Clinical significance of methicillin-resistant
Staphylococcus aureus colonization in residents in
community long-term-care facilities in Spain

A. MANZUR1*, E. RUIZ DE GOPEGUI2, M. DOMINGUEZ3, D. MARISCAL4,
L. GAVALDA5, J. L. PEREZ2, F. SEGURA6, M. PUJOL1 AND the Spanish Network for
Research in Infectious Diseases†

1 Infectious Diseases Service, 3 Microbiology Service and 5 Preventive Medicine Hospital Universitari de
Bellvitge, Barcelona, Spain
2 Microbiology Service Hospital Universitari Son Dureta, Balearic Islands, Spain
6 Infectious Diseases Service and 4 Microbiology Service, Corporacio` Sanitaria Parc Tauli, Barcelona, Spain

(Accepted 17 March 2011; first published online 28 April 2011)

SUMMARY
Methicillin-resistant Staphylococcus aureus (MRSA) is highly prevalent in Spanish hospitals and
community long-term-care facilities (LTCFs). This longitudinal study was performed in
community LTCFs to determine whether MRSA colonization is associated with MRSA infections
and overall mortality. Nasal and decubitus ulcer cultures were performed every 6 months for an
18-month period on 178 MRSA-colonized residents (86 490 patient-days) and 196 non-MRSA
carriers (97 470 patient-days). Fourteen residents developed MRSA infections and 10 of these were
skin and soft tissue infections. Two patients with respiratory infections required hospitalization.
The incidence rate of MRSA infection was 0.12/1000 patient-days in MRSA carriers and
0.05/1000 patient-days in non-carriers (P = 0.46). No difference in MRSA infection rate was found
according to the duration of MRSA colonization (P = 0.69). The mortality rate was 20.8% in
colonized residents and 16.8% in non-carriers; four residents with MRSA infection died. Overall
mortality was statistically similar in both cohorts. Our results suggest that despite a high
prevalence of MRSA colonization in LTCFs, MRSA infections are neither frequent nor severe
while colonized residents remain at the facility. The epidemiological impact of an MRSA reservoir
is more relevant than the clinical impact of this colonization for an individual resident and
supports current recommendations to control MRSA spread in community LTCFs.

Key words: Epidemiology, geriatrics, long-term care, MRSA, MRSA infections, multiresistant
microorganism, nursing homes, S. aureus.

INTRODUCTION
Methicillin-resistant Staphylococcus aureus (MRSA) has a high prevalence in acute-care hospitals in Spain,
and also in long-term-care facilities (LTCFs) [1–3]. This scenario is similar to other countries of the
European Union [4–8]. In the nosocomial setting patients with persistent MRSA carriage have a higher
risk of developing MRSA infections [9, 10] than methicillin-susceptible S. aureus (MSSA) carriers and
non-carriers. Although, it appears that MRSA colonization in LTC settings might have different clinical
implications than in acute-care hospitals, few studies
have addressed this issue and most report a low prevalence of MRSA infection in residents [11, 12]. A relatively small number of residents require hospitalization or die as a consequence of MRSA infections and this suggests that severe infections are uncommon in this population. The most frequent MRSA infections in LTCFs are skin and soft tissue infections while bloodstream infections account for about 10% of cases [13].

Very few longitudinal studies have investigated the incidence of MRSA infections in residents in LTCFs [12, 14]. We therefore considered it necessary to analyse the clinical impact of MRSA colonization in this population in order to identify suitable measures to prevent spread and infections due to MRSA in this setting. To this end a multicentre longitudinal study was performed among residents in community LTCFs to determine the incidence of MRSA infection and assess whether MRSA colonization is associated with greater risk of infection and overall mortality.

METHODS

Study population and characteristics of community LTCFs

Characteristics of this population have been described previously [2]. Nine community LTCFs for the elderly, located in two communities in Spain (Catalonia and Balearic Islands) with 1586 beds (median 120, range 72–552) were included. Five were located in the catchment area of a 900-bed acute-care hospital (Hospital Universitari de Bellvitge), three in that of a 490-bed hospital (Corporació Sanitària Parc Taulí) and one in that of an 800-bed hospital (Hospital Universitari Son Dureta). These facilities provide care for the elderly long-term resident, who may be disabled or infirm. Each LTCF has a dementia ward and its own medical staff. Residents are accommodated in rooms with up to three beds. Surveillance for MRSA and decolonization procedures are not routine. In addition to standard precautions for all patient care, contact precautions are applied for residents colonized or infected by MRSA. Known MRSA carriers are not denied admission [15].

