Antibiotic use in residential aged care facilities

Ching Jou Lim, Rhonda L Stuart, David CM Kong

CPD

Background

High infection burden among the residential aged care facility (RACF) population has long been recognised; however, existing infection prevention effort is often limited to infection surveillance activity. There is a scarcity of evidence to guide antimicrobial stewardship in the Australian RACF setting.

Objective

This review summarises the current trends in antibiotic use and multi-drug resistant (MDR) organisms, challenges related to antibiotic prescribing and areas of suboptimal antibiotic prescribing for further improvement, particularly in the Australian RACF setting.

Discussion

There is widespread antibiotic prescribing in RACF, which may lead to the emergence of antibiotic resistance. Accordingly, there is an immediate need for judicious antibiotic use in this high-risk population to curb the rapid emergence of MDR organisms and other adverse consequences associated with inappropriate antibiotic use, as well as to reduce healthcare costs.

Keywords

antimicrobial drug resistance; homes for the aged

Residential aged care facilities (RACFs) are an important part of the healthcare system. With the rapid growth in the elderly population, there is a growing demand for access to RACFs. It has been estimated that approximately 6% of those aged over 65 years, and 30% of individuals over 85 years of age live in RACFs.[1] Most of the residents of RACFs are vulnerable to infections because of frailty, poor functional status, multiple comorbidities and compromised immune systems.[2,3] In addition, the close living proximity and frequent nurse–resident or resident–resident contact will facilitate the spread of organisms in the RACF setting.[2] This coupled with regular patient transfers between acute-care hospitals and RACFs further augments the infection burden among residents in RACFs, compared with community-dwellers.[4]

The clinical diagnosis of infection syndromes among RACF residents is challenging, due in part to the residents' atypical clinical presentation. The most common symptoms of infection among elderly residents are non-specific manifestations such as delirium, falls, functional decline and behavioural changes, in the absence of fever.[5] These atypical presentations can lead to delayed diagnosis, late initiation of empirical antibiotic therapy and poorer clinical outcomes. Not surprisingly, early antibiotic therapy is often preferred 'in case' RACF residents deteriorate,[6] which may lead to antibiotic initiation without confirmed infection. Difficulties in establishing symptoms, because of underlying resident cognitive impairment, language barriers and frequent turnover of nursing staff in RACFs, further complicate the decisions for antibiotic prescribing.[7]

Occurrences of infectious syndromes in the absence of on-site diagnostic facilities or timely expert support have been reported to result in the frequent transfer of RACF residents to acute-care hospitals.[8] A population-based study in Western Australia reported that one-quarter of RACF residents were transferred to hospital because of infection, incurring inpatient

costs of approximately $12.1 million over 2 years.[9] Furthermore, the frequent referral of RACF residents to hospitals has also been shown to be associated with poorer clinical outcomes.[10] Thus, these are reasons to encourage infection management within RACFs to avert hospital admission. Timely management of infectious syndromes, including prudent antibiotic prescribing, in the RACF setting is crucial to ensure optimal care of the residents. This article will provide a snapshot of surveillance of infections and MDR organisms in RACFs, antibiotic prescribing in RACFs, including areas of antibiotic prescribing that needed improvement, and the role of antimicrobial stewardship.

Surveillance of infections and MDR organisms in RACFs

In Australia, an integrated surveillance system for monitoring infections in RACFs, which would be useful to guide antibiotic prescribing and infection management, remains to be established.[11] Prior to 2011, there was a scarcity of published data describing the trends of infections in the Australian RACF setting. In 2011, Forrest et al reported an average baseline infection rate of 3.2 infections/1000 occupied bed days (OBDs) over a 9-year period (2001–2009) in five RACFs in Sydney.[12] A 6-month pilot study involving 30 RACFs in rural Victoria has shown a total reported infection rate of 3.6 infections/1000 OBDs, higher than the confirmed infection rate of 2.2 infections/1000 OBDs according to the McGeer criteria.[13] The marked difference between the two rates and the variation in reporting between RACF nursing staff and infection control consultants warrants further investigation.[14] Another local study by Lim et al reported that although the types and incidence rate of infection (3.2–4.6 infections/1000 OBDs) in Australian RACFs were comparable with overseas data (1.8–11.8 infections)/1000 OBDs),[15] the patterns of antibiotic use in Australian RACFs, compared with those abroad were different. This highlights the importance of understanding local epidemiology of infections and antibiotic use in the RACF setting.

