Major Article

Prevalence of infections and antimicrobial prescribing in Australian aged care facilities: Evaluation of modifiable and nonmodifiable determinants

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Background: Infections in aged care residents are associated with poor outcomes, and inappropriate antimicrobial prescribing contributes to adverse events, such as the emergence of antimicrobial resistance. The objective of this study was to identify resident- and facility-level factors associated with infection and antimicrobial prescribing in Australian aged care residents.
Methods: Using data captured by a national point-prevalence survey (the Aged Care National Antimicrobial Prescribing Survey), risk and protective factors were determined by multivariate Poisson regression.
Results: In 2017, 292 facilities were surveyed. Infection prevalence was 2.9% (95% confidence interval [CI], 2.6%-3.2%), and antimicrobial use prevalence was 8.9% (95% CI, 8.4%-9.4%). Resident-level factors associated with infection prevalence included urinary catheterization and hospital admission within the last 30 days; facility-level factors included state and multipurpose service provision. Resident-level factors associated with antimicrobial prescribing included infection signs and symptoms; facility-level factors included state, nonmetropolitan locality, and not-for-profit status. Availability of guidelines for urinary tract infection (UTI) management was associated with reduced antimicrobial prescribing.
Conclusions: Looking ahead, reports should be peer grouped by significant facility-level factors. Priority should be given to implementing UTI management guidelines and prevention of infection in residents with indwelling urinary catheters. Enhanced monitoring and prevention strategies are required for residents recently admitted to hospital.
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Residents of residential aged care facilities are susceptible to respiratory tract, skin or soft tissue, and urinary tract infections (UTIs).[1] Reasons for this vulnerability include advanced age, underlying disease, impaired mental and functional status, administration of immunosuppressive medications, and use of invasive devices such as indwelling urinary catheters.[2-5] Residents also have close contact with potentially infected or colonized staff and other residents, and may require frequent and prolonged hospitalization.[6,7] Inappropriate antimicrobial prescribing for infections may lead to the emergence of antimicrobial resistance, *Clostridium difficile* infection, adverse drug reactions, and unnecessary cost.[8-12]

In Australia, aged care facilities are operated by not-for-profit, private, and mostly in the state of Victoria, government organizations. Approximately 2,670 aged care homes provide accommodation and other types of support, including assistance with day-to-day living and intensive forms of care.[13,14] Almost 180 multipurpose services (MPSs) deliver a flexible mix of acute, subacute, and aged care services to best meet a community's needs.[14,15] Most facilities are located in metropolitan areas where there is greater access to goods and services.[16] Many health services are provided by offsite practitioners (eg, local community pharmacists are supported to provide services such as supply of medications, education, and auditing).[17]

Since 2015, Australian aged care facilities have been invited annually to voluntarily participate in the Aged Care National

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Antimicrobial Prescribing Survey (acNAPS). This is a structured point-prevalence survey modeled on the European Centre for Disease Prevention and Control Healthcare Associated Infection in Long Term Care Facilities study.[18,19] Findings enable the prevalence of infections and antimicrobial prescribing to be estimated to inform relevant quality improvement activities.

The objective of this study was to analyze acNAPS data to identify facility- and resident-level factors associated with infection and antimicrobial prescribing in Australian aged care residents. In doing so, modifiable and nonmodifiable factors relevant to reporting and interpretation of the surveillance data could be determined. This information is necessary to inform future quality improvement activities focused on infection prevention and antimicrobial prescribing practices.

METHODS

Data collection

In 2017, acNAPS data were collected by nurses, infection control professionals, or pharmacists on a single survey day between June 19 and September 1. Three data collection forms were used:

(1) A facility form was completed for each participating facility and captured denominator data and data about infection prevention and antimicrobial prescribing practices.
(2) An infection form was completed for residents who presented with infection signs and symptoms on the survey day.
(3) An antimicrobial form was completed for residents who were prescribed an antimicrobial on the survey day.

Facility capacity, resident demographics (age and sex), use of the National Residential Medication Chart (NRMC), access to the *Therapeutic Guidelines: Antibiotic*, and endorsed guidelines for UTIs were captured by the facility form. Although recommended, facilities are not required to use the NRMC.[20] For subscribers, the *Therapeutic Guidelines: Antibiotic* aims to assist clinicians, including those working in aged care facilities, by providing prescribing guidelines for therapeutic and prophylactic antimicrobials. Optimal management of residents with suspected UTIs is outlined by a clinical algorithm.[21]

All data were obtained by review of clinical records (medical and nursing), medication charts, and direct liaison with clinical staff in participating facilities. Prior to the survey day, education regarding the surveillance methodology was provided. Staff responsible for the surveillance could participate in training webinars and a detailed user manual could be accessed via the National Centre for Antimicrobial Stewardship (NCAS) Web site. Individual support was available by telephone or e-mail liaison with NCAS staff. Surveys were submitted online via a secure Web portal.

