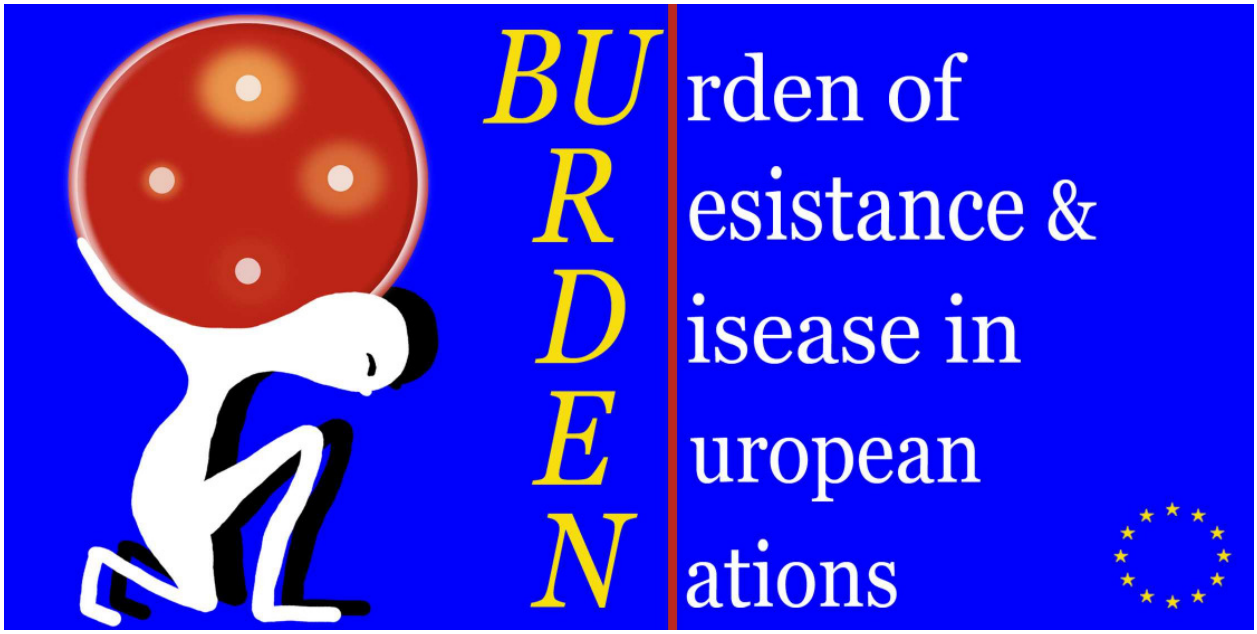

BURDEN Annual Report III - 2009

Deliverable D 2.4

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Contents

Foreword

At the end of the third and final project year this report compiles the work which has been accomplished in 2009 by all BURDEN participants.

In 2009, the focus was set on finalisation of data collection and on the analyses of these data. Up to date, almost all data have been analysed resulting in several scientific publications in peer review journals as well as scientific presentations at international European conferences. Several publications are in the process of being submitted. These are listed in chapter *3.1.2 "Achievements 2009"* of this report.

This annual report, together with the preceding annual reports I and II, will serve as a basis for the final evaluation report to be finalised by March 2010.

The BURDEN Coordination Team

The BURDEN Coordination Team at the Kick-off meeting in January 2007 in Freiburg

Section 1 The BURDEN Network

1.1. The BURDEN Project Management Group (PMG)

The PMG of the year 2009 consisted of five work package leaders and at least six specialists from the institutions involved in the project.

The PMG assisted the Coordinator in decision-making concerning achievements of the project and overall quality. It was the forum for the discussion to ensure consistency in the progress of the project towards milestones and deliverables, adapting to unforeseen events whenever possible, and to assess and evaluate project achievements.

The PMG also acted as a scientific and ethical committee and met on the occasion of the BURDEN Annual Plenary Meeting III. This meeting, as well as workshops within the framework of the project were also attended by other collaborating partners (Expert Advisory Board; see below).

Name	Function	Institute
Uwe Frank	Project Coordinator Work package Leader (WP 1,2,3)	University Medical Center (UKF-IEMHE), Freiburg, Germany
Peter Davey	Work package Leader (WP 4,5)	University of Dundee (UDDCH), Scotland
Marie-Laurence Lambert	Work package Leader (WP 6)	Institute of Public Health (IPH), Brussels, Belgium
Hajo Grundmann	Work package Leader (WP 7)	National Institute for Public Health & Environment (RIVM), Bilthoven, Netherlands
Martin Schumacher	Work package Leader (WP 8)	University Medical Center (UKF-IMBI), Freiburg, Germany
Christine Wilson	Administrative Coordinator (WP 1,2,3)	University Medical Center (UKF-IEMHE), Freiburg, Germany

Barbara Schroeren-Boersch	Data analyst (WP 1,2,3)	University Medical Center (UKF-IEMHE), Freiburg, Germany
Klaus Kaier	Scientist (WP 1,2,3)	University Medical Center (UKF-IEMHE), Freiburg, Germany
Martin Chalkley	Scientist (WP 4)	University of Dundee (UDDCH), Scotland
Duncan Heather	Administrator (WP 4,5)	University of Dundee (UDDCH), Scotland
Faranak Ansari	Epidemiologist (WP 4,5)	University of Dundee (UDDCH), Scotland
Marlieke de Kraker	Data manager (WP 7)	National Institute for Public Health & Environment (RIVM), Bilthoven, Netherlands
Martin Wolkewitz	Statistician (WP 8)	University Medical Center, Freiburg, Germany

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1.2 The BURDEN Expert Advisory Board (EAB)

The members of the EAB of the year 2009 met on the occasion of the scheduled workshops and BURDEN Annual Plenary Meetings. They provided scientific excellence on account of their expertise and gave valuable advice regarding the organisation of the project and dissemination of results.

Name	**Institute**
Ad Fluit	University Medical Center Utrecht, Netherlands
Eduard Huppertz	Health Economics Specialist, Germany
Ingrid Morales	Scientific Institute of Public Health, Brussels, Belgium

Open discussion of PMG and EAB members at the BURDEN workshop in Helsinki, Finland, May 2009

Section 2 Work packages

2.1 Work package 1 – Project Coordination

In 2009, the Coordination Team coordinated all the activities relating to the project from an administrative and process point of view, and kept track of the project development with respect to monitoring the deliverable schedule.

The Coordination Team planned and executed a PMG/EAB workshop in Helsinki, Finland in May and organised the BURDEN Annual Plenary Meeting III in October, providing programmes and invitations to these meetings.

Information on meetings/workshops is available on the BURDEN-website:

www.eu-burden.info → select "events" from left-hand menu

2.1.1 WP 1 - Results in 2009

2.1.2

WP 1 - Deliverables

D 1.3 – Completion of Technical and Financial Interim report II

WP 1 - Meetings in 2009

19 -20 May	**PMG/EAB workshop III**	Helsinki, FI
12 -13 October	**Annual plenary meeting III**	Freiburg, DE

2.1.2 WP 1 - Outlook for 2010

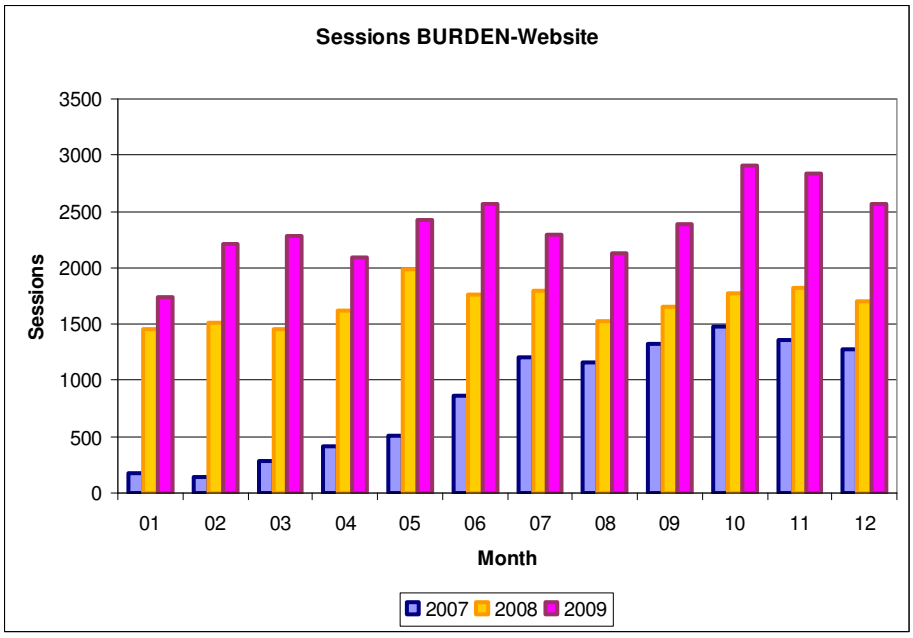
WP 1 - Deliverables

D 1.4 – Completion of Final Technical and Financial Interim report

2.2 Work package 2 – Dissemination of the Results

In 2009, the dissemination of BURDEN results was of fundamental importance in the third project year. The aim of dissemination was to increase public awareness. Therefore, the main audiences targeted were the public, public media, politicians, national health care officials, local hospital administrators and the scientific community.

The website was consistently updated throughout the year. The sessions on the website for 2007 through 2009 were documented in a graph (see below) and showed a continuous increase of website visits. Until December 2009, a total number of more than 55.000 visits were counted.



2.2.1 WP 2 – Results in 2009

February 2009 – Completion of annual BURDEN report II (*D 2.3 due Dec 2009)*

May 2009 – **Oral Presentation** at ECCMID in Helsinki, Finland: "*Modelling the effect of time-dependent exposure on hospital mortality using data from the BURDEN study group"*. Wolkewitz M., Schumacher M., Davey P. for the BURDEN Study Group.

