ORIGINAL ARTICLE ASIAN JOURNAL OF MEDICAL SCIENCES

Prevalence of methicillin-resistant *Staphylococcus aureus* in residents who died with pressure ulcers in residential aged care facilities

Catherine Anne Sharp

Founder and CEO, The Wound Centre, Sydney, Australia

Submission: 24-09-2023 Revision: 29-11-2023 Publication: 01-01-2024

ABSTRACT

Background: As mobility in the elderly declines, dependence on care increases, and that care involves preventing pressure ulcers (PUs). PUs may become colonized with methicillin-resistant *Staphylococcus aureus,* causing cross-infection problems and leading to sepsis and death. **Aims and Objectives:** The aim of this paper was to examine the prevalence of methicillin-resistant *S. aureus* in residents with PUs and consider regulations. **Materials and Methods:** A retrospective review of 80 records of residents aged ≥65 years from eight residential aged care facilities (RACFs) in Australia was undertaken. Records were reviewed for sex, age at death, source of admission, Stage of PU, and colonization with methicillin-resistant *S. aureus*. **Results:** A third of residents, 34% (95% confidence interval [CI] 25%–44%, 27/80), had PUs in the last week of life. Of residents admitted from hospital 13% (95% CI 9%–32%, 7/40) had PUs. Most (63%, 95% CI 44–78%, 17/27) residents with a PU had been admitted from hospital, and most PUs (78%, 95% CI 59–89%, 21/27) were open wounds, Stages 2–4. Half of all residents with a PU (48%, 95% CI 30–67%, 13/27) were colonized with methicillin-resistant *S. aureus,* and a third of residents with Stages 2–4 PUs (31%, 95% CI 13–58%, 4/13) were colonized with methicillin-resistant *S. aureus*. **Conclusion:** Nearly half of all PUs were colonized with methicillin-resistant *S. aureus,* suggesting PUs may be a reservoir for methicillin-resistant *S. aureus.* Regulations that could reduce PUs in RACFs "an air mattress appropriate to each care recipient's condition" are not being utilized. If PUs were prevented, reservoirs for methicillin-resistant *S. aureus* would be eradicated.

Key words: Pressure ulcers; Methicillin-resistant *Staphylococcus aureus*; Aged care

Access this article online

Website: http://nepjol.info/index.php/AJMS

DOI: 10.3126/ajms.v15i1.58777

E-ISSN: 2091-0576

P-ISSN: 2467-9100

INTRODUCTION

Pressure ulcers (PUs), also known as pressure injuries, decubitus ulcers, and bedsores, are among the most common adverse events in hospitals[1-5] and residential aged care facilities (RACFs).[2,5-7] Around 4,300 healthcare-associated PUs occur each year in Australia, with rates ranging from 9.8 to 28.9/10,000 hospitalizations.[4] The cost to the health system is about A$983 million per annum[8,9] yet PUs are considered largely preventable.[9,10]

The Clinical Practice Guideline for the Prevention and Management of Pressure Injury (2012), the "guide," is mandated for use in Australian RACFs by the Aged Care Quality and Safety Commission.[10] The "guide" recommends screening patients for PU risk "as soon as possible following admission and within a minimum of 8 h." These instructions for screening patients for PU risk fail to account for the speed at which PUs develop. Tissue death may begin at any time from ½ h[11] to 6 h of unrelieved pressure on any part of the body.[11-15] The evidence provided by Bliss[11] suggests that the current practice of not screening residents for 8 h adds to the risk of PUs. When busy staff is given the option of doing a task later rather than sooner, it usually results in the former option. Consequently, the 8-h screening window will not translate into good practice.