Definitions

Standardized and accepted definitions for confirmed infections (eye, oral, respiratory tract, skin and soft tissue, urinary tract, and other infections) were consistent with those detailed by the McGeer criteria.[22] The prevalence of infection was defined as the proportion of residents presenting with signs and symptoms of ≥1 possible or confirmed infection on the survey date. Residents presenting with multiple infections on the survey date were counted once.

Antimicrobial prescriptions included all antibiotics, antiviral agents, antifungal agents, and antiparasitic agents. The prevalence of antimicrobial prescribing was defined as the proportion of residents prescribed ≥1 antimicrobial on the survey date. Subset calculation of the prevalence of antimicrobial prescribing excluding topical and antiviral prescriptions was performed to enable comparison with previous reports using methodology used by the Healthcare Associated Infection in Long Term Care Facilities survey.[18] Residents prescribed multiple antimicrobials on the survey date were counted once.

Data analysis

Facility-level data were used to evaluate factors potentially associated with infection and antimicrobial prevalence, expressed as a risk ratio (RR). All factors captured by the facility form were analyzed if relevant to infection risk or antimicrobial prescribing. Nonmodifiable variables included state, remoteness, organization type, service type, facility size, sex, and age of residents. In addition, available modifiable factors were also included into models for infection risk (presence of an indwelling urinary catheter, admission to hospital in last 30 days, and availability of alcohol-based handrubs) and antimicrobial use (presence of an indwelling urinary catheter, admission to hospital in last 30 days, signs and symptoms of infection, use of the NRMC, access to national antimicrobial prescribing guidelines, use of endorsed guidelines for management of UTIs, and the scope of pharmacy services provided at the facility level).

Facility-level characteristics, such as state and organization type, were analyzed as categorical variables, with the exception of the number of residential places. For resident cohort characteristics, such as number of male residents or those with an indwelling urinary catheter on survey day, the percentage of residents with the characteristic was analyzed.

Funnel plots of infection and antimicrobial prevalence were constructed by facility size, using 3 SD control limits to identify outliers. Counts of infections and antimicrobial prescriptions were modeled with number of residents on survey day set as the offset. Single-level Poisson models demonstrated significant overdispersion for both infection ($z = 2.53$, $P < .01$) and antimicrobial ($z = 5.01$, $P < .01$) data.[23] Multilevel Poisson models were therefore used to model the extra Poisson dispersion[24] and possible intraclass correlations.[25] Health services were specified as a random intercept. Model fit was assessed using scaled residuals.[26] Multilevel models were not significant for overdispersion. All analyses were conducted using the LME4 package[27] in R programming language (Version 3.3.2; R Foundation for Statistical Computing, Vienna, Austria).

RESULTS

A total of 292 residential aged care facilities (12,319 residents) participated in the 2017 acNAPS. Of these, 352 residents had ≥1 possible or confirmed infection, and 1,092 were prescribed ≥1 antimicrobial on the survey date. Characteristics of participating facilities are summarized in Table 1. More than two-thirds of facilities were located within a single Australian jurisdiction (Victoria). Most surveyed facilities were government operated and located in nonmetropolitan areas. Across all facilities, the median proportion of residents aged ≥85 years was 57.7%. The median proportion of male residents was 33.3%.

Overall infection prevalence was 2.9% (95% confidence interval [CI], 2.6%-3.2%), whereas the prevalence of antimicrobial prescribing was 8.9% (95% CI, 8.4%-9.4%). Excluding topical and antiviral prescriptions, the prevalence of antimicrobial prescribing was 6.2% (95% CI, 5.8%-6.7%). Figure 1 demonstrates the relationship between facility size and prevalence of infection and antimicrobial prescribing. Using 2 SDs from the mean threshold, 27 and 40 facilities were identified as outliers for infections and antimicrobial prescribing, respectively.

For infection prevalence, when outlier facilities (ie, those with higher infection prevalence) were compared with nonoutlying