Study design

This was a multicentre prospective cohort study conducted from November 2005 to May 2007. The studied population consisted of all residents in the LTCFs at baseline (n = 1377) and was identical to that of our previously published cross-sectional study [2]. A total of 231 residents was found to be colonized with MRSA at baseline (MRSA carriers cohort). A representative sample of non-MRSA carriers was selected from the 1146 residents without MRSA at baseline as follows: for each MRSA carrier identified, one non-MRSA carrier was randomly selected from the same ward and screened 6 months later. Those with two consecutive negative cultures were included in the non-MRSA carrier cohort (n = 196). Subjects were visited by the investigators every 6 months over an 18-month period.

During this period no changes were made to infection control practices in the LTCFs and data from the study results were not available to clinical staff. Decolonization treatment or contact precautions were not applied to the MRSA carriers detected throughout the study.

Data collection and definitions

Complete clinical data were obtained for all residents at baseline and medical charts were reviewed thereafter at 6-monthly intervals. Occurrences of infections, decubitus ulcers, antibiotic use, hospital admission and deaths were recorded. In the MRSA carrier cohort, persistent colonization was defined as at least two MRSA-positive cultures separated by fewer than two negative cultures. Transient colonization was defined as two or more negative cultures after a single positive culture for MRSA [16]. Duration of carriage was defined as the period from the first positive culture until the first negative culture with a consecutive negative culture if available and only residents who survived at the end of the study were considered for this analysis. MRSA infection was recorded in the clinical charts of each facility.

Microbiological methods

Nasal, and where applicable, decubitus ulcer swabs were obtained for culture every 6 months. Swabs were placed in Stuart’s transport medium and plated on coagulase-mannitol agar plates and selective MRSA agar (MRSA Select, Bio-Rad Laboratories, Spain) before inoculating into brain heart infusion plus 7% NaCl. After 24 h of incubation at 35 °C, broths were subcultured on coagulase-mannitol and selective MRSA agar; plates were incubated for 48 h and inspected daily. Putative S. aureus colonies were identified by the latex agglutination test (Pastorex®).
Staph-plus, Bio-Rad Laboratories) and DNase production (DNase Test Agar, Biomedics, Spain). Methicillin resistance was determined by the cefoxitin disk diffusion method and antimicrobial susceptibility testing was performed by disk diffusion following Clinical and Laboratory Standards Institute recommendations [17].

Statistical analysis

Secondary outcomes (MRSA infections and overall mortality) were compared between prevalent MRSA carriers and non-MRSA carriers. Categorical variables were analyzed with χ² or Fisher’s exact tests as appropriate and continuous variables by Student’s t test or non-parametric tests. Mortality was compared by the Kaplan–Meier method. All statistical tests were two-tailed and P<0.05 was deemed significant. SPSS package version 15.0 was used (SPSS Inc., USA).

Approval for the study was obtained from the Research Ethics Committee of the Hospital Universitari de Bellvitge. No written informed consent was obtained because the study met the criteria for a waiver of this requirement.

RESULTS

The MRSA cohort comprised 178 colonized residents (86490 patient-days) and the non-carrier cohort 196 patients (97470 patient-days). Over the study period, 147 residents were lost to follow-up (53 at 6 months, 60 at 12 months and 34 at 18 months), 99 residents died and 30 were discharged. Table 1 compares residents who were lost to follow-up with those followed to completion.

Overall 14 residents developed MRSA infections, nine in the MRSA cohort and five in the non-carrier cohort. The type of infections were: 10 skin and soft tissue infections, seven related to decubitus ulcers, one urinary tract infection, one chronic external otitis and two respiratory infections which both required hospital admission.