May 2009 – **Oral Presentation** at ECCMID in Helsinki, Finland: *"The burden of healthcare-associated infection: the patient experience."* Burnett E:, Lee K., Rushmer R.,Ellis M.,Noble M., P. Davey

May 2009 – Poster Presentation in the European Network Corner at the ECCMID in Helsinki: "*Progress of the BURDEN Project"*.

October 2009 – **Publication:** "*Healthcare-associated infection and the patient experience: a qualitative study using patient interviews*". Burnett E:, Lee K., Rushmer R.,Ellis M.,Noble M., P. Davey in ***Journal of Hospital Infection*** *2010;74:24-27*

2.2.2 WP 2 – Outlook for 2010

March 2010 – Finalisation of Interim Technical Implementation Report III (D 2.4 *due Dec 2009*)

March 2010 – Completion of the Evaluation Report (D 3.2 *due Dec 2009*)

Throughout the year 2010– Preparation/finalisation of articles presenting the BURDEN results for publication in scientific journals

Conferences in 2010 for presentation of results

April 2010 – Poster Presentation of project results in the European Network Corner at the 20th ECCMID in Vienna, 10 – 13 April 2010

April 2010 – Oral and poster Presentations of project results in various sessions at the 20th ECCMID in Vienna 2010

2.3 Work package 3 – Project Evaluation

After development of an online questionnaire and corresponding database for internal process evaluation in 2008, the online-query was initiated in February 2009. The questionnaire was accessible via the BURDEN website after distribution of personalised passwords to the members of the PMG and EAB. This guaranteed that only eligible persons were able to participate in the query. The query and database was closed April 2009 and the data subsequently analysed by June 2009. The results were presented at the BURDEN Annual plenary meeting III in Freiburg, October 2009.

For WP 3´s last deliverable, the final project evaluation report, a questionnaire was produced to assess and evaluate the project outcomes. This questionnaire was distributed to all members of the PMG December 2009.

2.3.1 WP 3 - Results in 2009

February 2009 – Implementation of an online-questionnaire (internal process evaluation) for PMG and EAB *(D 3.1 due June 2008)*

April 2009 – Closing of query and database

June 2009 – Analysis of query data

December 2009 – Finalisation of questionnaire for the final project evaluation report and distribution to PMG

2.3.2 WP 3 - Outlook for 2010

Project evaluation questionnaires, which were distributed in December 2009 to all project partners (PMG) will be collected and integrated into the BURDEN final evaluation report.

Deliverable D 3.2 - Project evaluation report to DG SANCO (*due October 2009*, finalised by March 2010

PMG members in Charge of WP1, 2, 3:

Uwe Frank
WP 1,2,3 Leader
University Medical Center
Freiburg, Germany

Christine Wilson
WP 1,2,3, Administrative Coordinator
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Klaus Kaier
WP 1,2,3 Scientist
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Barbara Schroeren-Boersch
WP 1,2,3 Data analyst
University Medical Center
Freiburg, Germany

2.4 Work package 4 – Identification of needs

In 2009 we completed three pieces of work:

1. Publications on patient views about healthcare associated infection in the UK
    - The public are very concerned about healthcare associated infection. They are likely to greatly overestimate the actual risk to themselves or their loved ones.
    - Patients are reassured by evidence that healthcare staff follow good practice in infection control but remain concerned about the cleanliness of the environment.
2. Report on determinants of variation in MRSA bacteraemia at the regional level
    - Increasing length of stay and bed occupancy were both significantly associated with increasing risk of MRSA.
    - Including information about cleaning costs and staffing levels did not significantly improve the model.
3. Identification of information about the prevalence and costs of infection with antimicrobial resistance in European nations.
    - Information about the number of *S. aureus* bacteraemias and hospital beds was only available from a minority of European Member States. Information about bacteraemias was focused on MRSA. Reporting of MSSA bacteraemias is mandatory in England and Scotland but not in other countries.
    - Information about the number of hospital beds in European countries was available from either the WHO or OECD. However, the two sources only overlapped for nine countries and the estimates differed for four of these nine countries.
    - Estimation of the number of bacteraemias per country was made from EARSS data by two methods, one based on the catchment population and the other on the number of beds. The estimate based on catchment population probably underestimated the number of bacteraemias per country. The estimate based on hospital beds appeared accurate in the UK but needs to be checked in other countries.

- Publicly available data about hospital costs in European countries were too variable to provide meaningful information.

Deliverables

- **Deliverable 4.2** Report and determination of factors driving and impeding the development of AMR and the costs associated with these factors.

- **Deliverable 4.3** Recommendations to stakeholders and final report as a feedback to participants, EU and regional governing bodies and regulators, scientific community

We identified important gaps in the availability and quality of the information required for Deliverable 4.2. By combining data from Work Packages 4, 5 and 7 we have developed a cost model for Scotland that can be applied to other EU Member States as data become available. This is presented in Section 2.5.1

Recommendations to stakeholders and participants are provided in Section 2.5.2.

2.4.1 WP 4 - Results in 2009

2.4.1.1 Patient Views About Healthcare Associated Infection

Burnett E, Lee K, Rushmer R, Ellis M, Noble M, Davey P. Healthcare-associated infection and the patient experience: a qualitative study using patient interviews. *J Hosp Infect* 74(1), 42-47 (2010).

There is an increasing emphasis on the need for further patient involvement within healthcare to ensure that the voice of the patient is heard. This exploratory study utilised in-depth face-to-face interviews with patients to explore narratives from their experiences around healthcare-associated infection (HCAI). Interviews were undertaken with patients who had been diagnosed with a Staphylococcus aureus bloodstream infection and patients who had been in the same hospital but had not been diagnosed with a bloodstream infection. The lack of both verbal and written communications was a major concern for most patients regardless of their infection status. Some patients also stated that they were not comfortable about asking questions, and only a small number of patients and relatives stated that they would challenge staff about their practice. Although some patients retained confidence in the National Health Service (NHS), the majority had very little or no confidence in the NHS in relation to HCAI and would have serious concerns about this if they were to

return to hospital. The results suggest that there are a number of issues that must be addressed in order to enhance the quality of care, safety of patients and the patient experience in relation to infection prevention and control. In addition, policy-makers, managers and all healthcare workers must ensure that patients are involved in the design and evaluation of systems change and information.

Burnett E, Lee K, Rushmer R, Ellis M, Noble M, Davey P. Patient's views on infection prevention and control practice: A qualitative study using patient interviews (Submitted to American Journal of Infection Control)

Background: It is advocated that as populations become more diverse within healthcare, there is an increased requirement to enhance communication with patients. Qualitative research offers a roadmap for enhanced understanding of the unique experiences of patients, which ultimately promotes the quality of patient-provider relationships.

Methods: In depth face-to-face interviews with patients were undertaken to explore narratives from their experiences around healthcare associated infection. Interviews were undertaken with patients who had been diagnosed with a *Staphylococcus aureus* blood stream infection and patients who had been in the same hospital but had not been diagnosed with an infection.

Results: Many patients said they observed some good clinical practice such as hand hygiene and the use of personal protective equipment, although some disciplines of healthcare workers were perceived to be more diligent than others. However, patients felt that hospital hygiene and cleanliness were generally of a poor standard which significantly impacted on the quality of their care in hospital.

Conclusions: There were some positive outcomes in terms of staff practice. However, there remained a number of issues which must be addressed in order to enhance the quality and safety of patient and the patient experience in relation to infection prevention and control.

2.4.1.2 Determinants of variation in MRSA bacteraemia at the regional level

Background: The aim of this study was to repeat an analysis from English hospitals that considered how much variation in MRSA bacteraemia could be explained by variation in hospital characteristics. Three factors were independently associated with statistically significant variation in MRSA bacteraemia: bed occupancy >90% was associated with higher rates; higher hospital cleaning scores (PEAT scores) and expenditure on cleaning were associated with lower MRSA rates and better staffing levels (higher ratio of staff to patients and lower use of temporary staff) were associated with lower MRSA rates. The analysis was limited by only having access to data for three years.

In contrast with the study for England, we were limited to Board-level rather than hospital-level data, but we had access to a longer time period of data (5 years). The analysis from England used MRSA per 1000 episodes (Finished Consultant Episodes) as the dependent variable. This is the same as admissions in SMR01 and counts each separate admission to a hospital ward. In Scotland data about MRSA and other HAI are presented as number of cases per 1000 occupied bed days. The justification for using either of these composites as the dependent variable is that it tells us something about risk, either the risk of acquiring MRSA per admission to a hospital ward or per day spent in hospital. However, the advantage of taking MRSA cases as the dependent variable is that it is then possible to assess the extent to which variation in MRSA numbers is explained independently by admissions and length of stay. We have therefore done two analyses, one with MRSA per 1000 admissions (for comparison with previous analyses from England) and one with MRSA cases as the dependent variable.

Results: Number of MRSA cases and MRSA cases per 1000 admissions increased from 2001 to 2003 and decreased from 2004 to 2006.

For most Boards the profile of MRSA cases and MRSA cases per 1000 admissions was similar over time. Admissions were stable across all Boards. Length of stay decreased progressively over the six years in all Boards. Bed occupancy was stable in most Boards. The relationship between number of MRSA cases and admissions is

non linear which suggest that a simple ratio of MRSA cases per 1000 admissions is not appropriate.

In the regression analyses, MRSA cases and MRSA cases per 1000 admissions were modelled respectively using OLS, random effects and fixed effects estimation methods. Four variables were significantly associated with variation in MRSA cases (admissions, location, length of stay and bed occupancy) and two variables were associated with variation in MRSA cases per 1000 admissions (length of stay and bed occupancy). The regression models explained 96.7% of the variation in MRSA cases and 60.1% of the variation in MRSA per 1000 admissions.

