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Long-term Care for Older Adults: Reservoirs of Methicillin-Resistant *Staphylococcus Aureus* and Vancomyin-Resistant *Enterococci*

D.F. Gilpin, PhD, *Research Fellow, School of Pharmacy, Queen's University, Belfast, Northern Ireland.*

M.M. Tunney, PhD, *Senior Lecturer, School of Pharmacy, Queen's University, Belfast, Northern Ireland.*

N. Baldwin, PhD, *Research Fellow, School of Pharmacy, Queen's University, Belfast, Northern Ireland.*

C.M. Hughes, PhD, *Professor, School of Pharmacy, Queen's University, Belfast, Northern Ireland.*

Methicillin-resistant Staphlyococcus aureus (MRSA) and vancomycin-resistant Enterococci (VRE) are responsible for substantial morbidity and mortality in acute care settings. Older residents in long-term care (LTC) facilities possess many of the risk factors for colonization with these antibiotic resistant bacteria, and the potential exists for both transmission, via transiently colonized staff, within LTC, and subsequent reintroduction into hospitals. Infection control policies in LTC are primarily based on those used in acute care and may not be appropriate for this unique environment. Studies to determine which infection control procedures are effective at reducing the prevalence and transmission of MRSA and VRE in LTC are required.

Key words: *long-term care, MRSA, VRE, colonization, infection control*

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Introduction

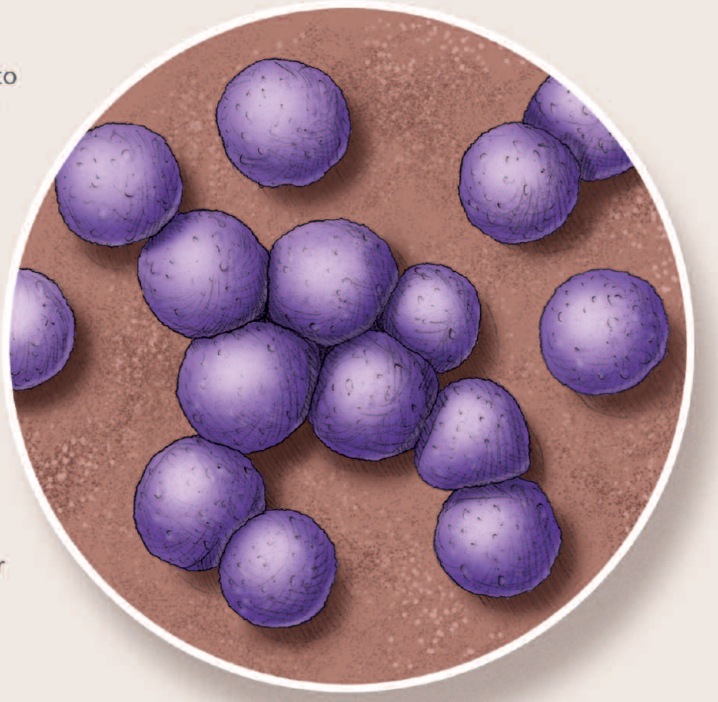
Antibiotic-resistant bacteria represent a challenge to health care facilities worldwide.[1] Treatment options for infections caused by these pathogens are limited, resulting in increased morbidity, mortality, and associated health care costs. Of particular concern are methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant *Enterococci* (VRE). Colonization by these organisms (meaning the presence and multiplication of organisms without tissue invasion or clinical signs of infection) is considered to be the precursor of invasive infection.[2] Furthermore, colonized patients can act as a source of transmission of the bacteria to other potentially more susceptible patients, perhaps by the hands of transiently colonized health care workers (HCWs) or through acquisition from a contaminated environment (Figure 1).[3]