RACFs are potentially an important reservoir for MDR organism transmission in the community. Frequent patient transfers between RACFs and acute-care hospitals can be a source for organism transmission in both directions. In the literature, there seems to be a shift in the epidemiology of MDR organisms in RACFs over the last decades. Generally, studies conducted in the 1990s and early 2000s reported that MDR Gram-negative bacilli (GNB) colonisation was less commonly observed when compared with methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE).[16-18] However, studies from the late 2000s have shown an emergence of MDR GNB; some studies highlight that MDR GNB colonisation rates far exceed those of MRSA and VRE.[19-21] The emergence of MDR GNB was not limited to asymptomatic carriage but also in clinical cultures for presumed infections.[22] Accordingly, there is a need to re-evaluate existing infection control strategies to focus on the emergence of MDR GNB in the RACF setting.

Of local relevance is the emerging trend with MDR GNB in Australian RACFs as reported by Stuart et al and Lim et al.[23, 24] Indeed, it is of concern that a cluster of carbapenem-resistant *Acinetobacter baumannii*, which has not been reported in the RACF setting elsewhere, was identified by Lim et al who conducted their study in four RACFs in Victoria.[24] Awareness of the emerging trend is pivotal to guide empirical antibiotic treatment among this high-risk population, and emphasises the importance of microbiological investigation to guide appropriate antibiotic use. Identifying risk factors for acquiring MDR organisms enables appropriate selection of empirical antibiotic therapy to optimise clinical outcomes.[25] Knowledge of the risk factors will also guide targeted infection control interventions to minimise the emergence or spread of MDR organisms.

Recent hospitalisation has been recognised to be independently associated with acquisition of MRSA[26,27] and VRE,[28,29] but was less commonly associated with MDR GNB colonisation. Prior exposure to antibiotics, particularly broad-spectrum antibiotics such as fluoroquinolones,[24,27] seems to be one of the most prominent risk factors associated with colonisation or infection with MDR Gram-positive and Gram-negative organisms in the RACF setting. In contrast to other age-related risk factors, such as presence of a wound or pressure ulcer and physical function deterioration (all of which are not modifiable to any great extent), reducing unnecessary or widespread use of antibiotics might be a more straightforward strategy to curb the rapid emergence of MDR organisms.

Antibiotic prescribing in RACFs

Widespread antibiotic prescribing is frequently reported in the RACF setting. Exposure to at least one course of antimicrobials occurs in 50–75% of RACF residents annually,[30,31] and more than one in 10 residents receive an antimicrobial at any given time.[32] Existing surveillance activities in Australian RACFs have focused mainly on monitoring infection rates; limited attention has been given to antibiotic use or resistance patterns.[11] Two single day point prevalence studies reported prevalence rates of 8–9% for antibiotic use,[33,34] whereas a longitudinal study has documented antibiotic use of 7.07 courses/1000 OBD in Australian RACFs.[15]

Interestingly, the patterns of antibiotic prescribing in RACFs vary across different countries, with prescribing patterns more comparable in studies conducted within the same country. For instance, the United States and Canadian RACFs commonly reported significant use of quinolones,[30,32] whilst other countries such as Australia showed lower use of these antibiotics.[15,33,34] The reduced prescribing of fluoroquinolones in Australia may be due to the reimbursement policy that restricts the indications for prescribing of these agents.[15] Similarly, the use of intravenous (IV) antibiotics can also be influenced by the policy or healthcare model of an individual RACF.