The incidence rate of MRSA infection in the total MRSA cohort (n=178) was 0-12/1000 patient-days and in the 196 non-carriers, 39 residents acquired MRSA colonization during the study, giving an incidence rate of MRSA infection in this cohort of 0-05/1000 patient-days. The incidence rate of MRSA infection was statistically similar for prevalent MRSA carriers and residents with newly acquired MRSA colonization (P=0.46). Table 2 shows that no

Table 1. Characteristics of residents who were lost to follow-up with those followed to completion for the study period

|                          | Completed follow-up (n=280) | Lost to follow-up (n=147) | P     |
|--------------------------|----------------------------|--------------------------|-------|
| Female sex, n (%)        | 191 (68-0)                 | 102 (69-4)               | 0.08  |
| Age, yr, mean (s.d.)     | 80.9 (11.6)                | 83.5 (10.8)              | 0.06  |
| Charlson Index ≥ 2, n (%)| 99 (35-4)                  | 70 (47-6)                | 0.87  |
| Barthel Index < 30, n (%)| 101 (36-2)                 | 75 (51-1)                | 0.009 |
| Decubitus ulcers, n (%)  | 40 (14-2)                  | 35 (23-8)                | 0.22  |
| Centre <150 beds n (%)   | 109 (39-1)                 | 60 (40-8)                | 0.77  |
| Centre MRSA prevalence >20%, n (%) | 172 (61-6) | 88 (59-9) | 0.15  |
| MRSA colonization, n (%) | 128 (45-6)                 | 104 (70-7)               | 0.17  |
| Two-site colonization, n (%) | 17 (5-0)                | 17 (11-6)                | 0.59  |
| Infections (all microorganisms), n (%) | 152 (54-1)               | 45 (30-6)                | 0.34  |
| MRSA infections, n (%)   | 8 (2-8)                    | 5 (3-4)                  | 0.25  |
| Hospital admissions, n (%) | 39 (13-9)                  | 20 (13-6)                | 0.08  |

Table 2. Incidence rate of MRSA infection during the 18-month period related to the duration of MRSA colonization

| Duration of MRSA colonization | Follow-up (days) | No. of MRSA infections | Incidence rate of MRSA infections |
|-------------------------------|------------------|------------------------|----------------------------------|
| < 6 months                    | 156-60           | 3                      | 0.19/1000 patient-days           |
| 6 months                      | 97-20            | 0                      | _                                |
| 12 months                     | 52-05            | 3                      | 0.58/1000 patient-days           |
| 18 months                     | 32-202           | 2                      | 0.06/1000 patient-days           |
difference was found in MRSA infection rate between transient and persistent MRSA carriers (lineal regression \( P = 0.69 \)). In addition there were no differences in infections of any aetiology for both cohorts, and MRSA carriers did not require more hospital admissions than non-carriers during the study period (Table 3). The mortality rate was 20.8% in residents in the MRSA cohort and 16.8% in non-carriers. Four of 14 residents with MRSA infection died during the study period but these were not attributed to MRSA infection. No statistical difference was found in the overall mortality in either group (log rank test 0.19, \( P = 0.66 \)) (Fig. 1).

**DISCUSSION**

In a previous study we reported a prevalence of MRSA colonization of about 17% in residents of community LTCFs in Spain [2], which represents a large reservoir of this microorganism in the healthcare setting. Several studies have highlighted the relevance of this epidemiological aspect which might influence the infection control practices implemented by acute-care hospitals [18–22] but there are limited data on the relationship of MRSA colonization and the development of infection in residents of LTCFs [13, 14]. This aspect has usually been assessed in settings where patients are at great risk of MRSA infection, such as intensive care units [10]. Our findings show that MRSA carriers in community LTCFs are not at high risk of developing severe MRSA infection while residing at the facility. This is in agreement with the out-of-hospital risk of MRSA infection reported in another population [23]. Moreover, from a clinical point of view, MRSA infections were not severe and only 2/14 cases required hospitalization. As previously reported, we found that the main MRSA infections were skin and soft tissue infections. Remarkably the majority of infections were associated with the presence of decubitus ulcers, the most frequent skin lesion in this population. This emphasizes the need to enhance efforts to prevent the development of decubitus ulcers. Since in community LTCFs accurate microbiological diagnoses are often lacking, MRSA infections could have been underestimated and therefore we analysed the incidence of infection of any aetiology in both cohorts and found no differences. Prior studies have demonstrated an incidence of MRSA infections of 6.5% [13] and a relative risk of 3.6 in MRSA carriers in LTCFs [12].