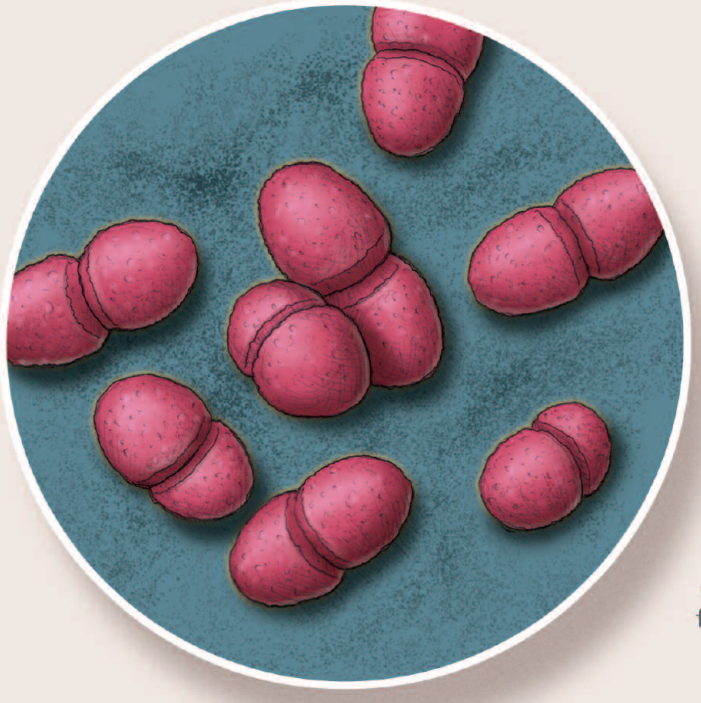
Risk factors associated with colonization by antibiotic resistant bacteria are shown in Table 1.[4] In addition to their age, older residents in long-term care may have one or more of these risk factors. Therefore, facilities providing long-term care (LTC) to older residents can be reservoirs for these organisms, with potential for reintroduction back into the hospital, when affected residents require hospital treatment, or into the wider community.[5–7] Although many infection control procedures aimed at reducing the prevalence and transmission of MRSA and VRE have been implemented and assessed in acute care facilities, these are not always appropriate to the care home setting. Within this unique environment, care providers have to balance the medical needs of their residents with maintaining a homelike environment. For the purposes of this review, LTC is defined as a facility that provides rehabilitative, restorative, and/or ongoing skilled nursing care to older patients or residents in need of assistance with activities of daily living. This includes nursing and residential homes, and studies conducted in Veterans Affairs Centres, where the average age of patients was over 65 years old. This review summarizes the current state of knowledge of VRE and MRSA in long-

Figure 1:
Methicillin-Resistant *Staphylococcus Aureus* and Vancomyin-Resistant *Enterococci*

Methicillin-Resistant *Staphylococcus*

- Older people living in LTC were more likely to be colonized than their independently living counterparts
- Increased duration of colonization also correlates to both increased risk of infection and increased opportunity for transmission.
- As potentially more aggressive strains of MRSA are observed in hospitals and associated with outbreaks in the community, there are increasing reports of their spread in care homes
- Although staff colonization may be transient, it provides an opportunity for MRSA dissemination and may be a risk factor for colonization among residents in LTC





Vancomyin-Resistant *Enterococci*

- Most commonly colonizes the gastrointestinal tract although a significant proportion of patients are also skin colonized.
- Environmental contamination has also been described, particularly with individuals who are fecally incontinent. Therefore the potential exists for VRE transmission within LTC.
- Hands of staff are the primary source for the spread of infection

term care for older people, discusses routes of transmission and dissemination of these pathogens, and suggests measures for their control.

