Prevention of meticillin-resistant *Staphylococcus aureus* bloodstream infections in European hospitals: moving beyond policies☆

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A R T I C L E   I N F O

S U M M A R Y

Background: There is evidence that meticillin-resistant *Staphylococcus aureus* (MRSA) bacteraemia can be reduced with improved infection control and antibiotic stewardship.
Aim: To survey infection control and antibiotic stewardship practices within European hospitals and to identify initiatives that correlate with reduced MRSA prevalence.
Methods: Online questionnaires were sent to European hospitals about their surveillance, hand hygiene, intravenous device management, admission screening, isolation, antibiotic prescribing, hospital demographics and MRSA blood culture isolates during 2010.
Findings: In all, 269 replies were received from hospitals in 29 European countries. Lower MRSA prevalence showed significant association with presence of incidence surveillance, performance of root cause analysis, mandatory training requirements for hand hygiene, accountability measures for persistent non-compliance, and multi-stakeholder teamwork in antibiotic prescribing. Presence of policies on intravenous catheter insertion and management showed no variation between different MRSA prevalence groups. However, low-prevalence hospitals reported more competency assessment programmes in insertion and maintenance of peripheral and central venous catheters. Hospitals from the UK and Ireland reported the highest uptake of infection control and antibiotic stewardship practices that were significantly associated with low MRSA prevalence, whereas Southern European hospitals exhibited the lowest. In multiple regression analysis, isolation of high-risk patients, performance of root cause analysis, obligatory training for nurses in hand hygiene, and undertaking joint ward rounds including microbiologists and infectious disease physicians remained significantly associated with lower MRSA prevalence.

Conclusion: Proactive infection control and antibiotic stewardship initiatives that instilled accountability, ownership, teamwork, and validated competence among healthcare workers were associated with improved MRSA outcomes.

Introduction

Bloodstream infections (BSIs) caused by meticillin-resistant *Staphylococcus aureus* (MRSA) continue to constitute a major challenge to European healthcare institutions and impact on morbidity and mortality as well as economic costs.[1] For more than a decade, comparable surveillance of MRSA proportions in *S. aureus* blood cultures has been ongoing in the majority of European countries through the European Antimicrobial Resistance Surveillance Network (EARS-Net, previously EARSS). MRSA proportions have been shown to correlate well with incidence, and have been used to calculate overall MRSA bacteraemia rates.[2]

The results from EARS-Net highlight significant geographical differences: MRSA prevalence is consistently reported to be low (at times practically absent) in almost all Northern European countries but increases into Central/Eastern Europe and reaches its highest levels in the Southern European countries bordering the Mediterranean.[3] Over the past decade, a decline in MRSA bacteraemia has been reported by EARS-Net.[4] However, this reduction has been far from uniform throughout Europe. Improvement has been highest in the UK and Ireland; indeed, MRSA bacteraemia incidence in England has fallen by more than 80% from its previous endemic level of less than a decade ago.[5,6] Significant improvement has also been reported in France and Belgium but the reduction has been far less dramatic than reported in the British Isles and achieved over a much longer period of time.[7] On the other hand, little change has been reported in most countries within Southern and Eastern Europe, where MRSA proportions remain high in bacteraemia isolates and, in some instances, have even increased in recent years.[8]

MRSA bacteraemia can be reduced through effective infection control and antibiotic stewardship interventions.[9] MRSA BSI incidence and proportions have therefore been used to monitor the effectiveness of such programmes.[10] Thus, it is helpful to study the variation in MRSA BSI between countries and healthcare institutions in order to identify any practices that are associated with low prevalence.

Methods

This study was embedded as a work package in the Implement Project.[11] A consultation exercise using a Delphi-type approach was undertaken among ten experts in infection prevention and control. These were primarily epidemiologists as well as infection control doctors and nurses involved in the project or within the board of the International Federation of Infection Control (IFIC). Survey questions were developed and then short-listed, following feedback, to incorporate infection control and antibiotic stewardship measures deemed relevant for the prevention and control of MRSA bacteraemia. These focused on surveillance, isolation, hand hygiene, intravenous device management, decolonization and screening, as well as antibiotic prescribing.

The questionnaire also collected, as the primary outcome measure the proportions of *S. aureus* blood culture isolates reported by the responding hospital in 2010 that were meticillin resistant. This was calculated by including the number of *S. aureus* blood culture isolates that showed oxacillin resistance as the numerator, and the total number of *S. aureus* bacteraemias as the denominator, both on a first-per-patient basis. Basic hospital demographics were also captured.

The survey was made available online in French, German, Spanish, Italian, and Greek translations, in addition to the original English version, using SurveyMonkey (Menlo Park, CA, USA). It was advertised widely in Europe between March and December 2011, especially to members of European societies affiliated with IFIC. To avoid multiple replies from the same respondent, the survey was programmed to accept only one reply from each IP source. All data received from the questionnaires were checked for plausibility, entered into a database and analysed descriptively. Statistical analysis was performed using STATA 10 (StataCorp LP, TX, USA). All variables were binary, asking whether the intervention was in place within the responding healthcare facility or not. Presence of infection control and antibiotic stewardship interventions was grouped by geographical region based on the EARS-Net epidemiological map: North, Central/East, France/Belgium, South and UK/Ireland. The χ^2-test for association was used to test variables between high- and low-MRSA prevalence groups to identify any association. $P \leq 0.05$ was considered statistically significant.

Ordinal logistic regression analysis was then performed to cross-validate the simple associations identified between specific variables and MRSA prevalence in the univariate analysis. Separate logistic regression was performed on each group of initiatives. Factors showing significant regression coefficients ($P < 0.05$) were then extracted from each group, introduced into a separate model and retested. Some factors (such as intravenous device competence assessment) were excluded from the logistic regression model due to co-linearity whereas others were not retained due to lack of statistical significance.

Results

After cleaning the data, 269 replies were retained. They originated from secondary and tertiary care hospitals, defined as institutions having at least two specialized services (such as intensive care, renal dialysis, haematology, etc.). These hospitals were located in 29 different European countries (Table I). Within these respondents, 222 hospitals supplied information on the MRSA proportions identified in their *S. aureus* blood culture isolates during 2010.

A significant variation was evident in MRSA proportions between the various regions. Whereas 90.6% of Northern hospitals reported MRSA proportions of <5%, the equivalent was only seen in 12.5% of institutions from Southern Europe. No hospital from the Northern and Central/Eastern regions reported MRSA