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Major article

Predictors of use of infection control precautions for multiresistant gram-negative bacilli in Australian hospitals: Analysis of a national survey

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Introduction: Despite the global expansion of extended spectrum β−lactamase-harboring *Enterobacteriaceae* (ESBL-E) and carbapenem-resistant *Enterobacteriaceae* (CRE), only limited research on the infection control management of patients with these organisms is available.

Methods: We present a national survey of infection control practices amongst adult acute-care hospitals in Australia, for ESBL-E, CRE, and the emerging threat of patients with overseas health care contact.

Results: In total, 97 health services responded, representing 9% of all eligible hospitals. The proportion of hospitals that reported use of contact precautions (CP) was 96% (93 out of 97) for ESBL-E, 81% (79 out of 97) for CRE, and 72% (48 out of 67) for patients transferred from an international hospital. For ESBL-E hospitals frequently employed risk-stratification to limit the use of CP (40 out of 97; 41%). On multivariate analysis predictors of a strategy to limit use of CP for ESBL-E were government funding (odds ratio, 4.8; $P = .003$) and a metropolitan location (odds ratio, 3.2; $P = .014$); predictors of any use of CP for CRE were location in an Australian state with a specific legislation on CRE ($P = .030$) and the presence of a written policy on CRE ($P = .011$).

Conclusions: Infection control management of multiresistant gram-negative bacilli varied considerably across the Australian hospitals surveyed. A lower rate of reported CP use for CRE than for ESBL-E was unexpected and indicates a vulnerability in some Australian hospitals. Multivariate analysis revealed various drivers influencing infection control practice in Australia.

A marked expansion of community-onset extended-spectrum β-lactamase harboring *Enterobacteriaceae* (ESBL-E), and the burgeoning of carbapenem-resistant *Enterobacteriaceae* (CRE) has occurred during the past decade.[1,2] Furthermore, patients with overseas health care contact are increasingly identified as a vector for the global movement of new antimicrobial resistance mechanisms, including those mediating CRE.[3]

The majority of current infection-control guidelines include recommendations for the control of multiresistant gram-negative bacilli (MRGNBs), including CRE and ESBL-E. Fewer guidelines include recommendations for patients with overseas health care contact.[4] Given the small number of published studies on which to base recommendations[5] and the rapidly changing epidemiology of MRGNBs, guidelines in this area risk being outpaced by on-the-ground events.

Australia is a low-prevalence country for ESBL-E, with a 2010 national survey of community onset isolates indicating 3.4% of *Escherichia coli* and 3.6% of *Klebsiella pneumonia* were ESBL producing.[6] CRE in Australia originate from 2 key sources: low-level endemicity of metallo-β-lactamase-producing *Enterobacteriaceae* within critical-care areas and some specialty units on the country's eastern coast,[7] and residents returning after overseas health care contact.[8,9] We have previously described variations in the infection control practices used for patients hospitalized with expanded-spectrum cephalosporin-resistant *Escherichia coli* as part of an Australasia-wide study.[10,11] Such a disparity has been noted in other reports.[12,13]

In summary, we present a national survey of practice in infection control management of patients harboring ESBL-E, CRE, and

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patients with overseas health care contact, amongst acute-care adult hospitals in Australia. Our aim was to define the scope of variation of infection control practices for these groups in Australia and to identify factors that determine which policy and practice is applied in differing health services.

METHODS

The study population was adult acute care hospitals within Australia. At the time of the survey Australia (population 23 million) was serviced by approximately 700 publically funded hospitals and 300 private hospitals across its 6 states and 2 administrative territories.[14,15]

A draft survey was constructed, including questions based on those used in a previously published work.[12] The survey was pilot tested on 5 experienced infection control practitioners and modified based on their feedback. The survey questioned health service practice of infection control, rather than the details of written policy. Where a service used varied practices within their network, respondents were asked to answer for the area that best fit the description of an adult acute care facility. The full survey is in the Supplementary material.

