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The relationship between patient characteristics and the development of a multi-resistant healthcare-associated infection in a private South Australian hospital

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Abstract. ***Background*:** The prevention of healthcare-associated infections (HAI) and the rise of multi-resistant organisms are significant public health issues. Infections caused by multi-resistant organisms (MRO) can have similar clinical manifestations to infections caused by non-multi-resistant organisms (non-MRO HAI) but antibiotic treatment options are more limited, which can result in treatment failure. This study aimed to reduce the incidence of MRO HAI in a specific South Australian hospital setting by identifying factors that are associated with MRO transmission.

***Methods*:** Using a case-control design, we analysed data from 1017 adult patients who developed an HAI in the 9-year period from 2003 to 2011 in a private South Australian hospital. We compared risk factors in patients who developed MRO HAI (cases) with risk factors in patients who developed non-MRO HAI (controls). Data were collected from the hospital's patient management database and individual medical records, and analysed using univariate and multivariate techniques.

***Results*:** Independent predictors for the development of MRO HAI were the presence of an indwelling urinary catheter and renal disease. The development of a secondary infection was significantly more likely in MRO relative to non-MRO HAI, as was secondary bloodstream infection following a primary urinary tract infection.

***Conclusion*:** All effective interventions for reducing MRO, specifically in UTI, should be implemented where feasible. Increased healthcare worker education on aseptic non-touch technique, and safe insertion and management of an IDC, particularly important in patients with underlying renal disease, could assist in decreasing the risk of MRO HAI in this setting.

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Introduction

The prevention of healthcare-associated infections (HAI) and the rise of multi-resistant organisms (MRO) are issues of public health importance.[1,3] Infections caused by MRO, including methicillin-resistant *Staphylococcus aureus* (MRSA), vancomycin-resistant enterococci (VRE) and multi-resistant Gram-negative organisms (MRGN), are more commonly seen in healthcare settings[1] and are an increasing concern and challenge to healthcare provision.

In Australia, it is estimated that ~200 000 HAI occur annually.[2] Morbidity and mortality are negative outcomes for patients as a result of acquisition of HAI. Infections caused by MRO can contribute to prolonged stays in hospital, increasing occupied bed days,[4–11] increased hospital costs,[4,8–10,12,13] intensive care treatment,[12,14,15] antibiotic therapy,[1,3] readmission to hospital,[16,17] further surgery,[8] severe adverse outcomes,[5,8] and MRO related mortality.[5,7,8,14,17–19]

Increased financial costs to society and the individual can result following the development of HAI with subsequent complications.[13] Immeasurable costs causing harm to patients include reduced time spent with family members,[3] and pain and suffering, leading to a decrease in quality of life[2,3] with physical, emotional and social changes.[3,20,21] Diminished worker productivity with loss of income[3,20] increases the burden to family members and society.

The development of MRO HAI is known to be associated with a range of patient characteristics such as severe underlying illness and varying comorbid conditions,[1,4,6,8,12,19,22–24] older age,[4,19,22,23] and pre-existing carriage of multi-resistant organisms.[7,17] Hospital exposures have been demonstrated to contribute to the development of MRO HAI and include the presence of medical devices,[1,11,18,22,25] surgery,[1,12,26] intensive care,[1,12,14,15] and longer lengths of stay in hospital.[14,15,27]

We investigated factors associated with MRO transmission, including hospital treatment and the underlying diseases of patients contributing to the manifestation of MRO HAI, in a private South Australian

Implications

- Specifies risk factor for healthcare-associated MRO infection which can be used for risk management in hospitals.
- Provides evidence to justify targeted interventions including insertion and management of indwelling catheters.
- Demonstrates the need for future research to explore transmission mechanisms and patients' comorbidities for specific HAIs.

hospital setting. In identifying these factors, this study aimed to inform targeted prevention activity to reduce the incidence of MRO HAI in a specific South Australian hospital setting. Specific objectives included comparing the characteristics of patients who developed MRO HAI and non-MRO HAI, identifying associations between existing patient comorbidities and the development of MRO HAI and identifying patient related risk factors for MRO HAI.

Methods

In Australia, public healthcare facilities are funded by the government and provide a wide range of healthcare at little or no cost to the patient. Private healthcare facilities are funded by private health insurers supported by the independent contributions of members. Approximately 50% of Australians aged 15 years and over have private health insurance, including 47% of Australians with hospital cover.[28]

This study was conducted in a private hospital in metropolitan Adelaide, South Australia with more than 200 beds offering elective surgical and medical care. It has an 18 bed critical care unit which includes intensive care beds. The hospital offers a range of different services and medical specialties including general medicine; urology; orthopaedics; colorectal; oncology; vascular; plastic surgery; cardiology; gastroenterology; gynaecology; ear, nose and throat (ENT); neurology; and general surgery.

Using a case-control approach, we analysed data from patients aged at least18 years old who had acquired any HAI (MRO or non-MRO) during the period January 2003 to December 2011. Age below 18 years of age was the only exclusion criterion.

Cases were patients who developed an HAI caused by MRO including methicillin-resistant *Staphylococcus aureus*, vancomycin-resistant enterococci and multi-resistant Gram-negative organisms. Controls were patients with an HAI caused by non-MRO. An HAI is here defined as any localised or systemic condition resulting from an infectious agent or toxin for which no evidence was apparent on admission to the acute care setting.[29]

Infection-control reports are compiled by infection-control staff at the time the infection is confirmed. Hardcopy reports are stored in the infection-control staff office and are used to generate electronic reports for hospital use. Reports dating from January 2003 to December 2011 were reviewed to identify patients who were previously reported as having an HAI. A data collection form was created to record patients' dates of admission and discharge, lengths of stay in occupied bed days, demographics, medical speciality, types of infection, infecting organism, hospital exposures, complications and comorbidities present on admission.

Data were collected from a range of additional sources including the hospital's patient management database, which records coding data based on the International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Australian Modification (ICD-10-a.m.). Patients' medical records and laboratory reports were also reviewed. Unique patient identification numbers were used to link health information and de-identify patients' details. These identifiers were destroyed at the time of analysis. A separate form for each episode of infection was used to record the data.

The medical records of patients who died, regardless of the cause of death, were archived offsite and were not accessible. While precise cause of death was not available, this outcome was categorised as 'all cause mortality'.

As well as a range of demographic and health-related data, we collected data on comorbidities and medical speciality on admission. We also collected data on the type of infection including surgical-site infection (SSI), bloodstream infection (BSI), urinary tract infection (UTI), pneumonia, chest infection, skin or soft tissue infection, device-related infection, any medical devices used, MRO carrier status and the specific site of infection. Known patient carrier status was identified through the hospital's patient management database and alert system or through MRO screening of patients with identified risk factors for MRO on admission. Information on surgical and non-surgical procedures performed, and intensive care treatment were also collected, as well as data on chemotherapy and radiotherapy treatments. Complications of the HAI were recorded including return to theatre, readmissions, development of a secondary infection by type of infection, and mortality.

Data analyses were performed using Stata software version 12 (Stata Corp, College Station, TX, USA). Chi-square, Mann–Whitney tests, and log binomial models formed part of the analysis. Odds ratios were calculated with 95% confidence intervals and all statistical tests were performed at the 0.05 α level. This project received formal approvals from the Medical Records Department and ethics committee of the private hospital concerned, and from the University of Adelaide Human Research Ethics Committee.

Results

During the study period, a total of 1017 HAI were identified in adult patients and were included in the study. This represented ~0.63% of all patients admitted to the hospital during the same period. Of these infections, a total of 103 MRO HAI were identified as cases and a total of 914 non-MRO HAI were