Table 1. Antibiotic prescribing in RACFs – areas of concern

Areas for potential antibiotic misuse	Evidence/reasons	Changes to be considered
Antibiotic therapy for asymptomatic bacteriuria[33,40,46]	• Strong evidence from several RCTs for not treating asymptomatic bacteriuria in institutionalised elderly patients, given the lack of treatment benefit[47] • Association with increased antibiotic resistance[48] • Asymptomatic bacteriuria is widespread among RACF residents with chronic indwelling urinary catheters but antibiotic therapy does not prevent recurrent bacteriuria nor symptomatic infection[49]	• Urinalysis and/or urine cultures should not be collected from asymptomatic patients • Nearly all chronically catheterised patients are bacteriuric;[50] thus, indwelling catheter should be changed prior to the initiation of antibiotic and a urine specimen collected from the newly placed catheter • Discontinuation of catheter use and proper aseptic technique in changing catheter are keys to prevent UTIs or other urinary complications[49]
Widespread use of prophylactic antibiotics for UTI[33,37,51]	• Inconclusive evidence for long-term urinary prophylaxis among institutionalised elderly patients in RACFs.[52] Prolonged antibiotic use in the absence of infection risk selecting for resistant organisms	• Other alternatives (eg cranberry products) could be considered before starting prophylactic antibiotic[53] • Long-term antibiotic prophylaxis is only recommended for women experiencing ≥2 symptomatic UTIs over a 6-month period or ≥3 episodes over a 12-month period, after an existing infection is eradicated[54]
Empirical antibiotic prescribing without microbiological investigation[38,44,46]	• Inappropriate empirical antibiotic prescribing is often associated with poorer clinical outcomes and may increase risk of mortality in some cases[55] • Causative agents should be identified, especially in symptomatic UTIs, to guide empirical antibiotic therapy	• Initiate empirical antibiotic therapy if infectious symptoms are of sufficient intensity that a delay of 2–3 days while waiting for culture results is not appropriate[7] • Proper documentation of previous antibiotic susceptibility results could guide emprical prescribing, when it is not possible to obtain a culture
Widespread antibiotic prescribing for URTI or acute bronchitis[46,56]	• Among the institutionalised elderly, URTIs are usually due to viral pathogens, where empiric antibiotic treatment is seldom necessary, unless these involve prolonged symptoms, or patients with pre-existing underlying lung diseases[7]	• Differentiation between viral and bacterial origin of presumed RTI is critical to reduce inappropriate antibiotic use • A minimum set of criteria regarding patient assessment and investigation should be followed prior to decisions on antibiotic therapy[7]
Prolonged duration of antibiotic treatment[30,57,58]	• Evidence that antibiotic courses of ≤7 days are as effective as longer treatment duration for most common bacterial infections[59] • Unnecessarily prolonged antibiotic treatments increase the risks for antibiotic resistance and side effects	• Prescribers to have access to aged care evidence-based antibiotic treatment guidelines (with recommendations about appropriate dosages and duration of therapy)[60] • All antibiotic treatment plans, particularly those via phone orders, should be properly documented in antibiotic ordering form with clear treatment indications and planned duration of treatment/cessation date[61]
Widespread prescribing of quinolones as empirical treatment for UTIs[42,43,62]	• Excessive use of quinolones is mainly due to their excellent bioavailability, long half-life and broad-spectrum activities which are suited for treatment of lower respiratory tract infection, as well as complicated UTIs.[63] • High rates of quinolone-resistant Gram-negative organisms have been reported in RACFs with high quinolone use[64]	• Avoid quinolones as first-line empirical therapy[7,60] • If a quinolone is prescribed, microbiological culture and sensitivity should be performed and treatment re-assessed
Broad-spectrum or parenteral antibiotic treatment for elderly residents with advanced dementia or end stage of illness[65,66]	• Some evidence indicating antibiotic therapy may be futile (ie did not prolong survival or reduce discomfort) for the end stages of life[67] • Other studies have reported that antibiotics relieve discomfort among dying patients[68,69]	• Aggressive antibiotic therapy for pneumonia in RACF residents with advanced dementia is contentious and may be best guided by advance care directives

RCTs, randomised controlled trials; RTI, respiratory tract infection; UTI, urinary tract infection; URTI, upper respiratory tract infection

Some facilities reported that 7–9% of antibiotics are administered parenterally,[35,36] whereas others showed <1% usage of IV therapy.[37,38] In Australia, administration of IV antibiotics is normally provided by specialised support from hospitals.

There has been little research exploring the factors responsible for the variation in antibiotic prescribing. Importantly, a population-based study involving 363 RACFs in Canada showed that variation in antibiotic prescribing did not seem to be driven by resident (clinical characteristics, infection burden, etc) nor facility-associated (size of RACF, institutional antibiotic policy, etc) factors; instead, it was influenced by the prescriber's preference.[30] These findings suggest that interventions to improve antibiotic use should focus on influencing antibiotic prescribing behaviour.

