Risk factors associated with antimicrobial resistant organism carriage in residents of residential aged care facilities: a systematic review protocol

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Review question/objective

This review will aim to answer the following questions:

1. What are the resident risk factors associated with antimicrobial resistant organism carriage in the residential aged care setting?
2. What are the institutional risk factors associated with antimicrobial resistant organism carriage in the residential aged care setting?
3. What are the environmental risk factors associated with antimicrobial resistant organism carriage in the residential aged care setting?

The objective of this systematic review is to synthesize the best available evidence of the risk factors associated with antimicrobial resistant organism carriage in residents of residential aged care facilities. More specifically, the objective is to identify the factors that make some residents more at risk than others to either colonization or infection with an antimicrobial resistant organism. These may include patient/resident factors (predisposing medical conditions, immune status, functional capacity), institutional factors (staffing ratios, clinical policies and procedures, antibiotic use, indwelling devices) or environmental factors (cleaning of environment, cleaning of equipment, ward layout, hand hygiene facilities, shared and community living).

Background

Residential aged care facilities (RACFs) aim to provide nursing and personal care to the elderly who can no longer remain in their own home; in an environment that is safe and home-like.¹ Unlike acute healthcare facilities, RACFs are places where residents reside for many months or even years. While they may require nursing and medical care within this time, this can often be provided to residents within the RACF setting without the need for transfer to an acute hospital.

It has long been recognized that residents of RACFs are more susceptible to infections than the elderly living in the general community.² This is primarily due to factors that challenge their already diminishing immune system, such as multiple chronic diseases, polypharmacy, and functional impairment, which affects their hygiene practice and communal living.³ Unlike the elderly living in their own homes, the RACF environment can be conducive for infection transmission by the nature of its shared living...
arrangements, where many people interact directly with residents on a daily basis. Each one of these interactions increases the chance of the transference of pathogenic organisms. Some infections affecting residents of RACFs are caused by antimicrobial resistant organisms (AROs).  

Organisms may be become resistant to antimicrobials in a variety of ways: they may be intrinsically resistant to certain antimicrobial agents, or they may acquire resistance by mutation or via the acquisition of resistance genes from other organisms. The later occurs when new genetic material from resistant strains of bacteria is transferred to previously antimicrobial-susceptible bacteria. The use of antibiotics creates selective pressure for the emergence of such resistant strains. Bacteria that are resistant have an advantage over those that are susceptible and survive to multiply and continue to pass on that resistance.

AROs are commonly found in aged care settings and include: Methicillin Resistant Staphylococcus aureus (MRSA), Vancomycin Resistant Enterococcus faecalis (VRE), Multidrug Resistant Streptococcus pneumoniae (MDRSP), extended spectrum beta lactamase (ESBL) that produces Escherichia coli, and multi-resistant Pseudomonas aeruginosa. A recent study by Adam et al concluded that rates of antimicrobial resistance to these organisms are often higher in older age groups when compared to children, and adults under 64 years of age.

Residents can either be colonized or infected with an ARO. Colonization occurs when a resident has an ARO in or on a body site, but has no clinical signs or symptoms of disease. A colonized resident may be a temporary or a longer term carrier of an ARO, and may act as a reservoir for the organism and a potential source of transmission. Infection with an ARO occurs when the organism enters a body site and multiplies in the tissues, causing disease. Signs of infection with any kind of organism can include: fever, a rise in the white blood cell count, redness, swelling, pain and/or purulent drainage from a wound or body cavity. Residents who are infected with an ARO can also act as reservoirs and are potential sources of transmission of the organism. Reservoirs in this case are defined as people who have the ability to pass on a pathogenic organism to others, while not necessarily being affected by that organism themselves. Residents who are either infected or colonised with an organism can act as reservoirs for that organism. While infections with AROs are uncommon in RACFs, when they do occur they are associated with both increased morbidity and mortality. Additionally, if residents need to enter the health system, they may act as reservoirs for these organisms and introduce them into the acute care setting.