Discussion: Increasing length of stay and bed occupancy were significantly associated with increasing MRSA infection in both models. The difference between the models' R^2 (96.7% for MRSA *versus* 60.1% for MRSA per 1000 admissions) is explained by inclusion of admissions as an independent variable in one model and as part of the dependent variable in the other model. Presentation of infection surveillance data (e.g. MRSA bacteremias) adjusted for admissions or occupied bed days provides an estimate of the average risk of infection per patient or per day in hospital. However, for comparison of infection rates between hospitals or within a hospital over time it may be more informative to use all available clinical activity data in multivariable or time series analysis, with number of infections as the dependent variable, as has recently been recommended for surveillance of antimicrobials.

In conclusion, we recommend that MRSA bacteraemias should be the dependent variable in comparison of infection rates between Boards or hospitals and in longitudinal analysis of change over time, with admissions, occupied bed days and length of stay as explanatory variables. The number of Boards in Scotland is small and the relevant variation occurs at the hospital level so we recommend that these analyses should be repeated with data from individual hospitals.

2.4.1.3 Identification of information about the incidence and costs of infection with antimicrobial resistance in European nations.

Availability of information about *S. aureus* bacteraemia and hospital characteristics that may influence Hospital Acquired Infection rates

A questionnaire about the availability of data was sent to ECDC National Focal Points (Appendix, Table 7). In total 37 letters and questionnaires were sent: 35 went to the 27 Member States because six had two National Focal Points (Austria, Belgium, Finland, Italy, Latvia, Netherlands, Portugal, Sweden) and two went to EFTA countries that also had ECDC National Focal Points (Iceland and Norway). The three Candidate Countries did not have ECDC National Focal Points (Croatia, Former Yugoslav Republic of Macedonia and Turkey). Responses were received from 12 (41%) of 29 countries.

Three countries (Cyprus, Estonia and Luxembourg) were not able to provide any data (See Appendix, Table 1). Nine countries provided sources of information about hospital beds, seven about MRSA bacteraemias and six about MSSA bacteraemias. In the UK both England and Scotland have mandatory reporting of both MRSA and MSSA bacteraemias with publicly available reports on the websites of the HPA and the HPS.[1, 2] Malta has complete data available via EARSS because there is a single hospital. The remaining countries have partial data about bacteraemias based on voluntary reporting (see Appendix, Table 1). Six countries provided information about case mix, cleaning and staffing (see Appendix, Table 2). Cleaning costs were only available from Malta and the UK, other data were available from all six countries.

Estimation of numbers of bacteraemias in European Countries by combining EARSS data with other available information

This work was completed in collaboration with Marlieke de Kraker from WP7. The aim was to use EARSS data to estimate the total number of resistant and sensitive bacteraemias for all participating European countries in order to provide country specific estimates of the burden of resistance. EARSS hospitals are asked to provide information about the total number of beds in the hospital and about their catchment population (number of inhabitants who use the hospital). Data about the total number of hospital beds and the total population for each country are publicly available and it

is therefore possible to use two methods to estimate the total number of bacteraemias in each country.

Method 1: Extrapolation from number of hospital beds

Data about the number of hospital beds per 100,000 population were available from WHO or OECD for all but three of the EARSS participating countries (see Appendix, Table 3). Data were available from both sources for nine countries (Austria, Belgium, Czech Republic, Finland, Germany, Hungary, Norway, Slovakia, Turkey) and were the same for five countries. We used the WHO estimate as the default for Belgium, Czech Republic, Norway, and Slovakia. Data about population (millions) were available for all participating countries from the Population Research Bureau. Total beds for each country were calculated as:

Beds per 100,000 x population in millions x 100

In order to estimate the number of bacteraemias per country we calculated the % of total beds covered by EARSS participating hospitals and then inflated the number of bacteraemias.

Worked example for Austria:

Number of beds in EARSS hospitals:	47,000
Number of beds in Austria (see Appendix, Table 3):	63,080
% beds covered by EARSS hospitals:	74.5%
Number of *S. aureus* bacteraemias in EARSS hospitals:	1,466
Estimated *S. aureus* bacteraemias in Austria	1,968 (1466/0.745)

Method 2: Extrapolation from hospital catchment population

The % of the total population served by EARSS participating hospitals has been previously estimated (Monnet). This was used to inflate the number of bacteraemias to provide a national estimate for each country.

Comparison of methods

We expected the estimate from hospital catchment populations to overestimate the total number of bacteraemias because there is likely to be overlap in the catchment populations for hospitals, especially in densely populated areas. If this is true then the estimated catchment population for each participating EARSS hospital is likely to be an over-estimate, consequently inflating the number of EARSS hospital bacteraemias by catchment population will under-estimate the number of bacteraemias for the country.

Our results showed that the estimated number of bacteraemias from hospital beds was greater than the estimate from catchment population for all countries except Belgium (see Appendix, Figure 1a). The relationship between the two estimates is shown more clearly by plotting the difference between them against their average[3] (see Appendix, Figure 1b).

The UK has publicly available national data about number of *S. aureus* bacteraemias (MRSA and MSSA) for the whole country. Moreover mandatory reporting of both MRSA and MSSA bacteraemias is in place for England and Scotland. We therefore checked our estimate of *S. aureus* bacteraemias from EARSS hospitals against national reporting in the UK (see Appendix, Table 4). The two estimates were very close (20,179 based on HPA and HPS reporting *versus* 21,692 based on EARSS reporting). However, it would be reassuring to be able to check EARSS estimates from other countries before concluding that the method of calculation from hospital beds provides reliable national estimates.

Data about costs per hospital day

WHO-CHOICE is the World Health Organization's programme on "Choosing Interventions that are Cost Effective".[4] The website provides estimates of cost per day for hospital inpatients for 192 countries derived from an econometric model.[5] The model used data from 49 countries and covered a total of 2173 country-years of observations. Published unit costs of hospitals varied within countries, sometimes by an order of magnitude and the authors concluded that "Basing cost-effectiveness studies or budgeting exercises on the results of a study of a single facility, or even a small group of facilities, is likely to be misleading."[5] WHO estimates of cost per day in hospital for European countries are listed in the Appendix, Table 5. The WHO

estimates cost in International Dollars and in Local Currency. An international dollar has the same purchasing power as the U.S. dollar has in the United States. Costs in local currency units are converted to international dollars using purchasing power parity (ppp) exchange rates. A ppp exchange rate is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States. An international dollar is, therefore, a hypothetical currency that is used as a means of translating and comparing costs from one country to the other using a common reference point, the US dollar (http://www.who.int/choice/costs/ppp/en/).

WHO-CHOICE estimates are provided for three levels of hospital care: primary, secondary and tertiary.

Definition of hospital types used in the WHO-CHOICE cost database[4]

Facility type	Description
Primary-level hospital	Has few specialities, mainly internal medicine, obstetrics-gynecology, pediatrics, and general surgery, or only general practice; limited laboratory services are available for general but not for specialized pathological analysis; bed capacity ranges from 30 to 200 beds; often referred to as a district hospital or first-level referral.
Secondary-level hospital	Highly differentiated by function with five to ten clinical specialities; bed capacity ranging from 200-800 beds; often referred to as provincial hospital.
Tertiary-level hospital	Highly specialized staff and technical equipment, e.g., cardiology, ICU and specialized imaging units; clinical services are highly differentiated by function; may have teaching activities; bed capacity ranges from 300 to 1,500 beds; often referred to as central, regional or tertiary-level hospital.

The WHO-CHOICE daily costs for hospital inpatients in the UK in 2005 are £98 for primary, £128 for secondary and £174 for tertiary care hospitals.[4] In Scotland ISD (information and Statistics Division) publishes detailed costs for hospitals and specialties. In 2005-6 the ISD estimate of average inpatient costs for all Boards was £2478 per week, £354 per day[6] and in 2006-7 the ISD estimate was £515. For comparison with WHO-CHOICE we calculated a weighted average for Scottish hospitals:

Hospital type	Number in Scotland	WHO-CHOICE cost	Total cost for Scotland
Tertiary	6	£174.33	£1,045.98
Secondary	19	£127.63	£2,424.97
Primary	12	£97.83	£1,173.96
Total	37		£4,644.91
Weighted average			£125.54

This is only 36% of the ISD 2005 cost and 24% of the 2007 cost.

All of these estimates of hospital costs are based on averages of total running costs. A paper published 30 years ago identified five common fallacies in estimating the economic gain from early discharge of hospital inpatients:[7]

1. The hospital budget saves an amount equivalent to the average cost per day multiplied by the number of days saved.
2. Hospital waiting lists can be reduced correspondingly.
3. There are no adverse effects on the patient.
4. There is no burden for caregivers.
5. There are no costs imposed on primary care.

The first two of these fallacies are relevant to estimation of the economic cost of healthcare associated infection and the value of preventing infection. However, there are few intervention studies that have demonstrated that shortening hospital stay does increase hospital productivity without adverse effects on staff and patients.[8]

In conclusion, estimates of the cost per day for hospital inpatients are available for European countries but should be used with caution. On the one hand the WHO-CHOICE estimates are conservative, at least for the UK. On the other hand it would be foolish to assume that reducing hospital stay will save hospitals and European

nations an amount equivalent to the average cost per day multiplied by the number of days saved. Consequently we recommend that the burden of healthcare associated infection and antimicrobial resistance should be presented in natural units (deaths and additional hospital days). WHO-CHOICE can be used as a standardised international estimate of the cost of hospital resources but decision makers must have the freedom to substitute their own local estimates of cost.

2.4.2 WP 4 - Outlook for 2010

We have completed the work that is possible with publicly available data. Recommendations for enhancing the publicly available data are made in Section

PMG member in Charge of WP4:

Peter Davey

WP 4 Leader
University of Dundee, Scotland

2.5 Work package 5 – Case studies of the burden of AMR

In 2009 we completed three pieces of work:

1. Provided data about 1 year outcomes for patients with *E. coli* and *S. aureus* bacteraemia in Tayside from July 2008 to June 2008 to Work Package 8. These data were used in presentations by Martin Wolkewitz in 2009 and 2010 (see Work Package 8).