Appropriateness of antibiotic use and antimicrobial stewardship (AMS) in RACFs

About 40–75% of antibiotic use in RACFs has been considered inappropriate.[39–44] Indeed, two Australian studies reported that up to 40% of antibiotics prescribed are for episodes that did not meet the McGeer criteria.[15,34] It should be noted, however, that the McGeer criteria were developed for surveillance rather than as definitions to assist clinical decision making.[45] Thus, the criteria should be considered as conservative guidelines for assessing antibiotic use, and the data pertaining to 'inappropriate' antibiotic use based on these criteria should be interpreted with caution.

Identifying antibiotic prescribing patterns, particularly the areas of potential antibiotic misuse/overuse, is imperative to prioritise the allocation of resources for further AMS interventions in the RACF setting. Some areas of concern that warrant further investigation are highlighted in *Table 1*.

A recent Australian study has suggested that AMS interventions are needed to improve antibiotic use and deemed useful by all key stakeholder groups, including GPs, nursing staff and pharmacists.[61] Although there are practical organisational challenges to be overcome,[70] feasible AMS interventions applicable to the Australian setting have been proposed.[61] Fundamentally, AMS initiatives should commence with the least costly and intrusive approach, and more advanced measures should be added incrementally on the basis of available resources and institutional needs, with an aim to promote prudent antibiotic prescribing practices.

Conclusions and future directions

The need to optimise antibiotic use and prescribing through AMS programs in Australian RACFs is becoming critical given the increasing evidence of inappropriate antibiotic prescribing and the emergence of antibiotic resistance in this setting. Indeed, curbing widespread antibiotic prescribing will also prevent other adverse consequences associated with inappropriate antibiotic use such as development of *Clostridium difficile* infection, potential drug–drug interactions and side effects, and may possibly reduce healthcare costs. In the Australian setting, establishing clearer guidelines and models for AMS programs specifically targeting RACFs should be considered. Although there have been successful AMS initiatives from overseas settings, these have not been sufficiently explored within the Australian RACFs and should be trialled.

Authors

Ching Jou Lim BPharm, PhD, Lecturer, School of Pharmaceutical Sciences, Universiti Sains Malaysia, Penang, Malaysia

Rhonda L Stuart MBBS, FRACP, PhD, Infectious Diseases Physician, Monash Infectious Diseases, Monash Health, Clayton, VIC

David CM Kong BPharm, MPharm, PhD, Lecturer, Centre for Medicine Use and Safety, Monash University, Parkville, VIC. david.kong@monash.edu

Competing interests: David Kong has sat on Advisory Boards for Pfizer, Merck, Sharp and Dohme. He has also received funding for work unrelated to this article from Roche, Australian Unity, SHPA, Melbourne University, University Malaya, Dept of Health & Ageing, FRED, The Alfred, University Sains Malaysia.

Provenance and peer review: Commissioned, externally peer reviewed.