Address for Correspondence:
Catherine Anne Sharp, Founder and CEO, The Wound Centre, Sydney, Australia. **Mobile**: 61 0408121331. **E-mail:** info@thewoundcentre.com

If staff does not screen patients for the risk of PU within 8 h, it is more likely than not that PUs will develop. The key issue is whether 8 h of sitting or lying in one position predisposes to PU formation.[16]

It is not known whether any of the 4,300 "hospital-acquired" (HA)-PUs identified in Australia[4] were colonized with multi-resistant organisms (MROs) such as methicillin-resistant *Staphylococcus aureus*. Yet, around 3,800 HA-MROs occur each year in Australian hospitals, corresponding to 8.9–31.6 HA-MROs/10,000 admissions.[4]

Single-room isolation or cohorting has failed as an intervention to prevent the spread of methicillin-resistant *Staphylococcus aureus* (MRSA) when routinely practiced on surgical wards in one large Sydney teaching hospital.[17] Failure of isolation is complex; however, MRSA was never acquired by patients nursed in wards where an exclusion policy towards patients known to be colonized with MRSA was practiced.[17] Non-exclusion wards where cohorting or isolation was noted to have failed may have been due to poor hand hygiene compliance practices by health-care workers (HCWs) between patients.

Because there is a lack of evidence and resources to support MRSA isolation measures, the focus must be on a culture of safety that requires strategies to prevent harm and adverse events.[18]

Aims and objectives

The aims of this paper were to: (i) establish the prevalence of PUs in residents in eight RACFs; (ii) establish the prevalence of MRSA; and (iii) identify if there was an admission pattern. Considering risk-mitigation approaches that focus on the impact of potential adverse outcomes such as PUs and MRSA, this paper has used findings and regulations to inform policy and decision-making. These findings could be used to eliminate PUs, in turn eliminating reservoirs for colonization with MRSA and subsequent cross-infection. This paper will include dialogue relating to current regulations to prevent PUs.

MATERIALS AND METHODS

Sample

A retrospective review was made of a random selection of 80 records of residents aged ≥65 years who died between April 2011 and April 2014. This paper examined the source of admission (another RACF, home, or hospital), the presence of PUs in the last seven days of life, and the prevalence of MRSA-colonized PUs. Notes were examined for evidence of the presence of one or more PUs and evidence of MRSA.

As all residents in this research study were deceased, consent could not be obtained from the individuals, but lawful authorization for the research was provided by the University of New South Wales, Australia, Human Research Ethics Committee HC, number HC14163. The HREC approved data collection from 10 RACFs. The ethics committee agreed that consent was not required from the families of the deceased.

PUs

In this study, PU severity is categorized only as Stage 1 or Stage 2, even though there are four Stages and an unstageable category. Stage 1 is a PU described as "intact skin," "bruised, red and/or purple" and cannot be colonized with MRSA.

Stage 2 is described as "broken skin, an open wound and/or deep cavity, oozing pus." Stage 2 PUs range from small breaches in skin integrity to large reservoirs that can be colonized with MRSA. In this paper, Stage 2 includes Stages 3, 4, and unstageable PUs simply because nurses and care staff find it difficult to identify tissues such as fat, muscle, and bone. Therefore Stage 1, intact skin and Stage 2, open wound, seem to be the most sensible descriptions. Intact skin is not affected by MRSA whereas an open wound can become colonized very quickly and this can lead to infection, sepsis and death.

Statistical analysis

Data were entered onto a data collection spread sheet and exported into STATA SE version 14[19] for all statistical analyses. Descriptive statistics calculated included frequency and a 95% confidence interval (95% CI) around proportions. The frequency of PUs in residents that were documented as positive for MRSA colonization was examined for patterns of admission. International guidelines have previously been discussed, and in this paper, regulatory theory was selected as a mechanism for PU prevention, with the introduction of mandatory MRSA screening of all Stage 2 PUs as a possible mechanism for introducing patient safety in healthcare. Regulatory theory is relevant to this paper because PUs are preventable, and if prevented, one reservoir for the colonization of MRSA would be removed. For example, section 3 (item 3.2) of the Australian Quality of Care Principles 2014 (Cth) could be used to advance efforts to prevent PUs in RACFs by providing residents with "an air mattress appropriate to each care recipient's condition."

RESULTS

Twenty-seven percent (12/44) of residents who were transferred from hospital to a study RACF had a Stage

1 PU on admission, and 27% (12/44) had a Stage 2 PU. All (2/2) of the residents admitted from home with PUs were classified as stage 1, and 0% (0/2) of the residents transferred from another RACF were admitted with a PU. By the last week of life, 34% (95% CI 25–44%, 27/80) of all residents had a PU. Most (63%, 95% CI 44%–78%, 17/27) residents who had developed a PU by the last week of life were originally admitted from hospital. Most PUs in the last week of life (78%, 95% CI 59%–89%, 21/27) were Stage 2 PUs, and nearly half of all PUs (48%, 95% CI 30%–67%, 13/27) were colonized with MRSA. The site of colonization, for example, nares or axillae, was unknown (Table 1).