Vancomycin-resistant *Enterococci* in Long-Term Care for Older People

Increased risk of VRE colonization is clearly associated with increased age, and residents of LTC are significantly more likely to carry VRE than the younger, community-dwelling population.[8,9] Studies on the prevalence of VRE among older residents in LTC are divided into those that determined prevalence on admission to acute care settings (45%),[10] or directly in the care home (3–22%), as shown in Figure 2(a).[8,9,11–13] A recent report (2006) from the Canadian Nosocomial Infection Surveillance Programme (CNISP) (http://www.phac-aspc.gc.ca/nois-sinp/reports-rapport/vre-erv06_result-eng.php), determined that 3% of health-care associated VRE-positive cultures, identified on admission to hospital, were associated with LTC. Although there may have been a selection bias towards more acutely ill patients when determining VRE prevalence on admission to acute care settings, the potential for spread of VRE from LTC to the hospital was evident. Furthermore, VRE-colonized patients admitted from LTC facilities were found to be significantly more likely to develop a subsequent bloodstream infection than those not admitted from LTC.[14] However, transfer of VRE between LTC and hospitals occurs in both directions. Trick *et al.* estimated that 85% of VRE isolates from 12 LTC facilities were related, and more than 75% of these patients had been admitted to acute care facilities in the previous 7 months.[15] In the absence of inter-LTC facility transfer, this suggests that the likely primary source of VRE was the acute care facility. There is less robust evidence for within facility transmission of VRE, with some studies suggesting a lack of transmission.[12,16] However, one study of an outbreak in a Canadian LTC facility did demonstrate intra-facility dissemination with a strain of VRE, not circulating in local hospitals.[17]

Although VRE most commonly colonizes the gastrointestinal tract, a significant proportion of patients are also skin colonized, and environmental contamination has also been described, particularly with individuals who are fecally incontinent.[18] Therefore the potential exists for VRE transmission within LTC. Furthermore, Mody *et al.*[19] isolated VRE from the hands of 9% of health care workers in LTC facilities, and it is widely recognized that the hands of staff are the primary source for the spread of infection.[20] However, the rate of VRE transmission appears to be lower than those of MRSA or resistant gram-negative bacteria. While this may reflect reduced transmission capacity of VRE compared to these organisms, the arrival of VRE in facilities may be a more recent event in comparison and may still be adapting to the long-term care environment.[21]

Efforts to reduce the spread of VRE have focused on active surveillance, implementation of infection control procedures, including good environmental hygiene, and control of antibiotic usage (Table 2).[22–24] This combined approach has also been shown to be effective in practice.[25] Although a widespread VRE screening policy may not be economically viable in LTC, targeted surveillance of at-risk groups was found to be a useful and cost-effective way to pre-empt subsequent VRE infections in acute care, and may be of benefit in LTC.[26] Although the eradication of gastrointestinal carriage of VRE is difficult to achieve,[27] daily bathing with chlorhexidine, instead of soap, has been reported to reduce the acquisition rate of VRE by 50% and the risk of VRE-colonized patients developing infection.[28]

Table 1: Risk Factors Associated with Colonization by Antibiotic-Resistant Bacteria