Many infection control guidelines, for example the Australian Guidelines for the Prevention and Control of Infection in Healthcare 2010, Guidelines for the Control of Multidrug-resistant organisms in New Zealand 2007, UK MRSA Guidelines, and the Public Health Ontario Guidelines are for primary use by acute healthcare facilities. They provide detailed and rigorous infection prevention strategies and additional infection control precautions for use with patients in acute healthcare facilities who are colonized or infected with AROs. They all also briefly mention how these strategies can be modified to suit residents colonized or infected with AROs in the RACF setting. In recognizing that this setting is fundamentally different, they recommend a risk-management approach to implementation of infection prevention strategies for dealing with residents with AROs. A risk management approach in this context consists of the healthcare facility conducting its own risk assessment, including how to avoid, identify, analyze, evaluate and treat risks in that setting. All healthcare facilities need to be able to determine the risks in their own context and select the appropriate course of action. Facilities are advised to regularly conduct infection prevention risk assessments within their facility. Identifying risk in such a way requires a systematic and comprehensive process that ensures no potential risk is missed.
In practice, utilizing risk management strategies as outlined in these types of guidelines is difficult for staff in RACFs because it presumes an awareness of the ARO burden in a facility, and that the at-risk population has been fully identified. Furthermore, the risk factors associated with carriage of AROs in this setting are not well understood. Where specific guidelines applicable to RACFs are available, such as in the US, they concentrate mainly on interventions designed to prevent transmission of AROs, and where resident risk factors are discussed, these guidelines describe resident, institutional and, to a lesser extent, environmental risk factors. On examination of the references provided in these guidelines to support the information around risk factors, it appears they are not based on systematic reviews of the literature or other strong evidence.

With the exception of the US, the lack of aged care specific guidelines for the management of AROs often sees acute care guidelines adapted with minimal modification and use by staff in RACFs. This can result in the introduction of rigorous infection prevention strategies that, while appropriate for the acute care setting, are often inappropriate in the aged care setting. Such strategies often result in limiting a resident’s activity and engagement with the residential care community. In addition they impose potentially unnecessary financial burdens on facilities. Kim et al. determined the costs associated with isolation and management of colonized patients in the acute care setting as $1,363 per admission. Information on similar costing in the RACF setting, where length of stay would be much longer, is not readily available.

A preliminary review of the literature revealed several cross-sectional studies that determined potential risk factors for colonization with AROs in residential aged care settings. Raab et al. found risk factors associated with MRSA in residents of a German nursing home were: low body mass index (P=.005), presence of cerebral circulatory disorder (P=.07), and non-mobility status (P=.09). Pop-Vicas et al. looked at factors associated with colonization with multi-drug resistant gram-negative bacteria in residents of a RACF in Boston and found a diagnosis of advanced dementia (adjusted odds ratio = 2.9, 95% confidence interval = 1.2–7.35, P=.02) and non-mobility status (adjusted odds ratio = 5.7, 95% confidence interval = 1.1–28.9, P=.04) were significant risk factors for colonization. A study by Mody et al. concluded that the use of indwelling devices (i.e., urinary catheters and feeding tubes) was associated with colonization with MRSA at any site (odds ratio = 2.0, P=.04).

A retrospective cohort study conducted by Nuorti et al. concluded that an outbreak of multidrug-resistant Pneumococcal pneumonia in residents was associated with antibiotic use, previous hospitalization, previous pneumonia, and the need for assistance to take oral medication. A systematic review conducted in 2012 by Xue and Gyi looked at risk factors for MRSA colonization among adults in acute care settings. Notably, this review found that previous admission to a long term care facility (such as a RACF) within the last 18 months was associated with MRSA colonization. Xue and Gyi suggested that systematic reviews on risk factors in geriatric patients were a potential area for further research and their findings support the need for this review. While Xue and Gyi looked at a specific type of ARO (MRSA) in the acute setting, no systematic review has been conducted on risk factors for carriage of MRSA in the residential aged care setting. Similarly, a preliminary search has revealed that no systematic reviews appear to have been conducted for any other types of AROs in the aged care setting. Consequently, this proposed review will look at a previously unexamined area of the literature.

Identifying risk factors that influence the colonization or infection of residents of RACFs with AROs will inform risk identification and mitigation protocols for use in this setting. It may potentially lead to the development of a reliable assessment tool that staff can use to identify those residents most at risk. This review will provide an evidence base on which to build a planned approach to risk management and the implementation of transmission prevention strategies to prevent AROs in residents of RACFs.
Keywords
Antibiotic resistance, Drug resistance, Infection control, Residential aged care, Risk factors

Inclusion criteria

Types of participants
This review will consider studies that include permanent residents of residential aged care Facilities, both male and female. Carriage of an ARO will be defined as the presence of such an organism confirmed via a culture positive result from any site on the body. The carrier status must be clearly defined in included studies. Studies that report either ARO colonization or infection will be included. Studies that only look at a specific disease sub-population of residents who are under 65 years of age will be excluded. Studies that focus exclusively on residents under the age of 65 will also be excluded. Residents under the age of 65 included within studies that are not stratified by age will be included.