DISCUSSION

General guidelines for infection prevention

Methicillin-resistant *S. aureus* is most effectively transmitted from patient to patient after direct contact with healthcare providers.[20] For example, the hands of doctors or nurses may become colonized after caring for an MRSA-colonized or infected patient or a patient with a wound. If hand hygiene after contact is inadequate, the organism may be transmitted to other patients.[21]

Airborne transmission of MRSA in hospital settings has been found in aerosols while HCWs were undertaking routine care of patients, such as taking blood pressures and making beds.[22] Of the 99 air samples and 26 environmental settle samples collected, 29% (29/99) of the air samples and 19% (5/26) of the environmental settle samples were positive for MRSA.[22]

Residential aged care facility guidelines for infection prevention

Little is known about infection control policies and practices specifically for RACFs, except routine screening for MRSA or other HA-MROs is usually not required for new admissions to the RACF or readmission of residents from hospitals back to the RACF. Topics taught to RACF staff include standard precautions, cleaning, disinfection, personal protective equipment, and hand hygiene.[23] If hand hygiene, environmental cleaning, the wearing of gloves and gowns, and the cleaning of fomites such as sphygmomanometer cuffs are inadequate, HA-MROs may be transmitted to other residents.[24,25] Residents in RACFs have routine checks of general observations such as temperature, pulse, and blood pressure from time to time. Taking a resident's blood pressure involves wrapping a sphygmomanometer cuff around the upper arm. Usual nursing practice while performing blood pressure measurements includes moving from resident to resident using the same cuff to record blood pressure. Beard et al.,[24] demonstrated in 1969 that new sphygmomanometer cuffs became highly contaminated with pathogenic microorganisms soon after being introduced into wards at a large teaching hospital in Sydney. Beard et al. observed, "When such a potential source of sepsis is unrecognized the risks of transmission become magnified as no steps are taken to minimize them."[24] Forty-five years later, contamination with at least one species of bacteria was found in 85% of the 102 sphygmomanometer cuffs in the UK.[25] Zargaran et al., (2014) offered solutions to the threat of cross-infection from sphygmomanometer cuffs that must fulfill three criteria: (1) be an effective measure in removing the risk of patient-to-patient contamination; (2) offer a practical intervention; and (3) be cost-effective. The simplest solution would be to provide every resident with a single-patient-use cuff that remained with the resident for the duration of the stay and was disposed of on discharge or death.

Staff may also aerosolize MRSA while in close physical contact with MRSA-positive residents in RACFs, resulting in MRSA colonization. Colonization increases the risk of infection, especially on admission from a RACF into a hospital where residents may be cannulated for the purpose of taking blood, increasing the risk of bacteremia and death.[21] All patients discharged with a Stage 2 PU are, more likely than not, at increased risk of MRSA colonization.

A prospective swabbing survey of inanimate objects in the rooms of patients with MRSA in a 200-bed

Table 1: Prevalence of PUs, Stage 1 PUs, Stage 2 PUs, and MRSA among RACF residents

Residents	Residents transferred from hospital	Residents transferred from home	Residents transferred from another RACF	Residents in last week of life
Total residents	44	2	2	80
PU prevalence	54% (24/44)	100% (2/2)	0% (0/2)	34% (27/80) (CI: 44–78%)
Stage 1 PU	50% (12/24)	100% (2/2)	0% (0/2)	22% (6/27) (CI: N/A)
Stage 2 PU	50% (12/24)	0% (0/2)	0% (0/2)	78% (21/27) (CI: 59–89%)
PU colonized with MRSA	N/A	N/A	N/A	48% (13/27) (CI: 30–67%)

PU: Pressure ulcer, RACF: Residential aged care facility, MRSA: Methicillin-resistant *Staphylococcus aureus*, CI: Confidence interval

university-affiliated teaching hospital reported that 85% (23/27) who had MRSA in a wound or their urine had contaminated surfaces in their rooms.[26] Fewer patients (36%, 4/11) who had MRSA in sputum, blood, or conjunctivae had contaminated surfaces in their rooms. However, residents with Stage 2 PUs colonized with MRSA have a high probability of contaminating the environment of the RACF and that of a hospital during admission.