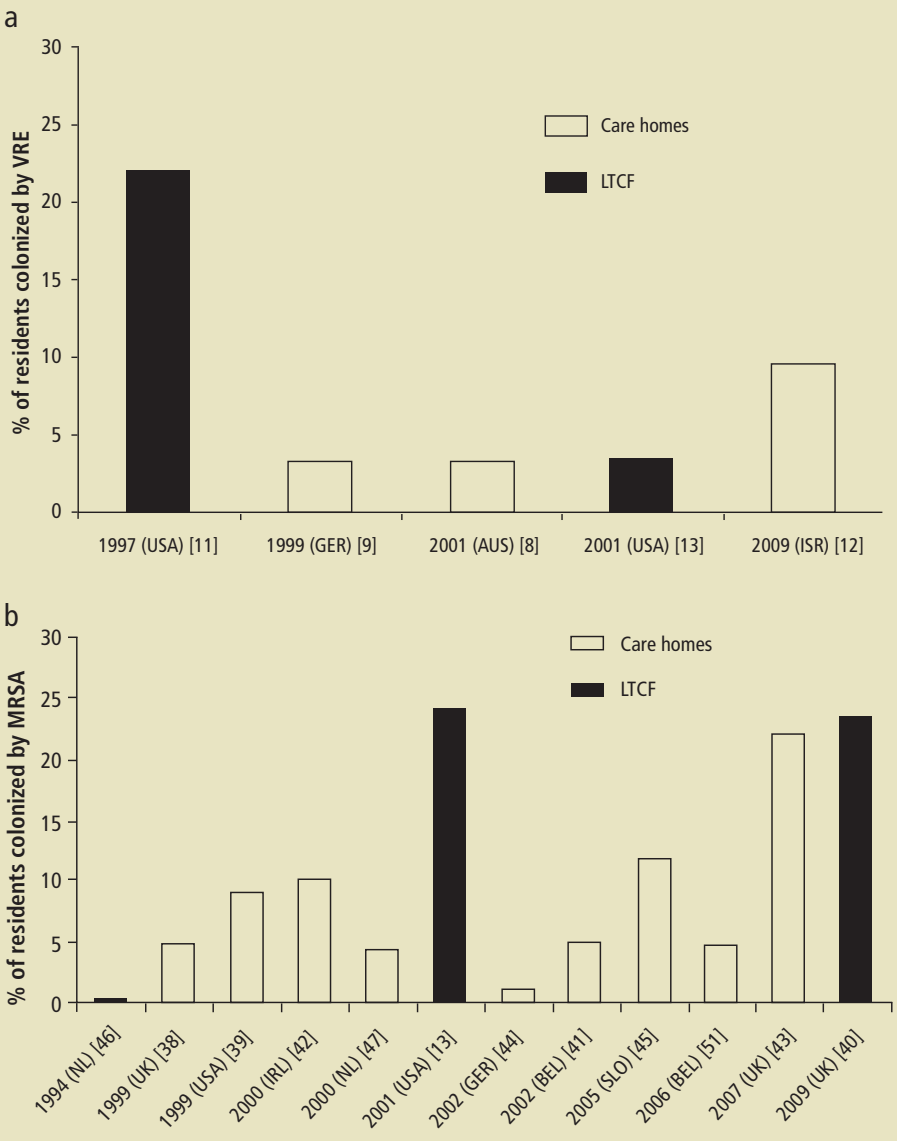
Increased age
Underlying burden of comorbidity
Antibiotic use
Presence of an indwelling device
Increased contact with the health care system.

Source: Niclaes L et al., 1999.[4]

Table 2: Practical Tips to Tackle MRSA and VRE in LTC Facilities

Prevention of acquisition:
Prudent use of antibiotics
Routine screening of staff and residents
In LTC facilities, good infection control leadership and improved infection control training of staff and caregivers
Continued dialogue between acute and long-term care, to ensure that information on colonized patients transferred between facilities is communicated effectively
Prevention of transmission:
Implement standard precautions
Consider implementation of contact precautions depending on individual's clinical situation and facility resources
Cohorting of infected or colonized residents
Environmental decontamination, particularly of frequently touched surfaces and any equipment in vicinity of patient
Decolonization of residents and staff: use of mupirocin and chlorhexidine

Figure 2: Prevalence of (a) VRE and (b) MRSA among Older Adults in Long-Term Care



The geographical locations are indicated for each, together with the references. The term "care homes" includes nursing and residential homes, and are mainly located in Europe; LTCF applies to facilities providing long term-care for older people in the USA.