Types of intervention(s)/phenomena of interest
All risk factors associated with carriage of any ARO in residents of residential aged care facilities will be considered in this review. A risk factor is a condition that is associated with the presence of an ARO in a resident. Examples of risk factors include, but are not limited to predisposing medical conditions, immune status, functional capacity (resident factors); staffing ratios, clinical policies and procedures, antibiotic use, indwelling devices (institutional factors); and cleaning of environment, cleaning of equipment, ward layout, hand hygiene facilities, shared and community living (environmental factors).

Types of outcomes
Outcomes of interest include the characteristics of residents with ARO carriage. These will be associated with the resident, the facility, and/or the environment (i.e. immune status, clinical policies, ward layout etc.). The measurement of these outcomes may include a risk ratio (RR), likelihood ratio (LR), or odds ratio (OR) of risk factors in comparison to residents who do not have an ARO.

Types of studies
This review will consider quantitative studies that identify risk factors associated with ARO carriage in residents of residential aged care facilities. Both experimental and epidemiological study designs will be considered for inclusion, including randomized controlled trials, non-randomized controlled trials, quasi-experimental, before and after studies, prospective and retrospective cohort studies, case control studies and analytical cross sectional studies. This review will also consider descriptive epidemiological study designs including case series, individual case reports and descriptive cross sectional studies for inclusion.

As the first ARO was confirmed in the late 1940’s, studies from 1950 onwards will be included.

Search strategy
The search strategy aims to find both published and unpublished studies. A three-step search strategy will be utilized in this review. An initial limited search of MEDLINE and CINAHL will be undertaken followed by analysis of the text words contained in the title and abstract, and of the index terms used to describe article. A second search using all identified keywords and index terms will then be undertaken.
across all included databases. Thirdly, the reference list of all identified reports and articles will be
searched for additional studies. Studies published in English will be considered for inclusion in this
review.

A search logic grid will be developed to identify the literature, covering the following key concepts:

- Residential aged care
- Infection control
- Drug resistance
- Risk factors

Initial keywords and MeSH terms will be identified and may include:

- Antibiotic resistance
- Drug resistance
- Chemotherapy
- Residential Aged Care Facility/Aged Care/Nursing home
- MRSA/Methicillin resistant *Staphylococcus aureus*
- VRE/Vancomycin resistant *Enterococci*
- *Streptococcus pneumonia*
- *Escherichia coli*
- *Pseudomonas aeruginosa*
- Risk/ risk factor

Where appropriate, alternative terms and spellings will be included to allow for variations across
countries and ensure all relevant articles are sourced. Search terms will be combined with the
appropriate Boolean logic.

The databases to be searched include:

- Cochrane (CENTRAL)
- CINHAL
- MEDLINE/ PubMed
- Embase

The search for unpublished studies (Grey Literature), such as government reports, conference papers,
theses, etc., will include the following search engines and databases:

- Mednar
- ProQuest (PQDT)
- Scirus
- AGAR
Assessment of methodological quality

Papers selected for retrieval will be assessed by two independent reviewers for methodological validity prior to inclusion in the review using standardized critical appraisal instruments from the Joanna Briggs Institute Meta-Analysis of Statistics Assessment and Review Instrument (JBI-MAStARI) (Appendix I). Any disagreements that arise between the reviewers will be resolved through discussion, or with a third reviewer.

Data collection

Data will be extracted from papers included in the review using the standardized data extraction tool from JBI-MAStARI (Appendix II). The data extracted will include specific details about the interventions, populations, study methods and outcomes of significance to the review question and specific objectives. Authors will be contacted for missing information as required.

Data synthesis

Where appropriate, an attempt will be made to pool quantitative data and conduct a statistical meta-analysis using JBI-MAStARI. If MAStARI is not appropriate for the data analysis then alternative computerized statistical software, such as Review Manager (RevMan) will be used to affect the meta-analysis. This may be required for managing data that deals with associations.

All results will be subject to double data entry. Results will be investigated using a fixed effect model where possible; however a random affects model will be used in the case of statistical heterogeneity. Effect sizes expressed as odds ratio (for categorical data) and weighted mean differences (for continuous data) and their 95% confidence intervals will be calculated for analysis. Where the studies have data format that does not lend itself to this type of analysis then the findings will be presented in narrative form.

Heterogeneity will be assessed using a statistically appropriate test, for example the standard Chi-square, and also explored using sub-group analyses where possible, based on the different study designs included in this review. Where statistical pooling is not possible the findings will be presented in narrative form including tables and figures to aid in the data presentation where appropriate.