Regulation for PU prevention

Regulation is broadly defined as the imposition of rules by the government and backed by the use of penalties that are intended specifically to modify the economic behavior of individuals and firms in the private sector.[27] Governments have a broad range of regulatory schemes reflecting the complex and diverse needs of their citizens, communities, and economies.[27] Consistent with public health principles, risk-based regulation may be used to prevent PUs by enforcing and improving the regulatory instruments that require providers to prevent PUs by providing residents with an alternating pressure air mattress (APAM). Pressure relief provided by an APAM has been shown to prevent PUs,[11,14,28] yet these are rarely used. This is clear in this report, where just over a third (34%, 27/80) of residents aged ≥65 years died with one or more PUs, and 78% (21/27) of PUs were Stage 2 open wounds. No resident identified as being at risk of a PU was provided with an APAM prior to the development of PUs, despite regulatory tools that should have been used in the interest of PU prevention.

What this study adds

Most of the PUs colonized with MRSA were identified in residents with a PU who had been admitted to a study RACF from a hospital. The prevalence of MRSA colonization in all residents' body sites other than PUs, such as nares, axillae, or rectal swabbing, in residents in the eight RACFs was not analyzed because most documentation in the notes was given as "MRSA+ve" without documentation of the site of colonization. Therefore, only residents with Stage 2, open-wound PUs, were examined for colonization.

PUs are becoming colonized and/or infected with multidrug-resistant organisms with increasing frequency. There are important differences between Stage 1 and all other Stages of PU. The intact skin of a Stage 1 PU will resist colonization with MRSA because MRSA resides in open wounds, mucous membranes, and blood. PUs, which are open wounds, therefore provide a major reservoir for MRSA colonization. Of the residents in this survey with a Stage 2 PU, 31% (4/13) were MRSA-positive. Stage 2 PUs require wound dressing changes, which increases the likelihood of cross-transmission where the clinician's hand hygiene may be poor. Hand hygiene compliance has not been evaluated in RACFs in this study.

Transferring patients to a RACF from hospital rather than back into their home was associated with increased PU risk on admission to a RACF.[29] Screening and swabbing PUs for MRSA is not yet a routine practice for RACF residents admitted from hospital, and there may be no policies for screening residents admitted from home or another RACF. As RACF nurses told this researcher, 'We don't bother swabbing anymore because they are probably all colonized with MRSA, and what are we going to do if they are positive? We can't isolate them!'

Prevention practices such as these for residents who may reside in RACFs anywhere from 38 days to 3,459 days, as in this study, are difficult, costly, and not necessary because PUs can be easily prevented.[28]

The prevention of MRSA used in hospitals is the same as for all *S. aureus* strains and includes good patient hygiene, HCWs' strict adherence to hand hygiene, and gloves and gowns for wound care.

PUs and MRSA are two common conditions identified in patient safety surveys and may be inextricably linked, but there is a lack of research evaluating the effects on MRSA transmission of infection prevention and control strategies.

Future research could include the examination of admissions to hospitals from RACFs and readmissions into RACFs for new MRSA colonization.

The prevention of PUs would eradicate a reservoir for the colonization of MRSA. By focusing regulatory standard-setting and enforcement activity to reduce the development of PUs and screening PUs for MRSA, we may reduce the cycle of PU colonization and cross-infection. In addition, a greater uptake of evidence-based preventive PU practices is required in hospital settings, irrespective of people's clinical needs.

Limitations of the study

A limitation of this paper is the lack of examination of the regulations, including screening for MRSA and the actual body site of colonization. The sample size produced wide confidence limits for the MRSA colonization rate in Stage 2 PUs (95% CI 30–67%, 13/27). Confidence limits were not calculated for Stage 1 PUs in residents in the last week of life. However, even the lower limit, 30%, indicates a high proportion of residents with Stage 2 PUs were colonized with MRSA, while the possible upper estimate of 67% indicates the risk of colonization may be endemic.