Persistent MRSA carriers are more often colonized at multiple sites, are more likely to transmit to others, and become infected than transient carriers [24]. However, this aspect has not been studied in MRSA-colonized residents in LTCFs. A recent study performed in a LTCF showed that the degree of bacterial colonization in persistent MRSA carriers was significantly higher than in transient MRSA carriers [14]. We did not find a relationship between the incidence of MRSA infection and the duration of MRSA carriage, possibly because of the very few cases of MRSA infections. Moreover, the incidence of MRSA infection was similar in prevalent MRSA carriers and residents with newly acquired MRSA, i.e. MRSA colonization acquired while residing at the facility. A recent study, which included a small number of residents in LTCFs, found that the risk of MRSA infection in long-term carriers in the first year exceeded the risk of infection in subsequent years [23]. It appears that MRSA carriers remain at considerable risk for subsequent MRSA infection regardless of the time since the initial detection of MRSA carriage. Available data indicate that MRSA colonization in LTCFs may have different and less severe consequences than in acute-care hospitals. The risk of MRSA infection in the population of community LTCFs might not be related to the duration of colonization but might instead be attributable to known risks associated with MRSA infection such as hospitalization, bronchoaspiration, and the presence of decubitus ulcers or invasive medical devices. Except for ulcers and bronchoaspiration, these risks are not frequent in this population [24]. Reports of MRSA producing Panton–Valentine leukocidin (PVL) strains in LTCFs are increasing [25–27]. Since these strains might produce spontaneous infections, MRSA infection rates could potentially rise in residents in LTCFs.

Table 3. Comparison of clinical outcomes in the MRSA-colonized cohort and the non-carrier cohort

|                     | MRSA-colonized cohort \((N = 178)\) | Non-carriers \((N = 196)\) | RR (95% CI) |
|---------------------|-------------------------------------|---------------------------|-------------|
| MRSA infections     | 10 (4.6)                            | 4 (2.1)                   | 2.85 (0.88–9.28) |
| All infections      | 103 (57.9)                          | 94 (48.0)                 | 1.49 (0.99–2.24) |
| Hospital admissions | 32 (18.0)                           | 27 (13.8)                 | 1.37 (0.79–2.40) |

RR, Relative risk; CI, confidence interval.
without obvious clonal spread. None of the strains in this study was PVL positive [2] and previous molecular typing had shown the presence of only two distinct clones [16] one of which (CC5-MRSA-IV) has been reported as widely disseminated in Spanish hospitals [28, 29].

We found no differences in overall mortality in MRSA carriers and non-carriers. The mortality rate was around 15–20% in this elderly population and bronchoaspiration was the most frequent cause of death (data not shown). Previous studies have reported an associated mortality of MRSA infections in LTCFs of 1% [13], and a relative risk overall mortality rate of 2.0 in MRSA carriers [12]. Significantly higher mortality was associated with MRSA carriers in LTCFs only in patients with severe cognitive impairment [30].

This study has some limitations, as we only performed cultures of nasal swabs and decubitus ulcers to detect MRSA colonization. A recent study demonstrated that more than half of community LTCF residents present multiple-site MRSA colonization and one-third of MRSA carriers would have been missed if only nasal swabbing had been performed [31]. Another limitation is the large number of residents lost to follow-up, principally because of death in an elderly population. Patients lost to follow-up had significantly more deterioration in functional status; this is expected since poor functional status is associated with death in this population [32].

In addition this study was originally designed to describe the natural history of MRSA colonization in residents in LTCFs and to identify risk factors for being colonized with MRSA [16]. The MRSA infection rate and mortality in both cohorts were considered as secondary outcomes, and thus, no specific calculations were initially performed to determine if the study had sufficient power to detect significant differences. Nevertheless, major strengths of this study are the prospective design and the fact that it includes multiple facilities with a similar profile. Moreover, MRSA infections and mortality were evaluated in a population with a high prevalence of MRSA carriage.

Community LTCFs are institutions intended for the promotion of a healthy lifestyle for elderly people, a segment of population that is growing steadily; promoting comfort, optimal social environment and preserving functional status of residents are major objectives. The profile of community LTCFs and the endemicity of MRSA in these centres with a low clinical impact for colonized residents while in the facility, make the implementation of control measures to limit MRSA spread controversial. Standard precautions for all residents should be applied routinely; barrier precautions, cohorting, decolonization and other measures should be undertaken only for controlling MRSA infection outbreaks [33–36]. Our results together with the clinical experience and available literature suggest that MRSA infections are neither frequent nor severe while MRSA-colonized
residents remain in a LTCF. However, when admitted to an acute-care centre, they may spread MRSA to other patients who may develop severe infections. Therefore the epidemiological impact of the reservoir of MRSA in LTCFs is more relevant than the clinical impact of this colonization for an individual resident. The present results support current recommendations to control MRSA spread in community-LTCFs [33–36].