2. Completed a longitudinal study of 1 year outcomes of *S. aureus* bacteraemia from 1996 to 2006 in Tayside (with additional funding from the Chief Scientist Office in Scotland). Oral presentation at a joing meeting of the British Society for Antimicrobial Chemotherapy and the Intensive Care Society, Birmingham, 24th March 2010/

3. Developed a European cost model for the impact of antimicrobial resistance on *E. coli* and *S. aureus* bacteraemias with Work Packages 4 and 7

DELIVERABLE 5.4 Case histories of the human or social cost of illness (completed by WP 4)

DELIVERABLE 5.5 Final written report

2.5.1 WP 5 - Results in 2009

2.5.1.1 1 year outcomes for patients with *E. coli* and *S. aureus* bacteraemia in Tayside from July 2008 to June 2008

Analyses of the outcomes of *Staph aureus* and *E. coli* bacteraemias from Tayside in 2007-8 are presented under Work Package 8. Please note that there were too few cases of *E. coli* resistant to 3rd generation cephalosporins so the results compare *E. coli* resistant to EITHER 3rd generation cephalosporins OR quinolones with other *E. coli.*

2.5.1.2 Longitudinal study of 1 year outcomes of S. aureus bacteraemia from 1996 to 2006 in Tayside

A full report and Executive Summary for this study was submitted to the Chief Scientist Office in March 2010. Following approval by the Health Services Research Committee the Executive Summary will be posted on the CSO website and a copy is attached (Appendix 1). Results will be submitted for publication later in 2010, in collaboration with Work Package 7. The results of this study add value to BURDEN in three key areas:

1. The study captured the emergence of MRSA bacteraemias in Tayside: there was only one case of MRSA in 2006 (NB data only collected from July 2006) and four in 2007. The greater impact of MRSA on mortality has not reduced over time. Work Package 7 recruited hospitals from countries with relatively high prevalence of MRSA so the results of the longitudinal study provide reassurance that the results of WP7 can be applied to countries with lower prevalence of MRSA.

2. Although the prevalence of MRSA increased over time the number of MSSA bacteraemias also increased (see Appendix, Figure 2). These findings are consistent with data from England and other European countries. Consequently the burden of MRSA is additional to the burden of MSSA.

3. Mortality for patients with *S. aureus* bacteraemia diverged from comparators for at least 100 days after onset. Risk of readmission to hospital within two weeks was 10% for patients with *S. aureus* bacteraemia compared with 0.1%

foi comparators. Consequently the outcomes measured in Work Package 7 (30 day mortality and length of index admission) are likely to underestimate the impact of resistance on mortality and hospital costs.

2.5.1.3 European cost model (with Work Packages 4 and 7).

Relationship between prevalence of resistance, mortality and additional hospital days

Point estimates for adjusted attributable 30 day mortality from Work Package 7 were:

- *S. aureus* bacteraemia 20% for MRSA and 10% for MSSA
- *E. coli* bacteraemia 19% for 3rd generation cephalosporin (3GC) resistant and 8% for sensitive

Point estimates for adjusted attributable 30 day and 1 year mortality from Work Package 5 (Tayside longitudinal study) were:

- 30 day Hospital Acquired *S. aureus* bacteraemia 30% for MRSA and 15% for MSSA
- I year Hospital Acquired *S. aureus* bacteraemia 34% for MRSA and 19% for MSSA

For every 10% increase in resistance the predicted additional deaths per 100 bacteraemias are 1.1 for *E. coli* and 1.0 *S. aureus* bacteraemia (see Appendix, Figures 3a). In Tayside the attributable mortality for hospital acquired *S. aureus* bacteraemia was higher than for all *S. aureus* bacteraemias in WP7 and the attributable 1 year mortality was higher than the attributable 30 day mortality. Nonetheless the predicted additional deaths per 100 bacteraemias are 1.5 using 30 day or 1 year mortality (see Appendix, Figure 3b).

The impact of resistance on length of stay was greater for *E. coli* bacteraemia than for *S. aureus* bacteraemia. Adjusted median additional length of stay was 8 days for 3GC R *E. coli*, 2.9 days for 3GC S *E. coli*, 4.0 days for MRSA and 2.4 days for MSSA (Work Package 7). Consequently the predicted increase in length of stay per

100 bacteraemias for every 10% increase in resistance is 51 days for *E. coli versus* 16 days for *S. aureus* (see Appendix, Figure 4).

Population based estimates of burden of *S. aureus* bacteraemia

Prevalence based estimates can only provide partial information about the incremental burden of resistance for a fixed number of bacteraemias. However, the full burden only becomes clear with data about total number of bacteraemias (see Appendix, Figure 2) combined with accurate information about national population, number of hospital beds and cost per bed day.

The burden of resistance is considerable (see Appendix, Table 6). Although the prevalence of MRSA was only 35% the number of deaths per 100,000 population was greater than for MSSA (3.4 *versus* 3.2) and the additional hospital costs were similar (£8,559 for MRSA *versus* £9,647 for MSSA based on WHO-CHOICE estimates of daily cost). However, the additional hospital cost for MRSA was much higher with ISD hospital cost estimates (£24,134 with 2005 costs and £35,098 with 2007 costs).

Population based data allows comparison of the public health impact of bacteraemia with other diseases.[9] In Scotland in 2007 there were 6.6 deaths from *S. aureus* bacteraemia per 100,000 inhabitants (see Appendix, Table 6). For comparison deaths per 100,000 inhabitants were 15.3 for prostate cancer and 29.8 for colon cancer.[10] *S. aureus* bacteraemia is just one of six bacteraemias included in EARSS[9] and population based estimates of the burden of disease are therefore likely to show that bacteraemias and sepsis cause as many deaths as common cancers.[11]

The median number of blood culture sets used per 1,000 patient days in EARSS hospitals was 23.8 in 2008 but the range was from 4.2 to 104.2. ECDC is currently working on quality indicators for antibiotic stewardship and standardisation of criteria for taking blood cultures should be on the agenda. Population based estimates of the burden of bacteraemias are likely to be more comparable between hospitals that have similar standards for taking blood cultures.

2.5.2 WP 5 - Outlook for 2010

- We have only been able to check estimates of the total number of bacteraemias for the UK but have identified sources of information for eight other countries. We hope to be able to check estimates for total number of bacteraemias in at least one more country before submission of a paper for publication.

Recommendations, Work Packages 4 and 5

- The public need better quality information about the actual risk of HAI and the effectiveness of infection control practices.

- Presentation of infection surveillance data (e.g. MRSA bacteraemias) adjusted for admissions or occupied bed days provides an estimate of the average risk of infection per patient or per day in hospital. However, for comparison of infection rates between hospitals or within a hospital over time it may be more informative to use all available clinical activity data in multivariable or time series analysis, with number of infections as the dependent variable, as has recently been recommended for surveillance of antimicrobials.

- Currently 55% (765/1,380) EARSS hospitals provide data about the number of hospital beds. Inclusion of more information about hospital beds should be a priority for EARSS.

- Accurate data about the total number of hospital beds in European countries are not currently available. Estimates from the WHO and OECD conflict. These data are vital to the interpretation of EARSS data at the population level.

- We recommend that the economic burden of healthcare associated infection and antimicrobial resistance should be expressed in terms of additional hospital days rather than financial cost. WHO-CHOICE estimates of the cost per day in European hospitals are probably conservative. However, it is unlikely that reducing hospital days will save an amount equivalent to the average cost multiplied by the number of days. Providing decision makers with data about the number of additional hospital days allows them to make the necessary value judgements.

- Population based surveillance of bacteraemias is likely to be more meaningful if there is standardisation of clinical criteria for blood culture sampling. We commend ECDC for developing quality criteria for antibiotic

stewardship and suggest that criteria for taking blood and other cultures should be on the agenda.

PMG member in Charge of WP5:

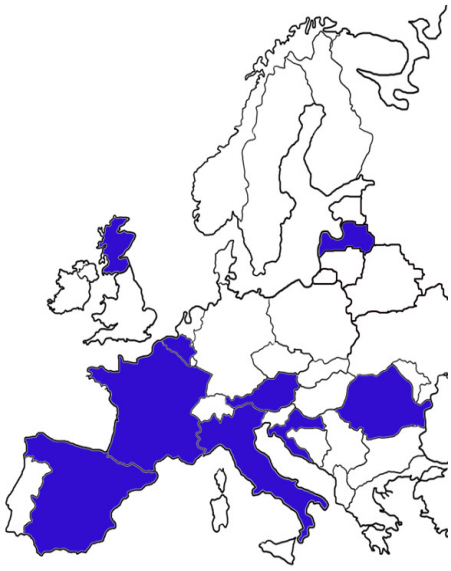
Peter Davey

WP 5 Leader
University of Dundee, Scotland
On behalf of WP4 (Martin Chalkley,
Shaolin Wang) and WP7 (Marlieke de Kraker, Hajo Grundman)

2.6 Work package 6 – Impact of AMR and appropriate treatment in ICU-acquired infections

In 2009, computerized algorithms were developed for the evaluation of the appropriateness of antibiotic treatment in cases of health care associated pneumonia and bloodstream infections with *Pseudomonas aeruginosa*, *Escherischia coli*, and *Staphylococcus aureus* (resistant or sensitive). These are now being validated by international experts.

The BURDEN database was completed in October 2009 (milestone 6.3, due April 2009). More than 100.000 ICU admissions from 10 EU countries (France, Spain, Austria, Italy, Belgium, Portugal, Scotland, Latvia, Croatia, Slovakia) are now available for analysis. The delays in completing the database are attributable to transferral of leadership for WP6 from former project leader Carl Suetens (now: ECDC) to Marie-Laurence Lambert (IPH-Brussels) and to delays of some countries in providing data.



