the Department of Health along with healthcare researchers independent of this programme.

- Terms of Reference were drawn up and finalised by relevant parties at ONS and HPA in early September 2005
- Membership of the Steering Group was agreed and letters of invitation sent out at the end of September 2005.
- First meeting of the Steering Group - 21<sup>st</sup> November 2005.
- Subsequent meetings have been held on 6<sup>th</sup> March 2006 and 4<sup>th</sup> July 2006

### ***Project Board***

A Project Board was established to ensure that the project plan is adhered to through achievement of milestones, monitoring of spending against budget, and maintenance and monitoring of a risk register. Membership comprises key individuals within HPA

and ONS whose professional knowledge and experience are fundamental to the shaping and monitoring of the programme.

- Membership of the Project Board was agreed in early October 2005 and letters of invitation were sent out on 11<sup>th</sup> October 2005
- First meeting of the Project Board - 7<sup>th</sup> November 2005.
- Subsequent meetings have been held on 13<sup>th</sup> December 2005, 22<sup>nd</sup> February 2006, 27<sup>th</sup> April 2006 and 13<sup>th</sup> June 2006

### ***Publications and presentations***

A number of materials were produced and placed in the public domain to promote the study.

- Communicable Disease Report (CDR) Weekly leading news article published 15<sup>th</sup> September 2005 aiming to publicise the new initiative to link surveillance and mortality data and the confidential study of deaths following HCAI<sup>3</sup>
- Web page on HPA website detailing study went live on 14<sup>th</sup> September 2005 ([http://www.hpa.org.uk/infections/topics\\_az/mortality/linkage.htm#p2](http://www.hpa.org.uk/infections/topics_az/mortality/linkage.htm#p2))
- Poster presentation on the outline of the confidential study of deaths was given at the HPA Conference, 12<sup>th</sup>-14<sup>th</sup> September 2005<sup>4</sup>
- Two abstracts submitted in May 2006 for the HPA Conference, 11<sup>th</sup>-13<sup>th</sup> September 2006<sup>5,6</sup>

### ***Confidential Study***

#### ***Pilot phase***

##### **1. Identification of cases**

Cases for the pilot follow-back were identified retrospectively through the ONS mortality database by 20<sup>th</sup> September 2005. The sampling frame was comprised of individuals who had died between 1<sup>st</sup> January – 31<sup>st</sup> March 2005 in hospitals in England with MRSA documented on the death certificate. Two-stage stratified random sampling according to number of deaths (1; 2 -4; 5+) and hospital type (specialist; acute general; single specialty, primary care hospital) was employed to

select a small number of cases for investigation. In total 20 cases were selected from nine hospitals.

## 2. Development of data collection tool

A data collection tool was developed between August and December 2005 based on a literature review of HCAI-associated mortality and its risk factors and with advice from the Project Board and a number of Project Advisors. This comprises three distinct parts; case note review, organisational questionnaire and staff interviews.

- A. Case Note Review.** This identifies (where possible) the probable source of MRSA and factors that may have contributed to either the acquisition of MRSA or the subsequent death. It will facilitate the development of a time-line detailing key dates and events, including the patient's admission/transfer history.
- B. Organisational factors that may influence the risk of MRSA acquisition in the Trust.** This attempts to ascertain information on the following:
  - Management of Infection Control in the Trust
  - Surveillance Activities
  - Control of MRSA in the Trust, including screening
- C. Staff Interviews.** A structured topic guide has been developed to facilitate interviews with the attending clinician and infection control teams. This aims to gather further data on organisational factors influencing acquisition of MRSA and other HCAs. In addition, case specific information including factors influencing acquisition and professional opinion on the contribution of MRSA and other HCAs to individual patients' deaths is also sought.

## 3. Study visits

A formal, direct approach to each Trust Chief Executive (CEO) was made in December 2005. The letter sought permission for the Trust to be included in the study and provided assurances on the confidential nature of the study. The letter was approved by the Steering Group in December 2005.

During February and March 2006 formal approval was sought from all the Trusts' Research & Development departments in line with the NHS Research Governance Framework and, where required, an honorary contract obtained for the researcher.

The CEOs of all 9 Trusts responded favourably by February 2006 and allowed access to the selected Trusts. Formal R & D approval was obtained from all the Trusts during April and May 2006.

All nine Trusts were visited and staff interviewed during May and July 2006. The investigative tools were tested in all the trusts for a total of 18 patients. Two patients were removed from the pilot study as they were subject to local investigation due to litigation. Not all relevant staff were interviewed in all Trusts due to problems of staff availability. It is anticipated that this will be improved by arranging interviews with clinicians through the Trust Medical Directors and to this end contact details of Medical Directors will be sought.

#### 4. Expert review panel

An independent panel of experts was specifically convened for the study with the aim of reaching a consensus on the relative contribution of different factors to the patient's death. Members were selected and formally invited to join in January 2006.