References

1. Australian Bureau of Statistics. Housing assistance: home care, hostels and nursing homes. Canberra: Commonwealth of Australia, 2006. Available at www.abs.gov.au/AUSSTATS/abs@.nsf/2f762f95845417aeca25706c00834efa/63378CA41AC510AECA2570EC00114198 [Accessed 16 December 2014].
2. Garibaldi RA. Residential care and the elderly: the burden of infection. J Hosp Infect 1999;43:S9–18.
3. Nicolle LE, Strausbaugh LJ, Garibaldi RA. Infections and antibiotic resistance in nursing homes. Clin Microbiol Rev 1996;9:1–17.
4. Ingarfield SL, Finn JC, Jacobs IG, et al. Use of emergency departments by older people from residential care: a population based study. Age Ageing 2009;38:314–18.
5. Jarrett PG, Rockwood K, Carver D, Stolee P, Cosway S. Illness presentation in elderly patients. Arch Intern Med 1995;155:1060–64.
6. Brown NK, Thompson DJ. Nontreatment of fever in extended-care facilities. N Engl J Med 1979;300:1246–50.
7. Nicolle LE, Bentley DW, Garibaldi R, Neuhaus EG, Smith PW. Antimicrobial use in long-term-care facilities. SHEA Long-Term-Care Committee. Infect Control Hosp Epidemiol 2000;21:537–45.
8. Barker WH, Zimmer JG, Hall WJ, Ruff BC, Freundlich CB, Eggert GM. Rates, patterns, causes, and costs of hospitalization of nursing home residents: a population-based study. Am J Public Health 1994;84:1615–20.
9. Calver J, Horner B, Boldy D, et al. The burden of infectious diseases in Western Australian residential aged care facilities: a population-based record linkage study. Australian Infection Control 2006;11:79–89.
10. Boockvar KS, Gruber-Baldini AL, Burton L, Zimmerman S, May C, Magaziner J. Outcomes of infection in nursing home residents with and without early hospital transfer. J Am Geriatr Soc 2005;53:590–96.
11. Cruickshank M, Ferguson J, editors. Reducing harm to patients from health care associated infection: the role of surveillance. Australian Commission on Safety and Quality in Health Care, 2008. Available at www.safetyandquality.gov.au/wp-content/uploads/2008/01/Reducing-Harm-to-Patient-Role-of-Surveillance1.pdf [Accessed 16 December 2014].
12. Forrest J, Tucker A, Brnabic AJM. A 9-year infection-control surveillance program in Sydney-based residential aged-care facilities. Healthcare Infection 2011;16:108–14.
13. Smith M, Bull AL, Richards M, et al. Infection rates in residential aged care facilities, Grampians region, Victoria, Australia. Healthcare Infection 2011;16:116–20.
14. Smith M, Bull AL, Dunt D, et al. Formative and process evaluation of a healthcare associated infection surveillance program in residential aged care facilities, Grampians region, Victoria. Healthcare Infection 2012;17:64–69.
15. Lim CJ, McLellan SC, Cheng AC, et al. Surveillance of infection burden in residential aged care facilities. Med J Aust 2012;196:327–31.