The BURDEN WP 6 final meeting (due April 2009) took place in Brussels October 29-30, 2009, and brought together data providers and experts from 12 different EU countries. Because of late completion of the database, only preliminary results were presented.

2.6.1 WP 6 - Results in 2009

October 2009: *Feedback of selected indicators to participating ICUs (D 6.2, due July 2009)*

Due to the above mentioned delays, deliverable 6.3 and publications will be postponed to 2010 (see outlook for 2010).

2.6.2 WP 6 - Outlook for 2010

Deliverable 6.3: Final WP6 report and feed-back to the scientific community - due September 2009, completed March 2010

Aspired scientific articles:

Impact of antibiotic resistance in ICU-acquired blood stream infections and pneumonia in Europe: data from the Burden project (submission expected March 2010)

Consequences of antibiotic resistance in ICU-acquired pneumonias due to *Pseudomonas aeruginosa*, *Escherichia coli*, and *Staphylococcus aureus* (submission expected April 2010)

Antibiotic resistance of pathogens most commonly found in ICU-acquired blood stream infections: impact on mortality and ICU-length of stay (submission expected June 2010)

Impact of appropriateness of treatment in ICU-acquired pneumonias and blood stream infections (submission expected July 2010)

PMG member in Charge of WP6:

Marie-Laurence Lambert

WP 6 Leader
Institute of Public Health (IPH)
Brussels, BE

2.7 Work package 7 – Analytical study; Burden of resistance and infectious disease

In 2009 the main focus of WP 7 was to analyse the data collected in the previous year. In February 2009 the partners were visited by WP8 staff from Freiburg (Germany) for some interactive statistical support. In April 2009 the third and final workshop was organised for all on-site investigators. All but one of the hospitals were represented by the WS participants, in total 15 people were present. The results of the questionnaire were presented and discussed; all data were validated. Next to that, all participants gave a short presentation about their local experience. For most, it was a very positive experience to work for this project, amongst others it improved registration of specific care routines in the hospital, raised awareness concerning patient care and infection control among staff and improved knowledge of the on-site investigators regarding hospital research. The first results on the 30-day mortality were presented for all four cohorts (patients with a MRSA, MSSA, third generation cephalosporin susceptible or resistant *E. coli* blood stream infection). In June 2009, the final report was finished and detailed analyses were performed. Presently two manuscripts are being prepared on the burden of MRSA and third generation cephalosporin resistant *E. coli* blood stream infections.

2.7.2 WP 7 - Results in 2009

April 2009 – Final meeting for all on-site investigators
June 2009 – Final report on the analytical study *(D 7.3 due March 2009)*

2.7.3 WP 7 - Outlook for 2010

All deliverables were accomplished in time and therefore no deliverables will need to be fulfilled in 2010. In 2010 WP7 will contribute to the final BURDEN report. Next to that, WP7 will prepare manuscripts based on WP7 results. The WP7 results will be presented at the SHEA (March 18-22, Atlanta) and ECCMID (April 10-13, Vienna).

PMG members in Charge of WP7:

Hajo Grundmann
WP 7 Leader
National Institute for Public Health & Environment (RIVM)
Bilthoven, Netherlands

Marlieke de Kraker
WP 7 data manager
National Institute for Public Health & Environment (RIVM)
Bilthoven, Netherlands

2.8 Work package 8 – Mathematical Model

In 2009 WP provided:

Cooperation with other BURDEN work packages:

WP 5: Results of historical cohort presented at the ECCMID conference (and BURDEN meeting) in Helsinki; two manuscripts in progress

WP 5: Data from the prospective cohort received, statistical analysis is in progress

WP 6: Data received and almost analysed, visit to Brussels to discuss analysis plan

WP 7: Statistical support has been provided: 1-week visit of Marlieke de Kraker in Freiburg to discuss analysis and results

2.8.1 WP 8 - Results in 2009

March 2009 – Report on analysis of the analytical study OR Statistical challenges in analysing hospital-associated mortality in presence of time-dependent risk factors (D 8.2)

December 2009 – Analysis and report on the mathematical model OR Impact of different types of ICU-acquired Pneumonia / Blood Stream Infection on ICU mortality and length of ICU stay *(D 8.3 due June 2009)*

Talks:

Wolkewitz M, Schumacher M, Davey P:
Modelling the effect of time-dependent exposure on hospital mortality using data from the BURDEN study group, ECCMID 2009, Helsinki

Manuscripts:

Mortality associated with bacteraemia caused by Staphylococcus aureus: a cohort analysis with follow up beyond hospital discharge from the BURDEN study group (submitted to *Proceedings of the National Academy of Sciences of the United States of America*)

2.8.2 WP 8 - Outlook for 2010

Finalisation of statistical analysis of prospective cohort (WP5)
Finalisation of statistical analysis with WP6 data (summary analysis)
Preparation of two to three manuscripts together with WP6
Publication of a total of four to five manuscripts

PMG members in Charge of WP8:

Martin Schumacher
WP 8 Leader
University Medical Center
Freiburg, Germany

Martin Wolkewitz
WP 8 Statistician
University Medical Center
Freiburg, Germany

Section 3 Activities in 2009

3.1. Summary of Project Events and Achievements

3.1.1 Events in 2009

PMG/EAB Workshop III, 19 - 20 May 2009, Helsinki, Finland in conjunction with the ECCMID

Annual Plenary Meeting, 12 - 13 October 2009, Freiburg, Germany

Information on meetings/workshops can be found on the BURDEN-website:

www.eu-burden.info → select "events" from left-hand menu

3.1.2 Achievements in 2009

Deliverables in 2009

D 1.3 – Completion of Technical and Financial Interim report

D 2.3 – Completion of annual BURDEN report II

D 3.1 – Distribution of questionnaire to members of the PMG and EAB

D 6.2 – Feedback of selected indicators to participating ICUs

D 7.3 – Final report on the analytical study

D 8.2 – Report on analysis of the analytical study

D 8.3 – Analysis and report of the mathematical model

Publications in 2009

Oral Presentation at ECCMID in Helsinki, Finland (May 2009): "*Modelling the effect of time-dependent exposure on hospital mortality using data from the BURDEN study group"*. Wolkewitz M., Schumacher M., Davey P. for the BURDEN Study Group.

Oral Presentation at ECCMID in Helsinki, Finland (May 2009): *"The burden of healthcare-associated infection: the patient experience."* Burnett E:, Lee K., Rushmer R.,Ellis M.,Noble M., P. Davey

Poster Presentation in the European Network Corner at the ECCMID in Helsinki (May 2009): "*Progress of the BURDEN Project"*.

***Journal of Hospital Infection 2010;74:24-27*:** "*Healthcare-associated infection and the patient experience: a qualitative study using patient interviews*". Burnett E:, Lee K., Rushmer R.,Ellis M.,Noble M., P. Davey in

Information on results can be found on the BURDEN-website:

www.eu-burden.info → select "results" from left-hand menu

3.1.3 GANTT-Chart 2009

All Work Packages: identification of needs 3rd year (2009)

Month	25	26	27	28	29	30	31	32	33	34	35	36	39
	Jan 09	Feb 09	Mar 09	Apr 09	May 09	June 09	July 09	Aug 09	Sep 09	Oct 09	Nov 09	Dec 09	Mar 10
Work													
WP 1		D1.3		Brussels						Freiburg		Luxembourg	D1.4
WP 2				Brussels						Freiburg		M2.4/M2.4/D2.4/D2.5	
WP 3				Brussels		M3.2		M3.3		Freiburg/D3.2		Luxembourg	
WP 4				Brussels						Freiburg		Luxembourg	
WP 5				Brussels						Freiburg		Luxembourg	
WP 6				Brussels/M6.3			M6.4/D6.2		M6.5/D6.3	Freiburg		Luxembourg	
WP 7			M7.3/D7.3	Brussels						Freiburg		Luxembourg	
WP 8			D8.2	Brussels/M8.3		D8.3				Freiburg		Luxembourg	

Section 4 Project Outlook for 2010

4.1. Conferences in 2010 for presentation of BURDEN results

18 – 22	March	**SHEA**	Atlanta, USA
10 – 13	April	**20th ECCMID**	Vienna, AT
12 – 15	September	**50th ICAAC**	Boston, USA

4.2 Work package Deliverables

D 2.4 – Completion of the Final Technical Implementation Report III *(March)*

D 3.2 – Completion of the Evaluation Report (*March)*)

D 4.3 – UDDCH recommendations to stakeholders and final report

D 6.3 – Report on the impact of AMR and appropriate antimicrobial treatment in ICU acquired infections

4.3 Publications

Manuscripts (WP8):
Mortality associated with bacteraemia caused by Staphylococcus aureus: a cohort analysis with follow up beyond hospital discharge from the BURDEN study group (in progress)

Poster Presentation (WP2) of project results in the European Network Corner at the 20th ECCMID in Vienna, Austria, April 2010

Oral and Poster Presentations in various sessions at the SHEA in Atlanta, USA, March 2010 and at the 20th ECCMID in Vienna, Austria, April 2010

Section 5 Appendix

Table 1: Availability of data about number of MRSA and MSSA bacteraemias and hospital beds in 12 European countries

Country	MRSA bacteraemias	MSSA bacteraemias	Beds
Austria	EARSS hospitals only (75% total beds)	EARSS hospitals	Federal Ministry of Health
Cyprus	No data	No data	No data
Estonia	No data	No data	No data
France	InVS (Institut de Veille Sanitaire), voluntary reporting	InVS, voluntary reporting	SAE (annual Health Statistics)
Germany	KISS (ICU only)	KISS (ICU only)	Ministry of Health
Latvia	SVA (State Public Health Agency)	No data	VSTVA Health Statistics and Medical Technologies State Agency
Luxembourg	No data	No data	No data
Malta	EARSS covers 75% of hospital beds	EARSS covers 75% of hospital beds	Hospital statistics data
Netherlands	Working Party on Infection Prevention (www.wip.nl.)	No data	RIVM (National Institute for Public Health and the Environment
Norway	Ministry of Health (by enquiry)	Ministry of Health (by enquiry)	Ministry of Health
Sweden	No data	No data	National Board of Health and Welfare/Centre for Epidemiology (NBHW/EpC)
UK	HPA and HPS websites (mandatory reporting for England, Wales, Northern Ireland and Scotland)	HPA and HPS websites (mandatory reporting for England and Scotland only).	Hospital Episode Statistics (England), Information and Statistics Division (Scotland) websites. Data available for other administrations by enquiry

Table 2: Availability of data about case mix, cleaning costs and staffing in 6 European countries

	Case mix	**Cleaning costs**	**Staff per 100 beds**
Austria	Yes	No	Yes
France	Yes	No	Yes
Latvia	Yes	No	Yes
Malta	Yes	Yes	Yes
Sweden	Yes	No	Per 1,000 inhabitants
United Kingdom	Yes	No	Yes

Table 3: Estimated beds per 100,000 population for European countries that participate in EARSS. Numbers in red indicate discrepancy between WHO an OECD estimates, the WHO estimate was used as the default.