The panel comprises:

- Medical Director/ITU Physician (Chair)
- Microbiologist/Infection Control Doctor
- Senior Infection Control Nurse
- Consultant Physician
- Histopathologist
- Intensive Care Consultant

The first panel was convened on 9<sup>th</sup> May 2006. Members were provided with background information for the study along with case selection and data collection tools. They were also provided with training in the use of a standardised assessment form developed for the study during January to April 2006. A further meeting of the expert panel took place on 3<sup>rd</sup> July 2006.

Through a review of all data provided (copy of case notes, completed organisational questionnaires and interview transcripts) each anonymised case was reviewed and a consensus reached on the relative contribution of different factors to the patient's death.

### ***Main phase***

#### **1. Identification of cases**

Sampling for the main phase will be from the two most recent quarters of linked invasive MRSA infection/death records; sampling will therefore take place twice throughout the main phase. Sample 1 will be from the last quarter of 2005 and was drawn in June 2006. Sample 2 will be from the first quarter of 2006 and will be drawn in late December 2006. The sample will be drawn from deaths occurring in hospitals in England, with 20 cases sampled from the last quarter of 2005 and 20 from the first quarter of 2006 providing a total sample of 40 cases.

Based upon the results of the pilot phase, stratified random sampling according to number of deaths per hospital ( $\leq 4$ ,  $>4$ ) was employed to select cases for investigation. All cases at the sampled hospitals in the  $\leq 4$  deaths stratum will be reviewed, and a sub sample of 4 cases will be randomly selected from the hospitals with  $>4$  deaths. For sample 1, a total of 23 cases from 8 hospitals have been identified for follow-back.

#### **2. Permission from Trusts**

All CEOs for the selected hospitals' Trusts have been written to, to obtain consent to visit and review the selected cases. In addition all the relevant R&D departments have also been contacted seeking formal R&D approval. This took place during July 2006.

**Year 2 Plan of work (01/08/06 – 31/07/07):**

<i>Objective</i>	<i>Target date</i>
▪ Analysis of pilot data and review of data collection tools	Aug 2006
▪ Data collection for cases in Sample 1	Nov 2006
▪ Present confidential study methodology at HPA conference Warwick	Sept 2006
▪ Expert Review Panel to review cases from Sample 1	Dec 2006
▪ Sample 2 obtained and CEO and R&D approvals sought	Jan 2007
▪ Data collection for cases in Sample 2	Mar 2007
▪ Expert Review Panel to review cases from Sample 2	May 2007
▪ Analysis of results and preparation of final report	July 2007

**Data Linkage Study**

**Pilot phase**

The pilot phase of the data linkage study investigated whether infection records held by the HPA could be reliably linked (using available identifiers) to mortality records held by ONS. Reports of invasive *Streptococcus pneumoniae* infections were used in this work because they contain full surname data (which MRSA data do not), thereby allowing them to be used by the NHS Central Register (NHSCR) Tracing Service for comparison with probabilistic linkage. The NHSCR Tracing service was used to ascertain whether patients with a reported invasive *S. pneumoniae* infection between 1<sup>st</sup> July 2003 and 31<sup>st</sup> July 2004 had subsequently died. A probabilistic record linkage method was also developed to link the same infection records with mortality records from 1<sup>st</sup> July 2003 – 31<sup>st</sup> March 2005. Deaths identified by the two methods were then compared to evaluate the reliability of the probabilistic record linkage method. A number of invasive MRSA infection records were also submitted to the NHSCR Tracing Service for comparison and linkage method development.

## 1. Use of the NHSCR Tracing Service

- An application was made to ONS Medical Research to undertake follow-up of individual deaths identified as part of the study in June 2005
- 1244 *S. pneumoniae* infection records were submitted to ONS for Automatch (automated) tracing and 100 MRSA infection records were submitted for manual Operator matching on 5<sup>th</sup> September 2005
- Approval to undertake the study was received from ONS on 23<sup>rd</sup> November 2005
- *S. pneumoniae* and MRSA tracing results were released from ONS on 9<sup>th</sup> January 2006
- 249 *S. pneumoniae* records which were deemed untraceable by the Automatch process were resubmitted for manual Operator matching on 25<sup>th</sup> January 2006
- Second set of *S. pneumoniae* results were released from ONS on 16<sup>th</sup> February 2006

## 2. Development of a probabilistic record linkage method

A probabilistic record linkage method was developed which uses statistical probability to indicate the likelihood of records matching i.e. the likelihood that the infection and death records relate to the same person.<sup>7</sup>

- Mortality data requested from ONS – 5th August 2005
- Mortality data received from ONS – 17<sup>th</sup> October 2005
- Formatting of mortality data for analysis – November 2005
- Analysis of DOB and Soundex components of mortality records for subdivision of data for record linkage process – December 2005
- Calculation of record weighting for use in record linkage process – January 2006
- First round of record linkage performed using variables of forename initial, Soundex, month of birth, year of birth, NHS number & sex – 17th February 2006
- Analysis of first round of record linkage, comparison with NHSCR results completed, and refinements recommended
- Second round of record linkage performed using additional day of birth and postcode prefix variables – 14<sup>th</sup> March 2006