16. Pacio G, Visintainer P, Maguire G, Wormser GP, Raffalli J, Montecalvo MA. Natural history of colonization with vancomycin-resistant enterococci, methicillin-resistant *Staphylococcus aureus*, and resistant Gram-negative bacilli among long-term-care facility residents. Infect Control Hosp Epidemiol 2003;24:246–50.
17. Smith PW, Seip CW, Schaefer SC, Bell-Dixon C. Microbiologic survey of long-term care facilities. Am J Infect Control 2000;28:8–13.
18. Terpenning MS, Bradley SF, Wan JY, Chenoweth CE, Jorgensen KA, Kauffman CA. Colonization and infection with antibiotic-resistant bacteria in a long-term care facility. J Am Geriatr Soc 1994;42:1062–69.
19. March A, Aschbacher R, Dhanji H, et al. Colonization of residents and staff of a long-term-care facility and adjacent acute-care hospital geriatric unit by multiresistant bacteria. Clin Microbiol Infect 2010;16:934–44.
20. O'Fallon E, Schreiber R, Kandel R, D'Agata EM. Multidrug-resistant Gram-negative bacteria at a long-term care facility: assessment of residents, healthcare workers, and inanimate surfaces. Infect Control Hosp Epidemiol 2009;30:1172–79.
21. Pop-Vicas AE, Mitchell SL, Kandel R, Schreiber R, D'Agata EM. Multidrug-resistant Gram-negative bacteria in a long-term care facility: prevalence and risk factors. J Am Geriatr Soc 2008;56:1276–80.
22. O'Fallon E, Pop-Vicas A, D'Agata E. The emerging threat of multidrug-resistant Gram-negative organisms in long-term care facilities. J Gerontol A Biol Sci Med Sci 2009;64:138–41.
23. Stuart RL, Kotsanas D, Webb B, et al. Prevalence of antimicrobial-resistant organisms in residential aged care facilities. Med J Aust 2011;195:530–33.
24. Lim CJ, Cheng AC, Kennon J, et al. Prevalence of multidrug-resistant organisms and risk factors for carriage in long-term care facilities: a nested case-control study. J Antimicrob Chemother 2014;69:1972–80.
25. Drinka P, Niederman MS, El-Solh AA, Crnich CJ. Assessment of risk factors for multi-drug resistant organisms to guide empiric antibiotic selection in long term care: a dilemma. J Am Med Dir Assoc 2011;12:321–25.
26. Brugnaro P. Clustering and risk factors of methicillin-resistant Staphylococcus aureus carriage in two Italian long-term care facilities. Infection 2009;37:216–21.
27. Denis O, Jans B, Deplano A, et al. Epidemiology of methicillin-resistant Staphylococcus aureus (MRSA) among residents of nursing homes in Belgium. J Antimicrob Chemother 2009;64:1299–306.
28. Benenson S, Cohen M, Block C, et al. Vancomycin-resistant enterococci in long-term care facilities. Infect Control Hosp Epidemiol 2009;30:786–89.
29. Elizaga ML, Weinstein RA, Hayden MK. Patients in long-term care facilities: a reservoir for vancomycin-resistant Enterococci. Clin Infect Dis 2002;34:441–46.
30. Daneman N, Gruneir A, Bronskill SE, et al. Prolonged antibiotic treatment in long-term care: role of the prescriber. JAMA Intern Med 2013;173:673–82.
31. Richards C. Infections in residents of long-term care facilities: an agenda for research. Report of an Expert Panel. J Am Geriatr Soc 2002;50:570–76.
32. Pakyz AL, Dwyer LL. Prevalence of antimicrobial use among United States nursing home residents: results from a national survey. Infect Control Hosp Epidemiol 2010;31:661–62.
33. Smith M, Atkins S, Worth L, Richards M, Bennett N. Infections and antimicrobial use in Australian residential aged care facilities: a comparison between local and international prevalence and practices. Aust Health Rev 2013;37:529–34.
34. Stuart RL, Wilson J, Bellaard-Smith E, et al. Antibiotic use and misuse in residential aged care facilities. Intern Med J 2012;42:1145–49.
35. Broex E, Catry B, Latour K, et al. Parenteral versus oral administration of systemic antimicrobials in European nursing homes: a point-prevalence survey. Drugs Aging 2011;28:809–18.
36. Loeb MB, Craven S, McGeer AJ, et al. Risk factors for resistance to antimicrobial agents among nursing home residents. Am J Epidemiol 2003;157:40–47.
37. Blix H, Røed J, Sti M. Large variation in antibacterial use among Norwegian nursing homes. Scand J Infect Dis 2007;39:536–41.
38. Heudorf U, Boehlcke K, Schade M. Healthcare-associated infections in long-term care facilities (HALT) in Frankfurt am Main, Germany, January to March 2011. Euro Surveill 2012;17:pii:20256.
39. Jones SR, Parker DF, Liebow ES, Kimbrough RC 3rd, Frear RS. Appropriateness of antibiotic therapy in long-term care facilities. Am J Med 1987;83:499–502.
40. Loeb M, Simor AE, Landry L, et al. Antibiotic use in Ontario Facilities that provide chronic care. J Gen Intern Med 2001;16:376–83.
41. Moro ML, Mongardi M, Marchi M, Taroni F. Prevalence of long-term care acquired infections in nursing and residential homes in the Emilia-Romagna Region. Infection 2007;35:250–55.