The small sample size limitation could not be overcome using the method chosen to acquire data. Because residents are not routinely screened on admission to RACFs, it was

not possible to compare the risk of MRSA colonization in residents with and without PUs, nor was it possible to determine the source of MRSA from the notes. It is likely that residents were transferred between RACFs and hospitals many times over the years of residency because of their age-related co-morbidities. However, it is not known whether the study group was admitted to hospital within 12 months of admission to a study RACF when colonized with MRSA continued to test positive. Nor was it known whether residents admitted from home or another RACF had been hospitalized. This limitation exists because there is no access to hospital medical records.

CONCLUSION

Residential aged care facilities are invaluable for the care of the elderly but may, unintentionally, provide an environment that could promote the acquisition and spread of MRSA.

The elderly residents in the eight RACFs studied were at risk of PUs and MRSA colonization of their PUs. Providing residents at risk of PUs with APAMs may prevent PUs and prevent a reservoir for colonization.

ACKNOWLEDGMENT

I thank all the nurses and care staff without whose knowledge and enthusiasm none of this would have been written.

REFERENCES

1. Braga IA, Pirett CC, Ribas RM, Filho PP and FilhoAD. Bacterial colonization of pressure ulcers: Assessment of risk for bloodstream infection and impact on patient outcomes. J Hosp Infect. 2013;83(4):314-320.
   https://doi.org/10.1016/j.jhin.2012.11.008
2. Tsokos M, Heinemann A and Puschel K. Pressure sores: Epidemiology, medico-legal implications and forensic argumentation concerning causality. Int J Legal Med. 2000;113(5):283-287.
   https://doi.org/10.1007/s004149900125
3. Sharp C, Burr G, Broadbent M, Cummins M, Casey H and Merriman A. Pressure ulcer prevention and care: A survey of current practice. J Qual Clin Pract. 2000;20(4):150-157.
   https://doi.org/10.1046/j.1440-1762.2000.00384.x
4. Australian Commission on Safety and Quality in Health Care. Hospital-acquired Complication. Sydney: Australian Commission on Safety and Quality in Health Care; 2018.
5. Clinical Excellence Commission. 2019, 2018 NSW Pressure Injury Point Prevalence Survey Report, Sydney: Clinical Excellence Commission; 2019.
6. Bowblis JR and Ghattas A. The impact of minimum quality standard regulations on nursing home staffing, quality, and exit decisions. Rev Ind Organ. 2017;50(1):43-68.
   https://doi.org/10.1007/s11151-016-9528-x
7. Yap TL, Kennerly SM and Kao L. Pressure injury prevention: Outcomes and challenges to use of resident monitoring technology in a nursing home. J Wound Ostomy Continence Nurs. 2019;46(3):207-213.
   https://doi.org/10.1097/WON.0000000000000523
8. Nguyen KH, Chaboyer W and Whitty JA. Pressure injury in Australian public hospitals: A cost-of-illness study. Aust Health Rev. 2015;39(3):329-336.
   https://doi.org/10.1071/AH14088
9. Gillespie BM, Walker RM, Latimer SL, Thalib L, Whitty JA, McInnes E, et al. Repositioning for pressure injury prevention in adults. Cochrane Database Syst Rev. 2020;6(6):CD009958.
   https://doi.org/10.1002/14651858.cd009958.pub3
10. Aged Care Quality and Safety Commission. Guidance and Resources for Providers to Support the Aged Care Quality Standards. Aged Care Quality and Safety Commission; 2018.
11. Bliss MR. Death due to a pressure sore. Was the Coroner's verdict 'lack of care' justified? J Tissue Viability. 1994;4(1):10-13.
   https://doi.org/10.1016/s0965-206x(14)80233-7
12. Linder-Ganz E and Gefen A. The effects of pressure and shear on capillary closure in the microstructure of skeletal muscles. Ann Biomed Eng. 2007;35(12):2095-2107.
   https://doi.org/10.1007/s10439-007-9384-9
13. Gefen A. How much time does it take to get a pressure ulcer? Integrated evidence from human, animal, and *in vitro* studies. Ostomy Wound Manage. 2008;54(10):26-28, 30-35.
14. Exton-Smith AN, Overstall PW, Wedgwood J and Wallace G. Use of the 'air wave system' to prevent pressure sores in hospital. Lancet. 1982;1(8284):1288-1290.
   https://doi.org/10.1016/s0140-6736(82)92851-3
15. Peterson MJ, Gravenstein N, Schwab WK, van Oostrom JH and Caruso LJ. Patient repositioning and pressure ulcer risk--monitoring interface pressures of at-risk patients. J Rehabil Res Dev. 2013;50(4):477-488.
   https://doi.org/10.1682/jrrd.2012.03.0040
16. Sharp CA and White RJ. Pressure ulcer risk assessment: Do we need a golden hour. J Wound Care. 2015;24(5):237.
   https://doi.org/10.12968/jowc.2015.24.5.237
17. Barakate MS, Yang YX, Foo SH, Vickery AM, Sharp CA, Fowler LD, et al. An epidemiological survey of methicillin-resistant *Staphylococcus aureus* in a tertiary referral hospital. J Hosp Infect. 2000;44(1):19-26.
   https://doi.org/10.1053/jhin.1999.0635
18. Nicholson L. Healthcare-associated infections: The value of patient isolation. Nurs Stand. 2014;29(6):35-44.
   https://doi.org/10.7748/ns.29.6.35.e8789
19. StataCorp. Stata Statistical Software: Release 14. College Station, TX; 2015. Available from: https://www.stata.com/support/faqs/resources/citing-software-documentation-faqs [Last accessed on 2018 Dec 26].
20. Roghmann MC, Lydecker A, Mody L, Mullins CD and Onukwugha E. Strategies to prevent MRSA transmission in community-based nursing homes: A cost analysis. Infect Control Hosp Epidemiol. 2016;37(8):962-966.
   https://doi.org/10.1017/ice.2016.96
21. Simor AE, Augustin A, Ng J, Betschel S and McArthur M. Control of MRSA in a long-term care facility. Infect Control Hosp Epidemiol. 1994;15(2):69-70.
   https://doi.org/10.1086/646861
22. Beckingham W, Senanayake S, Collignon P and McKenzie G. Is methicillin-resistant *Staphylococcus aureus* aerosolized when healthcare workers carry out activities for patients? Healthc