Country	WHO beds	OECD beds	Default	Population (millions)	Estimated beds
Austria	76	76	76	8.3	63080
Belgium	53	67	53	10.5	55650
Bulgaria	62		62	7.7	47740
Croatia	55		55	4.4	24200
Cyprus	No Data				
Czech Republic	84	74	84	10.3	86520
Denmark		36	36	5.4	19440
Estonia	56		56	1.3	7280
Finland	70	70	70	5.3	37100
France		72	72	61.2	440640
Germany	83	83	83	82.4	683920
Greece		48	48	11.1	53280
Hungary	79	79	79	10.1	79790
Iceland	No Data				
Ireland		53	53	4.2	22260
Israel	60		60	7.2	43200
Italy		40	40	59	236000
Latvia	76		76	2.3	17480
Lithuania	80		80	3.4	27200
Luxembourg		57	57	0.5	2850
Malta	76		76	0.4	3040
Netherlands		45	45	16.4	73800
Norway	41	36	41	4.7	19270
Poland		65	65	38.1	247650
Portugal		35	35	10.6	37100
Romania	65		65	21.6	140400

Slovenia	48		48	2	9600
Spain		33	33	45.4	149820
Sweden	No Data				
Switzerland		35	35	7.5	26250
Turkey	27	27	27	73.7	198990
United Kingdom		36	36	60.5	217800

Data sources

WHO beds: WHO Statistical Information System (WHOSIS) - Health systems resources

OECD beds: OECD Health Data 2009 - Frequently Requested Data

Population: Population Reference Bureau 2006

Websites

WHO :

http://apps.who.int/whosis/data/Search.jsp?indicators=(Indicator).(HSR).Members

OECD :

http://www.oecd.org/document/16/0,3343,en_2649_34631_2085200_1_1_1_1,00.html

PRB: http://www.prb.org/pdf06/06WorldDataSheet.pdf

Table 4: Comparison of estimates of *S. aureus* bacteraemias in the UK in 2007 from national reporting and from EARSS hospitals

S. aureus bacteraemias in the UK in 2007 from national reporting

Mandatory reporting in England suggests that voluntary reporting detected 80% of the actual number of *S. aureus.*[12]

England, Wales and Northern Ireland voluntary reports[12]	14,114
Estimated England, Wales and Northern Ireland total	17,643 (14,114/0.8)
Mandatory reports from Scotland[2]	2,536
Total *S. aureus* bacteraemias	20,179

S. aureus bacteraemias in the UK in 2007 estimated from EARSS

In 2007 147 hospitals from the UK provided data to EARSS but only 20 included information about hospital beds.

Number of beds in 20 EARSS hospitals	5,623
Number of beds in the UK (Table 3)	217,800
EARSS hospitals beds (% UK total)	2.6%
EARSS hospitals *S. aureus* bacteraemias	564
Estimated UK bacteraemias	21,692

Table 5: Cost per hospital day from WHO-CHOICE[4]

	International dollars 2005			Local Currency 2005		
	Primary	Secondary	Tertiary	Primary	Secondary	Tertiary
Austria	162.85	212.46	290.19	141.68	184.84	252.47
Belgium	158.45	206.72	282.35	136.74	178.40	243.67
Bulgaria	61.15	79.77	108.96	35.71	46.59	63.63
Croatia	79.89	104.22	142.35	309.39	403.64	551.32
Cyprus	129.10	168.43	230.06	53.06	69.22	94.55
Czech Republic	111.14	144.99	198.04	1564.78	2041.42	2788.34
Denmark	162.39	211.85	289.37	1364.07	1779.57	2430.69
Estonia	95.24	124.25	169.71	731.90	954.84	1304.19
Finland	150.61	196.48	268.37	146.09	190.59	260.32
France	148.96	194.33	265.44	134.06	174.90	238.89
Germany	150.59	196.46	268.34	132.52	172.88	236.13
Greece	146.69	191.37	261.39	101.22	132.05	180.36
Hungary	97.69	127.45	174.08	12201.88	15918.63	21742.97
Iceland	169.57	221.22	302.16	16032.51	20916.09	28568.90
Ireland	179.32	233.94	319.53	179.32	233.94	319.53
Israel	130.70	170.52	232.90	443.48	578.56	790.24
Italy	140.65	183.49	250.62	120.96	157.80	215.54
Latvia	80.30	104.75	143.08	23.37	30.48	41.64
Lithuania	84.67	110.45	150.87	122.00	159.17	217.40
Luxembourg	281.81	367.66	502.17	257.86	336.40	459.49
Malta	110.08	143.62	196.16	27.08	35.33	48.26
Netherlands	166.14	216.75	296.05	146.54	191.17	261.12
Norway	211.26	275.61	376.44	1844.27	2406.04	3286.36
Poland	81.89	106.84	145.93	151.50	197.65	269.96
Portugal	108.77	141.90	193.82	76.14	99.33	135.67
Romania	59.98	78.25	106.89	86.20	112.45	153.60
Slovenia	235.77	307.59	420.13	14382.12	18762.98	25628.01
Spain	137.67	179.61	245.32	104.63	136.50	186.44
Sweden	155.14	202.40	276.46	1428.88	1864.12	2546.17
Switzerland	169.40	221.00	301.86	287.98	375.70	513.16
Turkey	52.14	68.02	92.91	45.88	59.86	81.76
United Kingdom	157.80	205.86	281.18	97.83	127.63	174.33

Table 6: Number of *S. aureus* bacteraemias in Scotland in 2007 with estimated deaths, hospital days and costs per 100,000 inhabitants.

Data sources: *S. aureus bacteraemia* from mandatory reporting;[2] population from the Office of National Statistics;[13] cost per hospital day from Information and Statistics Division.[14] Deaths and additional hospital days from Work Package 7.

	MRSA	MSSA	All *S. aureus*
Total bacteraemias	881	1655	2536
Population, millions	5.17		
Rate per 100,000 inhabitants	17.0	32.0	49.1
% MRSA	35%		
Deaths	176	166	342
Deaths per 100,000 inhabitants	3.4	3.2	6.6
Days per 100,000 inhabitants (95% CI)	68 (48-119)	77 (54-106)	145 (102-225)
Cost per 100,000 inhabitants (95% CI) with three different estimates of hospital costs			
1. ISD 2007-8	£35,098 (£24,568-£61,421)	£39,560 (£28,022-£54,395)	£74,658 (£52,590-£115,816)
2. ISD 2005	£24,134 (£16,984-£42,235	£27,202 (£19,268-£37,403	£51,337 (£36,162-£79,638)
3. WHO-CHOICE	£8,559 (£5,991-£14,978)	£9,647 (£6,833-£13,264)	£18,205 (£12,824-£28,242)

Figure 1a: Number of *S. aureus* bacteraemias per year in European countries estimated from EARSS data inflated either for population (catchment) or hospital beds (beds)

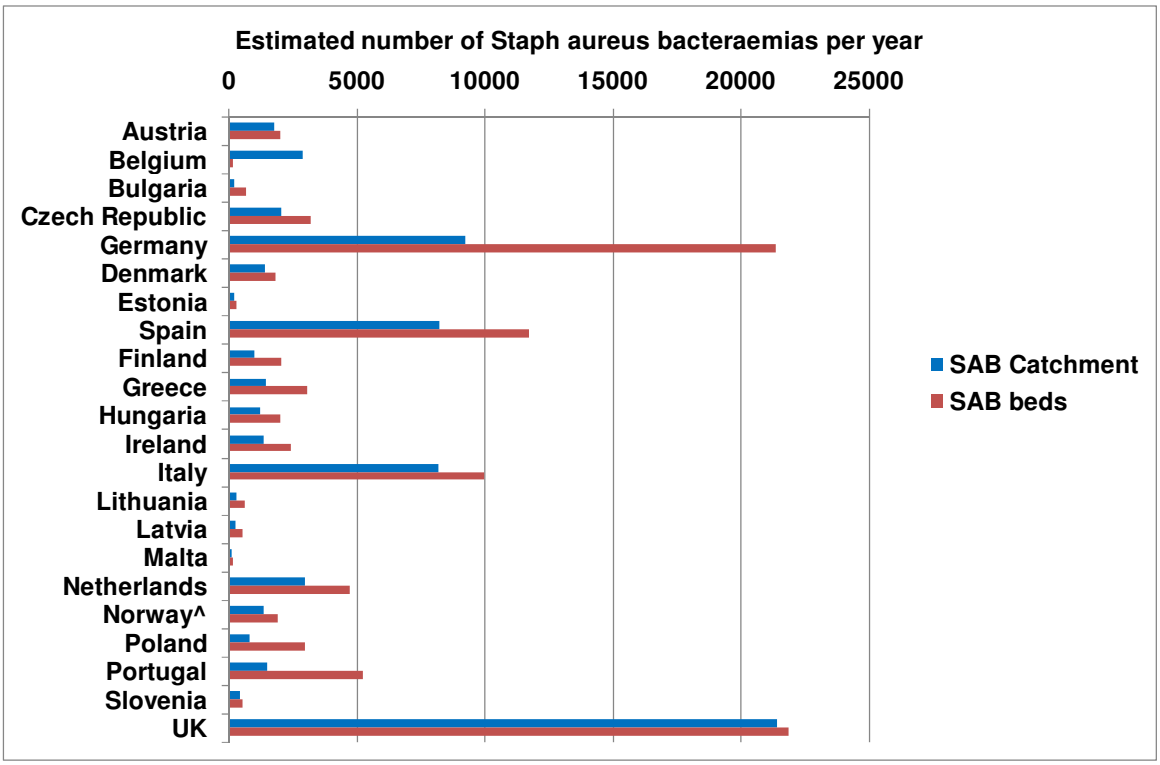


Figure 1b: Difference between estimates (beds – catchment) plotted against the average for both measures