Conflicts of interest

Nil

Acknowledgements

The author would like to acknowledge the following individuals for contributing their ideas and support in the conduct of this project:

Trish McReynolds: CF JBI GCertBiometrics, BHltSc (Nursing), Director - The Joanna Briggs Institute Aged Care Unit The Joanna Briggs Institute, the University of Adelaide, SA 5005, Australia

Ms Sara Blunt, DCEO, Eldercare Inc, Fullarton, Adelaide
References


Appendix I: Appraisal instruments

MAStARI appraisal instrument

JBI Critical Appraisal Checklist for Randomised Control / Pseudo-randomised Trial

Reviewer _______________________ Date _______________________

Author _______________________ Year ______________ Record Number __________

1. Was the assignment to treatment groups truly random? Yes No Unclear Not Applicable
2. Were participants blinded to treatment allocation? Yes No Unclear Not Applicable
3. Was allocation to treatment groups concealed from the allocator? Yes No Unclear Not Applicable
4. Were the outcomes of people who withdrew described and included in the analysis? Yes No Unclear Not Applicable
5. Were those assessing outcomes blind to the treatment allocation? Yes No Unclear Not Applicable
6. Were the control and treatment groups comparable at entry? Yes No Unclear Not Applicable
7. Were groups treated identically other than for the named interventions? Yes No Unclear Not Applicable
8. Were outcomes measured in the same way for all groups? Yes No Unclear Not Applicable
9. Were outcomes measured in a reliable way? Yes No Unclear Not Applicable
10. Was appropriate statistical analysis used? Yes No Unclear Not Applicable

Overall appraisal: Include □ Exclude □ Seek further info. □

Comments (Including reason for exclusion)


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### JBI Critical Appraisal Checklist for Descriptive / Case Series

<table>
<thead>
<tr>
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<th>Question</th>
<th>Yes</th>
<th>No</th>
<th>Unclear</th>
<th>Not Applicable</th>
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<tbody>
<tr>
<td>1.</td>
<td>Was study based on a random or pseudo-random sample?</td>
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<td>2.</td>
<td>Were the criteria for inclusion in the sample clearly defined?</td>
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<td>3.</td>
<td>Were confounding factors identified and strategies to deal with them stated?</td>
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<td>4.</td>
<td>Were outcomes assessed using objective criteria?</td>
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<td>5.</td>
<td>If comparisons are being made, was there sufficient descriptions of the groups?</td>
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<td>6.</td>
<td>Was follow up carried out over a sufficient time period?</td>
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<tr>
<td>7.</td>
<td>Were the outcomes of people who withdrew described and included in the analysis?</td>
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<td>9.</td>
<td>Was appropriate statistical analysis used?</td>
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**Overall appraisal:**
- Include [☐]
- Exclude [☐]
- Seek further info [☐]

**Comments (Including reason for exclusion):**

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# JBI Critical Appraisal Checklist for Comparable Cohort/Case Control

Reviewer: ___________________________ Date: ___________________________

Author: ___________________________ Year: _______ Record Number: _______

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<tr>
<td>1.</td>
<td>Is sample representative of patients in the population as a whole?</td>
<td>Yes</td>
<td>No</td>
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<td>2.</td>
<td>Are the patients at a similar point in the course of their condition/illness?</td>
<td>Yes</td>
<td>No</td>
<td>Unclear</td>
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<tr>
<td>3.</td>
<td>Has bias been minimised in relation to selection of cases and of controls?</td>
<td>Yes</td>
<td>No</td>
<td>Unclear</td>
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<tr>
<td>4.</td>
<td>Are confounding factors identified and strategies to deal with them stated?</td>
<td>Yes</td>
<td>No</td>
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<td>5.</td>
<td>Are outcomes assessed using objective criteria?</td>
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<td>6.</td>
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Overall appraisal: Include ☐ Exclude ☐ Seek further info. ☐

Comments (Including reason for exclusion)
________________________________________________________________________
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Appendix II: Data extraction instruments

MAStARI data extraction instrument

**JBI Data Extraction Form for Experimental / Observational Studies**

Reviewer ............................................... Date ..............................................
Author .................................................. Year ...........................................
Journal .................................................. Record Number ..........................

**Study Method**

RCT ☐ Quasi-RCT ☐ Longitudinal ☐
Retrospective ☐ Observational ☐ Other ☐

**Participants**

Setting

Population

**Sample size**

Group A __________________  Group B __________________

**Interventions**

Intervention A

Intervention B

Authors Conclusions:

Reviewers Conclusions:
Study results

Dichotomous data

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Continuous data

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<th>Outcome</th>
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