APPENDIX

Members of the Spanish Network for Research in Infectious Diseases who participated in the study: Raul Fernández, David Herrero, Rosario Casas, Eulalia Fontseca, Mónica Bota, Ricard Iniesta, Jesús Alburquerque, Catalina Andreu, Enrique Campos, Montserrat Vaquerio, Esperança Antón, Jordi Trelis, Anna Esteve, Maria Canals, Ana Díaz, Eva Penelo, Antonio Oliver, Javier Ariza, Francesc Gudiol.

ACKNOWLEDGEMENTS

This work was supported by Ministerio de Sanidad y Consumo, Instituto de Salud Carlos III, Spanish Network for Research in Infectious Diseases (REIPI RD06/0008).

DECLARATION OF INTEREST

None.

REFERENCES

1. Dominguez MA, et al. Spread and maintenance of a dominant methicillin-resistant Staphylococcus aureus (MRSA) clone during an outbreak of MRSA disease in a Spanish hospital. Journal of Clinical and Microbiology 1994; 32: 2081–2087.
2. Manzur A, et al. Prevalence of methicillin-resistant Staphylococcus aureus and factors associated with colonisation among residents in community long-term-care facilities in Spain. Clinical Microbiology and Infection 2008; 14: 867–872.
3. Olona-Cabases M, et al. Methicillin-resistant Staphylococcus aureus: a four-year experience in a spinal cord injury unit in Spain. Spinal Cord 1996; 34: 315–319.
4. Cretnik TZ, et al. Prevalence and nosocomial spread of methicillin-resistant Staphylococcus aureus in a long-term-care facility in Slovenia. Infection Control and Hospital Epidemiology 2005; 26: 184–190.
5. Barr B, et al. Prevalence of methicillin-resistant Staphylococcus aureus colonisation among older residents of care homes in the United Kingdom. Infection Control and Hospital Epidemiology 2007; 28: 853–859.
6. Talon D, Bertrand X. Methicillin-resistant Staphylococcus aureus in geriatric patients: usefulness of screening in a chronic-care setting. Infection Control and Hospital Epidemiology 2001; 22: 505–509.
7. O’Sullivan NP, Keane CT. The prevalence of methicillin-resistant Staphylococcus aureus among the residents of six nursing homes for the elderly. Journal of Hospital Infection 2000; 45: 322–329.
8. von Baum H, et al. Risk factors for methicillin-resistant Staphylococcus aureus carriage in residents of German nursing homes. Infection Control and Hospital Epidemiology 2002; 23: 511–515.
9. Pujol M, et al. Risk factors for nosocomial bacteremia due to meticillin-resistant Staphylococcus aureus. European Journal of Clinical Microbiology and Infectious Diseases 1994; 13: 96–102.
10. Corbella X, et al. S. aureus nasal carriage as a marker for subsequent staphylococcal infections in intensive care unit. European Journal of Clinical Microbiology and Infectious Diseases 1997; 16: 351–357.
11. Pujol M, et al. Nosocomial S. aureus bacteremia among nasal carriers of methicillin-resistant and methicillin-susceptible strains. American Journal of Medicine 1996; 100: 509–516.
12. Murder RR, et al. Methicillin-resistant staphylococcal colonisation and infection in a long-term care facility. Annals of Internal Medicine 1991; 114: 107–112.
13. Bradley SF. Methicillin-resistant Staphylococcus aureus: long-term care concerns. American Journal of Medicine 1999; 106: 2S–10S.
14. Stone ND, et al. Importance of bacterial burden among methicillin-resistant Staphylococcus aureus carriers in a long-term care facility. Infection Control and Hospital Epidemiology 2008; 29: 143–148.
15. Rodriguez-Bañó J, et al. Surveillance and control of methicillin-resistant Staphylococcus aureus in Spanish hospitals. A GEIH-SEIMC and SEMPSPH consensus document. Enfermedades Infecciosas y Microbiología Clínica 2008; 26: 285–298.
16. Manzur A, et al. The natural history of methicillin-resistant Staphylococcus aureus colonization among residents in community long-term-care facilities in Spain. Journal of Hospital Infection 2010; 76: 215–219.
17. Clinical and Laboratory Standards Institute. Performance standards for antimicrobial susceptibility testing; 16th Informational Supplement. CLSI document M100-S16. Clinical and Laboratory Standards Institute, Wayne, Pennsylvania, 2006.
18. Cooper BS, et al. Methicillin-resistant Staphylococcus aureus in hospitals and the community: stealth dynamics and control catastrophes. Proceedings of the National Academy of Sciences USA 2004; 101: 10223–10228.
19. Carleton HA, et al. Community-adapted methicillin-resistant Staphylococcus aureus: population dynamics of an expanding community reservoir of MRSA. Journal of Infectious Diseases 2004; 190: 1730–1738.
20. Manzur A, et al. Predictive factors of meticillin resistance among patients with Staphylococcus aureus bloodstream infection at hospital admission. Journal of Hospital Infection 2007; 66: 135–141.