There is also a need for more information and education regarding care of patients with VRE; for example, a study in Iowa indicated that more than 50% of facilities obtained culture samples from sites (e.g., nose or throat) not usually recommended swabs for culture of VRE. Furthermore, some institutions do not admit patients with VRE or MRSA, despite guidelines advising that adherence to proper infection control practices can limit the spread of these organisms.[29]

In patients who had been VRE positive, but who had cleared following treatment, antibiotic therapy was associated with recurrence of colonization in 62%, often due to relapse with the initial colonizing strain.[30] This was associated in particular with anti-anaerobic antibiotics (e.g., metronidazole) and vancomycin, both often used in the treatment of *Clostridium difficile*–associated diarrhea (CDAD).[31] The anti-anaerobic regimens result in overgrowth of intestinal VRE, leading to high-density VRE colonization of the intestine.[32,33] Skin and environmental contamination with VRE was common in VRE-colonized CDAD individuals treated with an anti-anaerobic regimen, resulting in increased potential for transmission.[34] Prudent antibiotic use, subsequent to VRE colonization, is therefore essential to prevent further dissemination of the bacteria.

MRSA in Long-term Care for Older People

Methicillin-resistant *Staphylococcus aureus* in LTC facilities was first reported in the 1980s.[35–37] Since then, the increasing prevalence has mirrored that observed in hospitals (0.15% in 1980, to 23.3% in 2009), as shown in Figure 2 (b).[13, 38–47] Although age has always been associated with increased likelihood of MRSA colonization, a clear association with care homes was demonstrated by Lee, *et al.*, who showed that older people living in LTC were more likely to be colonized than their independently living counterparts.[39] Methicillin-resistant *S. aureus* colonization may be intermittent or prolonged, which hampers accurate determination of prevalence rates.[42,48] Increased duration of colonization also correlates to both increased risk of infection and increased opportunity for transmission.[49,50]

As with VRE, the cycle of admission and discharge between acute and LTC facilitates the spread of MRSA in both settings. In 2007, 7% of MRSA identified in a CNISP study (2007) were associated with LTC (http://www.phac-aspc.gc.ca/nois-sinp/reports-rapport/mrsa-sarm_result-eng.php). With the high burden of MRSA colonization observed in acute care, it is not surprising that most MRSA isolated in care homes reflects that currently in circulation in nearby hospitals.[38,40,41,51] However, in contrast with VRE, these reports provide evidence for the dissemination of MRSA within this susceptible population. Furthermore, as potentially more aggressive strains of MRSA are observed in hospitals and associated with outbreaks in the

Key Points

Long term care for older adults can be a reservoir of antibiotic-resistant bacteria such as VRE and MRSA, with opportunity for transfer from this setting to acute care and to the general population.

Colonized individuals in long-term care are at increased risk of developing blood stream infections.

Staff carrying MRSA or VRE contribute to persistence and spread of the bacteria within long-term care, and can also transmit these bacteria to household contacts.

Opportunities exist for the transmission of VRE and MRSA via skin colonization of patients, staff carriage, and contaminated environments. There is a clear need for increased education and training of all LTC staff, and routine screening of these staff should be considered to reduce transmission and prevalence of MRSA, VRE, and other antibiotic-resistant bacteria.

community, such as those strains encoding the PVL-toxin, there are increasing reports of their spread in care homes.[52,53]

As with VRE, the role of colonized staff in the dissemination of MRSA in LTC has not been extensively studied. A recent study by our group conducted in nursing homes described a staff prevalence of 7%, and found residents were more likely to be colonized if the burden of staff colonization was greater.[40] Raab, *et al.* reported a similar finding, with 5.8% of staff colonized with PVL-MRSA, with the authors of both studies suggesting evidence of cross-transmission to LTC residents.[53] Eveillard *et al.* have also demonstrated cross-transmission of MRSA between patients and staff; this may result in persistent colonization, particularly among staff working in LTC and transmission to household contacts.[54] Although staff colonization may be transient, it provides an opportunity for MRSA dissemination and may be a risk factor for colonization among residents in LTC. To date, monitoring of staff for MRSA colonization is not included in strategies to control MRSA within LTC facilities.