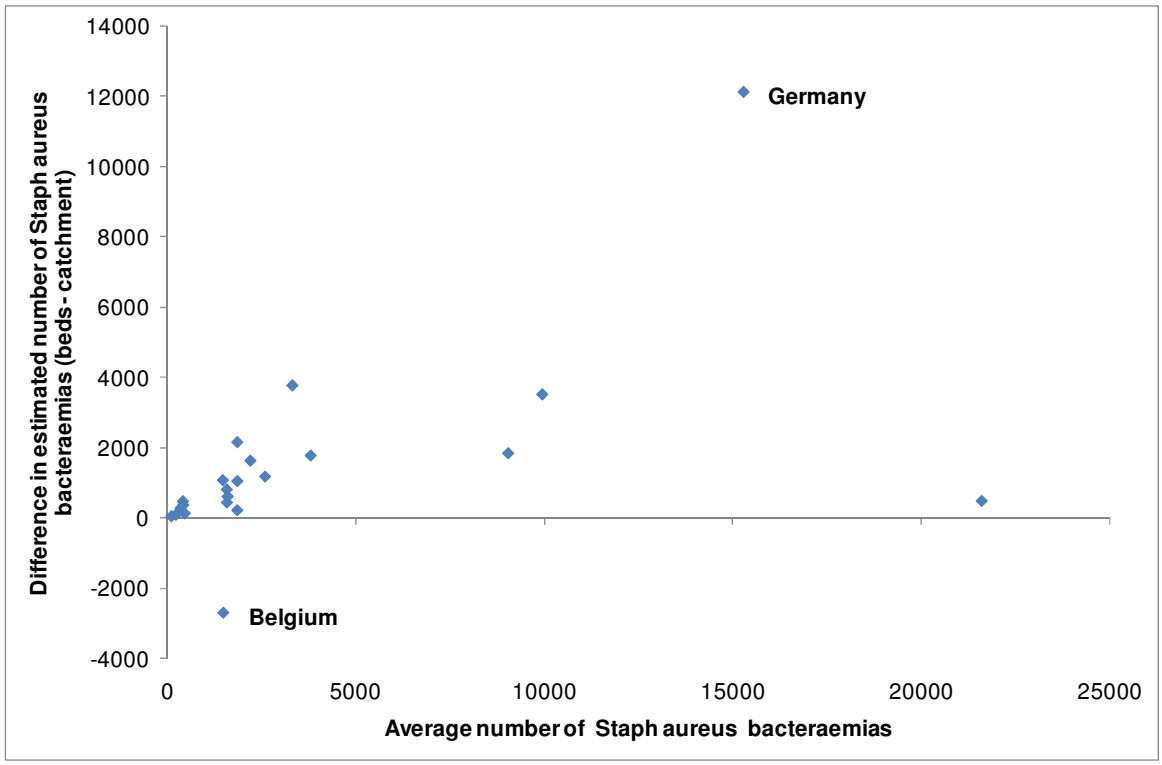
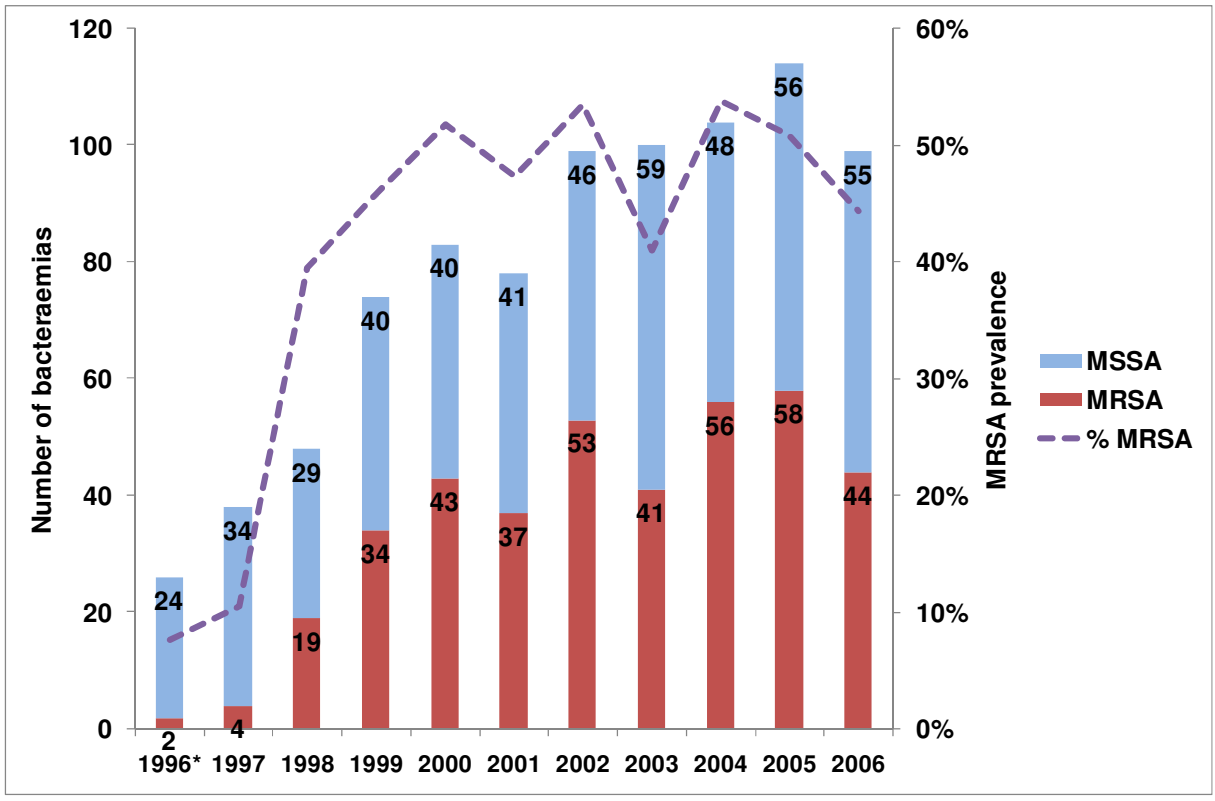


Figure 2: Longitudinal changes in *S. aureus* bacteraemia in Tayside, Scotland. Increase in the prevalence of MRSA was associated with increase in the number of MSSA bacteraemias as well as the number of MRSA bacteraemias



*1996 data were only collected from July; actual numbers have been multiplied by 2 to provide an estimated annual total.

Figure 3 a:Number of deaths per 100 bacteraemias by prevalence of resistance for S. aureus and E. coli based on adjusted attributable risk of mortality from WP7

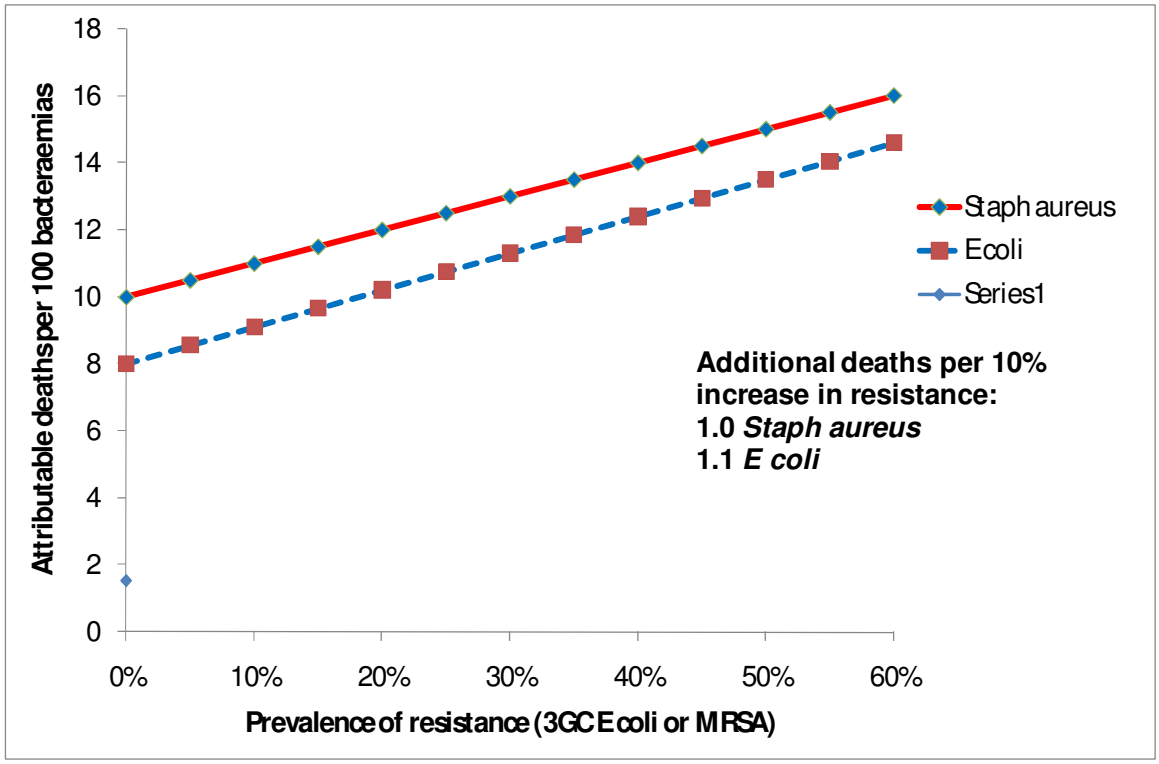


Figure 3b: Number of deaths per 100 bacteraemias by prevalence of resistance for *S. aureus* based on adjusted attributable risk of mortality at 30 days and one year from the Tayside longitudinal study of *S. aureus* bacteraemia (Appendix)