21. Gavalda L, et al. Comparative cost of selective screening to prevent transmission of meticillin resistant Staphylococcus aureus (MRSA), compared with the attributable costs of MRSA infection. Infection Control and Hospital Epidemiology 2006; 27: 1264–1266.

22. Ruiz de Gopegui E, et al. Epidemiological relatedness of meticillin-resistant Staphylococcus aureus from a tertiary hospital and a geriatric institution in Spain. Clinical Microbiology and Infection 2004; 10: 339–342.

23. Datta R, Huang S. Risk of infection and death due to meticillin-resistant Staphylococcus aureus in long-term carriers. Clinical Infectious Diseases 2008; 47: 176–181.

24. Vandenbergh MFQ, et al. Follow-up of Staphylococcus aureus nasal carriage after 8 years: redefining the persistent carrier state. Journal of Clinical Microbiology 1999; 37: 3133–3140.

25. Raab U, et al. Prevalence of and risk factors for carriage of Panton-Valentine leucocidin-positive meticillin-resistant Staphylococcus aureus among residents and staff of a German nursing home. Infection Control and Hospital Epidemiology 2006; 27: 208–211.

26. Wagenlehner F, et al. Management of a large healthcare-associated outbreak of Panton-Valentine leucocidin-positive meticillin-resistant Staphylococcus aureus in Germany. Journal of Hospital Infection 2007; 67: 114–120.

27. Kerttula AM, et al. Molecular epidemiology of an outbreak caused by meticillin-resistant Staphylococcus aureus in a healthcare ward and associated nursing home. Journal of Clinical Microbiology 2005; 43: 6161–6163.

28. Vindel A, et al. Methicillin-resistant Staphylococcus aureus in Spain: molecular epidemiology and utility of different typing methods. Journal of Clinical Microbiology 2009; 47: 1620–1627.

29. Rodríguez-Baño J, et al. Clinical and molecular epidemiology of community-acquired, healthcare-associated and nosocomial meticillin-resistant Staphylococcus aureus in Spain. Clinical Microbiology and Infection 2009; 15: 1111–1118.

30. Suetens C, et al. Methicillin-resistant Staphylococcus aureus colonization is associated with higher mortality in nursing home residents with impaired cognitive status. Journal of American Geriatric Society 2006; 54: 1854–1860.

31. Mody L, et al. Epidemiology of Staphylococcus aureus colonisation in nursing home residents. Clinical Infectious Diseases 2008; 46: 1368–1373.

32. Mahoney F, Barthel DW. Functional evaluation: the Barthel index. Maryland State Medical Journal 1965; 14: 61–65.

33. Mody L, et al. Preventing infections in nursing homes: a survey of infection control practices in southeast Michigan. American Journal of Infection Control 2005; 33: 489–492.

34. Manzur A, Pujol M. Impact and control of meticillin-resistant Staphylococcus aureus (MRSA) in long-term care facilities. Revista Española de Geriatría y Gerontología 2008; 43: 235–238.

35. Kreman T, et al. Survey of long-term-care facilities in Iowa for policies and practices regarding residents with meticillin-resistant Staphylococcus aureus or vancomycin-resistant enterococci. Infection Control and Hospital Epidemiology 2005; 26: 811–815.

36. Manzur A, Gudiol F. Methicillin-resistant Staphylococcus aureus in long-term-care facilities. Clinical and Microbiology Infection 2009; 15: S26–30.