- Analysis of second round of record linkage, comparison with NHSCR results completed, and refinements recommended
- Third round of record linkage performed – 29<sup>th</sup> March 2006
- Rules determined for identification of threshold values and manual checking procedures – April 2006
- Final round of record linkage performed – 19<sup>th</sup> April 2006

### 3. Comparison of probabilistic record linkage results and NHSCR Tracing results

After the final round of probabilistic record linkage was performed on the *S. pneumoniae* infection records, the results were compared to those obtained when the same infection records were traced for vital outcome through the NHSCR Tracing Service.

		NHSCR Tracing			
		Traced - Dead	Traced - Not dead	Not traced	
Probabilistic matching	Matched to a death record	465	1	10	<b>476</b>
	Not matched to a death record	15	692	60	<b>767</b>
		<b>480</b>	<b>693</b>	<b>70</b>	<b>1243</b>

Both methods were shown to be of very similar quality with respect to identifying individuals who had died following infection. It is not known, however, whether the ‘not traced’ cases are alive or dead. The best-case scenario would be that they are all allocated correctly by probabilistic record linkage. The worst-case scenario would be that record linkage allocated them all incorrectly. The probability that someone identified as dead by probabilistic record linkage had truly died therefore lies in the range 97.6-99.8%. Likewise, the probability that a person not identified as dead by probabilistic record linkage (i.e. either alive or dead but unlinked) was truly alive was 90.2-97.9%. As the development of the probabilistic record linkage method used only the variables that are available in an MRSA data set, it is therefore acceptable to use the probabilistic record linkage method to link infection and mortality records for the main phase of the study. As MRSA records contain no surname data, the

probabilistic record linkage also has the advantage of being able to make use of the Soundex variable whereas NHSCR Tracing cannot.

### ***Main phase***

#### **1. Provision of sampling frame for the confidential study of deaths following HCAI**

The probabilistic record linkage method has been used to provide the sampling frame for the main phase of the confidential study of deaths, sampling cases from all persons who died within 30 days of a documented MRSA infection during the period 1<sup>st</sup> October – 31<sup>st</sup> December 2005 from all hospitals in England. A second set of cases will be sampled during Year 2 of the study from persons who died during the period 1<sup>st</sup> January – 31<sup>st</sup> March 2006.

#### **2. Link MRSA infection records to death records (2004/5)**

Invasive MRSA infection records for the period 1<sup>st</sup> January 2004 – 31<sup>st</sup> December 2005 were linked to death records from the same time period. To allow a 30 day follow up for all MRSA infection records, a second round of record linkage will take place between infection records from Q4 2005 and death records from Q1 2006 once they are available.

#### ***Year 2 Plan of work (01/08/06 – 31/07/07):***

<i>Objective</i>	<i>Target date</i>
▪ Clean and format Q1 2006 death data and link to infection records for purposes of second round of main phase sampling for the confidential study	Aug 2006
▪ Draw up and agree analysis and dissemination plan, and send draft analysis plan to DH for comment	Sept 2006
▪ Link Q4 2005 MRSA infection records to Q1 2006 death records to allow 30 day follow up for all 2004/5 MRSA infection records	Sept 2006
▪ Present development of probabilistic record linkage method at the HPA conference in Warwick	Sept 2006
▪ Further validate probabilistic record linkage method using an alternative infection data set containing mortality outcome data	Sept 2006
▪ Prepare final report and associated materials	July 2007

## **Factors causing delay**

There have been minor delays within the project, none of which have yet caused substantial slippage in timelines. These were incurred as a result of the following unforeseen circumstances:

- Longer than expected elapsed times in receiving and formatting data. This has been taken into account when timetabling the confidential study main phase.
- Length of time taken by Trusts to provide formal R&D approval and honorary contracts where required. This has been taken into account when timetabling the confidential study main phase

## **Summary**

The pilot phase of the National Confidential Study of Deaths Following Healthcare-Associated Infection & HPA/ONS Data Linkage study has resulted in the development of a process for the review of patients who have died following a HCAI to describe events leading up to their deaths, including the presence of pre-determined avoidable factors, and the successful development of a probabilistic record linkage method for the linking of infection and mortality records.

The main phase of the National Confidential Study of Deaths Following Healthcare-Associated Infections will use the methods developed during the pilot phase to review a small sample of patients from the linked data to describe potentially avoidable or amenable factors present before their deaths. The developed probabilistic record linkage method will be used to provide the sampling frame for the main phase of the confidential study, to describe mortality in patients following diagnosed invasive MRSA infection, and to analyse cause of death information on death certificates of patients who have died following MRSA infection.

## References

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