Infect. 2008;13(3):77-82.
https://doi.org/10.1071/HI08025

23. Australasian College for Infection Prevention and Control. Infection Prevention and Control in Residential Aged Care. Australia: Australasian College for Infection Prevention and Control; 2012.
24. Beard MA, McIntyre A and Rountree PM. Sphygmomanometers as a reservoir of pathogenic bacteria. Med J Aust. 1969;2(15):758-760.
https://doi.org/10.5694/j.1326-5377.1969.tb107383.x
25. Zargaran D, Hardwick S, Adel R, Hill G, Stubbins D and Salmasi AM. Sphygmomanometer cuffs: A potential source of infection! Angiology. 2014;66(2):118-121.
https://doi.org/10.1177/0003319714522855
26. Boyce JM, Potter-Bynoe G, Chenevert C and King T. Environmental contamination due to methicillin-resistant *Staphylococcus aureus*: Possible infection control implications. Infect Control Hosp Epidemiol. 1997;18(9):622-627.
27. OECD. The Governance of Regulators, OECD Best Practice Principles for Regulatory Policy. Paris, France: OECD Publishing; 2014.
28. Sharp CA and Campbell J. Preventing pressure ulcers in aged care by auditing, and changing, work practices. Asian J Med Sci. 2022;13(4):191-195.
https://doi.org/10.3126/ajms.v13i4.41855
29. Sharp CA, Moore JS and McLaws ML. Two-hourly repositioning for prevention of pressure ulcers in the elderly: Patient safety or elder abuse? J Bioeth Inq. 2019;16(1):17-34.
https://doi.org/10.1007/s11673-018-9892-3

Authors' Contributions:
Catherine A Sharp collected all data, performed statistical analysis and wrote this paper.

Work attributed to:
Catherine A Sharp Founder & CEO The Wound Centre.

Orcid ID:
Catherine Anne Sharp - https://orcid.org/0000-0002-4266-8493

Source of Support: Nil, **Conflicts of Interest:** None declared.