42. Pettersson E, Vernby A, Mölstad S, Lundborg CS. Infections and antibiotic prescribing in Swedish nursing homes: a cross-sectional study. Scand J Infect Dis 2008;40:393–98.
43. Pickering TD, Gurwitz JH, Zaleznik D, Noonan JP, Avorn J. The appropriateness of oral fluoroquinolone-prescribing in the long-term care setting. J Am Geriatr Soc 1994;42:28–32.
44. Zimmer JG, Bentley DW, Valenti WM, Watson NM. Systemic antibiotic use in nursing homes. A quality assessment. J Am Geriatr Soc 1986;34:703–10.
45. Stone N, Ashraf M, Calder J, et al. Surveillance definitions of infections in long-term care facilities: revisiting the McGeer criteria. Infect Control Hosp Epidemiol 2012;33:965–77.
46. Warren JW, Palumbo F, Fitterman L, Speedie SM. Incidence and characteristics of antibiotic use in aged nursing home patients. J Am Geriatr Soc 1991;39:963–72.
47. Nicolle LE, Mayhew WJ, Bryan L. Prospective randomized comparison of therapy and no therapy for asymptomatic bacteriuria in institutionalized elderly women. Am J Med 1987;83:27–33.
48. Das R, Towle V, Van Ness PH, Juthani-Mehta M. Adverse outcomes in nursing home residents with increased episodes of observed bacteriuria. Infect Control Hosp Epidemiol 2011;32:84–86.
49. Nicolle LE, SHEA Long-Term-Care Committee. Urinary tract infections in long-term care facilities. Infect Control Hosp Epidemiol 2001;22:167–75.
50. Warren JW, Tenney JH, Hoopes JM, Muncie HL, Anthony WC. A prospective microbiologic study of bacteriuria in patients with chronic indwelling urethral catheters. J Infect Dis 1982;146:719–23.
51. Cotter M, Donlon S, Roche F, Byrne H, Fitzpatrick F. Healthcare-associated infection in Irish long-term care facilities: results from the first national prevalence study. J Hosp Infect 2012;80:212–16.
52. Lee BS, Bhuta T, Simpson JM, Craig JC. Methenamine hippurate for preventing urinary tract infections. Cochrane Database Syst Rev 2012;10:CD003265.
53. Beveridge LA, Davey PG, Phillips G, McMurdo ME. Optimal management of urinary tract infections in older people. Clin Interv Aging 2011;6:173–80.
54. Juthani-Mehta M. Geriatric Nephrology Curriculum: Chapter 32: Urinary tract infections in elderly persons. American Society of Nephrology p. 1–4.
55. Peralta G, Snchez MB, Garrido JC, et al. Impact of antibiotic resistance and of adequate empirical antibiotic treatment in the prognosis of patients with Escherichia coli bacteraemia. J Antimicrob Chemother 2007;60:855–63.
56. Vergidis P, Hamer D, Meydani S, Dallal GE, Barlam TF. Patterns of antimicrobial use for respiratory tract infections in older residents of long-term care facilities. J Am Geriatr Soc 2011;59:1093–98.
57. Daneman N, Gruneir A, Newman A, et al. Antibiotic use in long-term care facilities. J Antimicrob Chemother 2011;66:2856–63.
58. McClean P, Tunney M, Gilpin D, Parsons C, Hughes C. Antimicrobial prescribing in residential homes. J Antimicrob Chemother 2012;67:1781–90.
59. Lutters M, Vogt-Ferrier N. Antibiotic duration for treating uncomplicated, symptomatic lower urinary tract infections in elderly women. Cochrane Database Syst Rev 2008;3:CD001535.
60. Expert Group for Antibiotic. Antiobiotic: gastrointestinal tract infections: acute gastroenteritis: acute diarrhoea in special groups: travellers' diarrhoea. In: eTG Complete [Internet] Melbourne: Therapeutic Guidelines Ltd, 2014.
61. Lim CJ, Kwong MW-L, Stuart RL, et al. Antimicrobial stewardship in residential aged care facilities: need and readiness assessment. BMC Infect Dis 2014;14:410.
62. Mylotte JM. Measuring antibiotic use in a long-term care facility. Am J Infect Control 1996;24:174–79.
63. Ferrara AM. New fluoroquinolones in lower respiratory tract infections and emerging patterns of pneumococcal resistance. Infection 2005;33:106–14.
64. Viray M, Linkin D, Maslow JN, et al. Longitudinal trends in antimicrobial susceptibilities across long-term care facilities: emergence of fluoroquinolone resistance. Infect Control Hosp Epidemiol 2005;26:56–62.
65. Chen JH, Lamberg J, Chen YC, et al. Occurrence and treatment of suspected pneumonia in long-term care residents dying with advanced dementia. J Am Geriatr Soc 2006;54:290-95.
66. D'Agata E, Mitchell SL. Patterns of antimicrobial use among nursing home residents with advanced dementia. Arch Intern Med 2008;168:357–62.
67. Janssens JP, Krause KH. Pneumonia in the very old. Lancet Infect Dis 2004;4:112–24.
68. Givens J, Jones R, Shaffer M, Kiely DK, Mitchell SL. Survival and comfort after treatment of pneumonia in advanced dementia. Arch Intern Med 2010;170:1102–07.
69. Van Der Steen JT, Pasman HR, Ribbe MW, Van Der Wal G, Onwuteaka-Philipsen BD. Discomfort in dementia patients dying from pneumonia and its relief by antibiotics. Scand J Infect Dis 2009;41:143–51.
70. Lim CJ, Kwong MW-L, Stuart RL, et al. Antibiotic prescribing practice in residential aged care facilities – health care providers' perspectives. Med J Aust 2014;201:98–102.