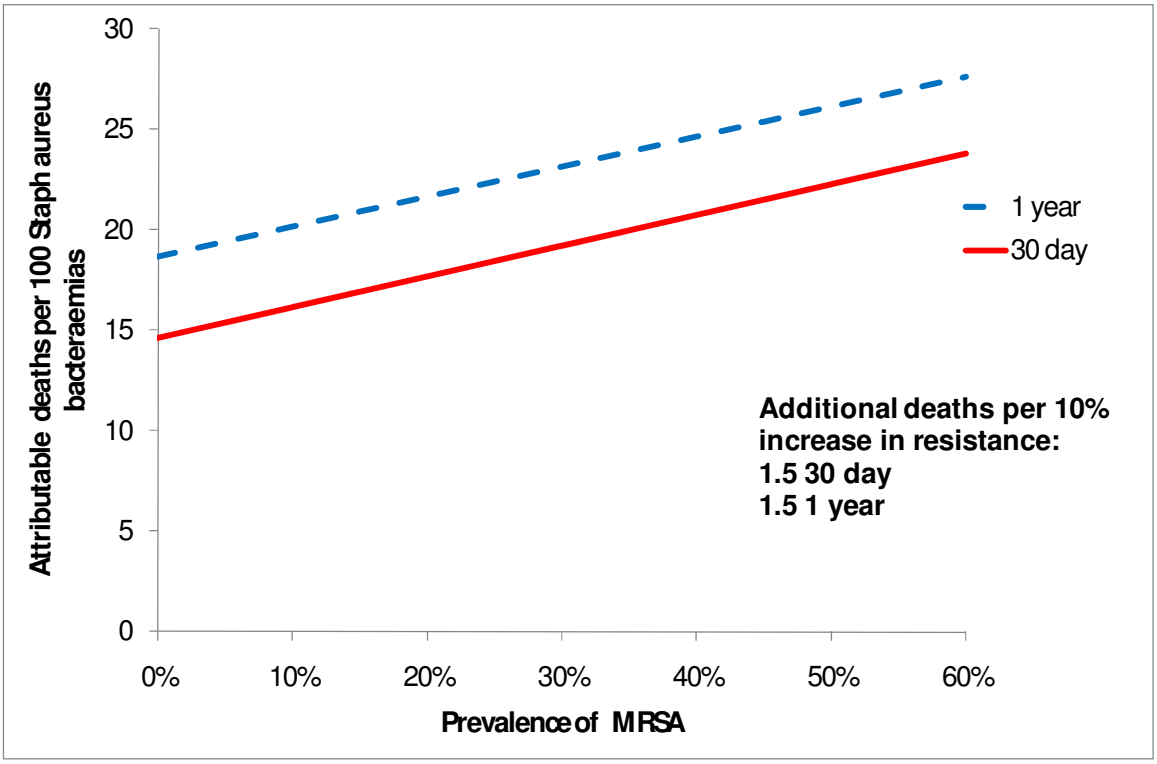


Figure 4: Additional hospital days per 100 bacteraemias by prevalence of resistance for *S. aureus* and *E. coli* based on data from WP7

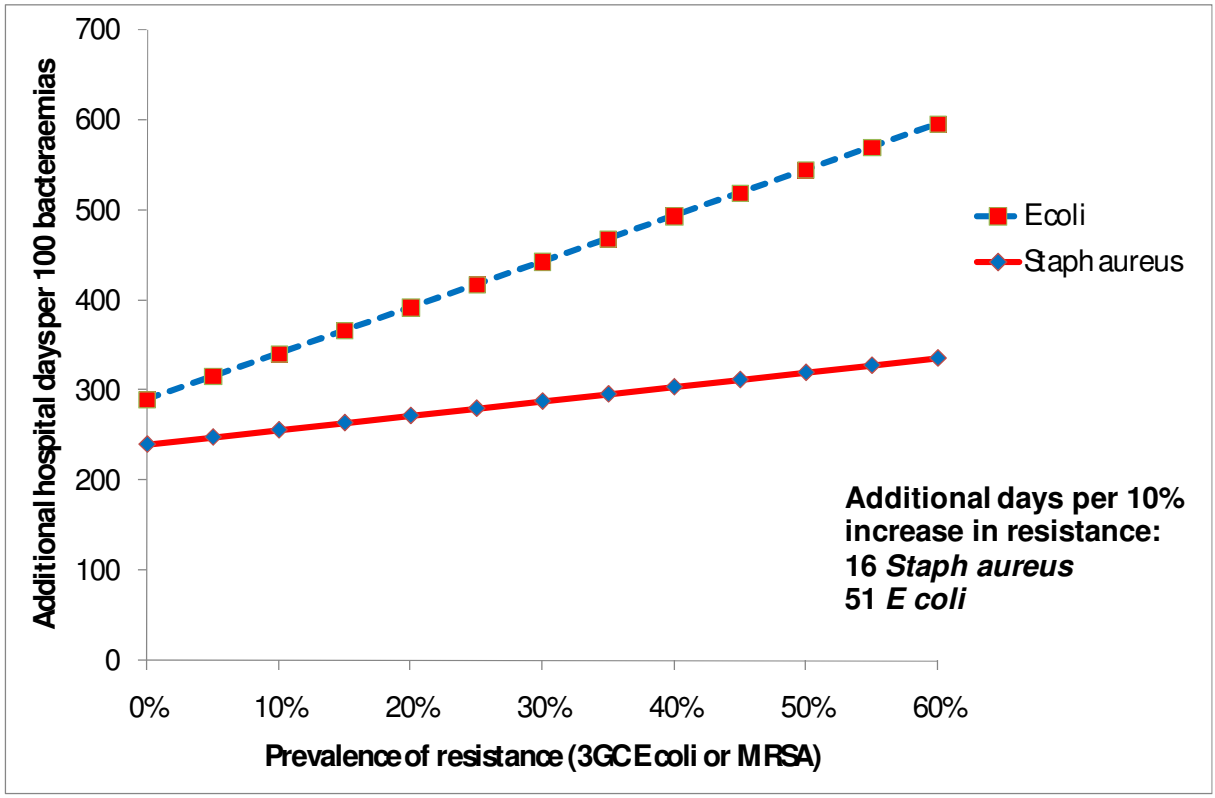


Table 7: Questionnaire to ECDC National focal points about hospital characteristics

Questionnaire on hospital characteristics that may influence hospital acquired infection

Please answer Yes or No to the availability of data in your country. Answer Yes if there is a national source of data for all hospitals in your country, with information for individual hospitals. If Yes please name the source of the data.

Data item	Available?	Source
Number of reports of MRSA bacteraemias per 1000 admissions		
Number of reports of Meticillin Sensitive *Staph aureus* bacteraemias per 1000 admissions		
Cleanliness Any nationally collected data about hospital cleanliness, in the UK this is part of the Patient Experience Action Team or PEAT score)		
Single rooms availability Proportion of all hospital beds provided in single rooms		
Average length of stay Median length of stay in days for all inpatient admissions in the hospital		
Average age of patients Mean age of inpatients in the hospital		
Emergency admissions Proportion of all inpatient admissions that were emergency admissions		
Bed occupancy rate Percentage of open and staffed beds (either total beds or general and acute only) which are occupied at midnight		
Cleaning service type A variable equalling 1 if hospitals contract out cleaning services and 0 if cleaning services are provided in-house. Where a hospital has a mixture of contract and in-house cleaning (e.g. in different hospital sites), this variable is a fraction derived by weighting cleaning service type by the number of beds		
Trauma and Orthopaedics Proportion of total admissions that were in the Trauma and Orthopaedics specialty		
Ear, Nose and Throat Proportion of total admissions that were in the Ear, nose and throat specialty		

Data item	Available?	Source
Ophthalmology Proportion of total admissions that were in the Ophthalmology specialty		
Neurosurgery Proportion of total admissions that were in the Neurosurgery specialty		
Nephrology Proportion of total admission that were in the Nephrology specialty		
Agency nursing staff Proportion of nursing staff that are employed using outside agencies		
Temporary nursing staff Proportion of nursing staff that are employed on temporary contracts		
Floor space per bed Total occupied floor space (in m^2) divided by the total number of available beds		
Number of beds Number of beds in the trust available to patients overnight.		
Male Proportion of all inpatient admissions that were male		
Expenditure on cleaning Total expenditure on cleaning services divided by total occupied floor area (in m^2)		
Nurses per 1000 bed days Numerator: number of (headcount) nurses Denominator: 1000 bed days		
Consultants (or equivalent, e.g. Attending Physicians, Senior Doctors) per 1000 bed days Denominator: 1000 bed days		

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