Similar to VRE, high MRSA prevalence in LTC facilities has significant implications for reintroduction of MRSA back into acute care. Several studies have reported that a high prevalence of MRSA colonization among individuals admitted from LTC facilites contributed to high prevalence on admission wards.[54] Lesse, *et al.*, described an increase in *S. aureus* bacteraemia in acute care, which almost exclusively resulted from increased prevalence of MRSA among nursing home residents.[55] Methicillin-resistant *S. aureus* colonization is a marker of mortality in residents of LTC,[4,56,57] with this risk increased in residents with impaired cognitive function.[51] This may, in part, be due to differences in treatment choices for these patients, which may have led to a delay in hospital admission and subsequent administration of appropriate therapy.

Although policies exist in several countries detailing strategies aimed at prevention of MRSA in nursing homes, these are usually developed for all health care settings and are not specific to LTC. Various observational studies have described the implementation of infection control policies such as increased screening and surveillance, decolonization with mupirocin and chlorhexidine to reduce transmission,[58] compared the use of gloves and contact isolation in LTC.[59] However, to date, no high-quality studies have investigated the effect of interventions aimed at reducing the transmission of MRSA in LTC facilities.[60]

VRE and MRSA Co-Colonization: A Potential Threat?

The potential for increasing glycopeptide resistance among *S. aureus* (Methicillin sensitive and resistant strains), arising as a result of horizontal gene transfer from VRE in a background of increasing glycopeptide use, has been recognized since first reported in in vitro and clinical reports.[61,62] High-level resistance to vancomycin is encoded for by the vanA operon, and to date 12 *S. aureus* isolates, from the USA, India, and Iran have been described, most of which express high-level resistance to vancomycin and teicoplanin.[63]

S. aureus and VRE co-colonization of the intestine has been described as a frequent event, providing the opportunity for horizontal gene transfer.[64] Given that many residents in LTC possess multiple risk factors for colonization by one of these organisms, the LTC environment may provide an opportunity to be colonized by both. However, relatively few vancomycin-resistant *S. aureus* have been described. This is in part due to the high metabolic cost associated with acquisition of the vanA operon.[65] However, microbes are adept at overcoming such biological constraints, and constant surveillance is required to avoid widespread dissemination of MRSA strains that are resistant to virtually all antibiotics among a vulnerable population that is most likely to succumb to invasive infection.

Clinical Pearls

Improved infection control education and training is required for all LTC staff to reduce the prevalence and transmission of MRSA and VRE.

Prudent antibiotic prescribing among older people in LTC is necessary to prevent the development of antibiotic resistance.

Conclusion

Care homes for older adults clearly provide a reservoir for the dissemination of MRSA and VRE back into hospitals and into the wider community. While MRSA may spread within the care home to a greater extent than VRE, VRE –colonized patients are known to be at increased risk of colonization with other pathogens.[66] This is not surprising, since the risk factors for acquisition of many antibiotic-resistant bacteria are similar. Therefore there is the potential that breaking the cycle of transmission of one antibiotic resistant bacteria may limit the spread of others.

One potential mechanism of spread of these pathogens is via healthcare workers. Staff carriage in LTC has been demonstrated,[19,40] but current USA guidelines suggest that the role of health care workers in the transmission of antibiotic resistant organisms in health care settings may be limited (http://www.cdc.gov/ncidod/dhqp/guidelines.html). However, the available evidence does suggest that colonized staff are an important vector of transmission within the facility and to the wider community. Despite this finding, screening of staff to determine carriage of antibiotic resistant organisms is not included in the majority of infection control guidelines.

There is a need for further high-quality studies to determine which infection control or decolonzation strategies will be effective at reducing the prevalence of MRSA and VRE within the care home setting. Care homes are clearly established reservoirs of antimicrobial resistance, with transfer to the acute care setting and to a lesser extent, the community. From an acute care perspective, this constant external burden of colonization may thwart hospital-based infection control efforts. An integrated approach to surveillance and infection controls programs between long-term and acute care services may be required to limit further spread of antimicrobial resistance in both settings.

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