The survey was conducted as an open invitation online survey, using a Web-based interface to collect responses. An e-mail invitation was disseminated via 2 frequently used national e-mail discussion groups, 1 hosted by the Australasian College for Infection Prevention and Control and the other hosted by the Australasian Society for Infectious Diseases.[16] The former sends e-mail messages to approximately 500 e-mail addresses (personal communication, Michael Wishart, HSN Hospital, Queensland, Australia, May 5, 2014) and the latter to approximately 900 e-mail addresses (personal communication, Dr Ashley Watson, Canberra Hospital, Australian Capital Territory, Australia, April 24, 2014). Follow-up e-mail messages were disseminated via these channels. The survey was open for a 2-month period (November 2012-January 2013). A small token of appreciation (a gift hamper) was offered to 1 randomly selected responding site.

Human research ethics approval for the conduct of this study was received from University of Queensland.

We requested that the nominal head of infection control complete or delegate completion of the survey at each site, to minimize multiple responses. If multiple responses from a single site were received, these were collapsed as follows: concordant, relative agreement (eg, difference in details only), or discordant. Answers in the latter 2 groups were combined using the following rules: affirmative responses (indicating the presence of a given policy) were presumed to be correct, and the most restrictive application of a policy or most conservative numerical was presumed to be correct. Infection control services were not recontacted because permission for this had not been sought in the ethics approval.

Where a single respondent answered for a health service/network of multiple adult acute-care hospitals, this was maintained as a single answer, with demographics from the single largest hospital used for analysis.

External data sources

Data are primarily as reported by the respondent. Key demographics (eg, hospital size, funding, and referral services) were confirmed with public data sources (Supplementary material 1-4). Denominator data for Australian hospitals was extracted from the Australian Institute of Health and Welfare (AIHW) annual report 2011-2012.[15]

Definitions

Contact precautions were defined as the use of any combination of gloves, gown, and or a single or cohort room.[17] Infection control practice was considered inclusive when all patients with a given resistance phenotype were managed in contact precautions or permissive if nonuse of contact precautions was allowed in some circumstance (risk stratification by bacterial species or patient characteristic) or was not used at all. Hospital type was stratified by funding source; public hospitals are fully funded by the Australian state and/or federal governments. They provide the vast majority of supraregional referral services in Australia, whereas private hospitals draw funding from patient billing revenue and primarily service patients covered by voluntary private health insurance or other third parties. Supraregional referral services were highly specialized referral services such as transplant service (ie, solid organ or allogeneic bone marrow transplant services) and other supraregional services (ie, major burns, spinal injury, and cystic fibrosis services). An infectious disease (ID) service was an ID physician providing consultation or inpatient services at the hospital. A written policy specifically pertained to the resistance phenotype (or patient group) queried, rather than a generic multiresistant organism (MRO)-type policy. Hospital size was classified by the AIHW Peer Group system.[18] Because private hospitals are not classified by this system, 2 researchers (BR and SH) independently assigned a peer group after review of any available hospital demographic data (from the survey and publicly available information on the hospital's Website). Disagreement was resolved by discussion. Principal referral hospitals (A1 by AIHW classification) are major city hospitals with >20,000 and regional hospitals with >16,000 (casemix-adjusted) separations per year. Large hospitals (A1, A2, B1, and B2) included principal referral, specialist women's hospitals, large metropolitan (>10,000 casemix-adjusted separations), and large regional hospitals (>8,000 or >5,000 casemix-adjusted separations, depending on location).

Relevant legislation and recommendations

At the time of the survey there were no national infection control management recommendations or legislation specifically pertaining to CRE or patients with overseas health care contact. Some recommendations for ESBL-E are provided in the national infection control guidelines.[17] Two Australian states work within state-level legislation (operational directives). One encompasses all MROs (MRO directive),[19] and the other specifically CRE (CRE directive).[20] See Supplementary material 1-4 for a comparison of state and national documents.

Statistical methods

Univariate analysis was undertaken using χ^2 test, Fisher exact test, and calculation of odds ratios. Multivariate logistic regression included all variables significant on univariate analysis at a $P = .2$ level. Using backward selection variables were retained in the final logistic regression model if their significance remained below $P = .2$. Models were assessed by calculation of a receiver operator curve and Hosmer-Lemshow goodness of fit test. Robust estimates of variance were used to account for a potential lack of independence between hospitals, given some operate in shared jurisdictions where standardization of policy may have occurred. In addition, when the geographic variable of state-based legislation was entered into multivariate analysis, it was maintained as a tripartite set (MRO policy, CRE policy, or no policy). All statistical tests were 2 tailed, and $P < .05$ was considered significant. STATA version 12.1 (Statacorp, College Station, Texas) was used.