

## PEER REVIEW HISTORY

BMJ Open publishes all reviews undertaken for accepted manuscripts. Reviewers are asked to complete a checklist review form ([see an example](#)) and are provided with free text boxes to elaborate on their assessment. These free text comments are reproduced below. Some articles will have been accepted based in part or entirely on reviews undertaken for other BMJ Group journals. These will be reproduced where possible.

### ARTICLE DETAILS

<b>TITLE (PROVISIONAL)</b>	The longitudinal prevalence of MRSA in care home residents and the effectiveness of improving infection prevention knowledge and practice on colonisation using a stepped wedge study design.
<b>AUTHORS</b>	C Horner, M Wilcox, B Barr, D Hall, G Hodgson, P Parnell and D Tompkin

### VERSION 1 - REVIEW

<b>REVIEWER</b>	Dr Clodna McNulty Head, Primary Care Unit Health Protection Agency Microbiology Department Gloucestershire Royal Hospital Great Western Road Gloucester GL1 3NN UK  I do not have any conflicts of interest.
<b>REVIEW RETURNED</b>	21/10/2011

Abstract – line 17: It is not clear what each survey was (different times or the three different groups).

Abstract – line 18: Need to say the three methods, presumably hand hygiene facilities, observation of hand hygiene and knowledge?

Abstract – line 25: Typo 'by' should be 'to'.

What this study adds – page 8 lines 8-9: This is not new information.

Introduction – page 7 line 12: 'are likely to be' – suggest better to say 'more likely' or 'at greater risk'.

Methods – page 9 line 10: Did you exclude care homes for residents with dementia?

Methods – page 11 table 1: This table is not very intuitive/easy to interpret. It may be better to have a time line with the intervention marked on an arrow representing times of surveys.

Group		Nov-Dec 2006	Oct-Nov 2007	May-June 2008	Jan-Feb 2009
Group 1	Pre-survey	↓			
	Post-survey		↑	↑	↑
Group 2	Pre-survey	↓	↓		
	Post-survey			↑	↑
Group 3	Pre-survey	↓	↓	↓	
	Post-survey				↑

Page 26: A weakness of the study is the 46% swabbing rate in the care homes, due to incapacity to give consent because of dementia, or severe health problems. The former has no influence on MRSA rates but the latter will influence results. Do you have details of the number who refused because of being too ill and was this similar in the three groups?

Page 26 – line 5: Do you have any information on turnover of staff?

Discussion:

You say that the hand hygiene education did not reduce MRSA. There is a danger that this may be interpreted by some that hand hygiene is, therefore, not worthwhile pursuing. Were there any other tangible benefits seen i.e. reductions in other infections, improved quality of care, staff morale etc?

Did the care homes take ownership of the project, as was seen in the hand hygiene initiatives in hospitals? Comparing and contrasting the interventions used to reduce MRSA in hospitals may give some insight into why this didn't work.

Many interventions use a cognitive behavioural theory. Just telling staff what to do may possibly be a reason it didn't work. Could you mention the theory of Planned Behaviour or Normalisation Theory in the discussion?

<b>REVIEWER</b>	Dr G Gopal Rao Consultant Microbiologist North West London Hospitals NHS Trust London HA1 3UJ No conflicting interests
<b>REVIEW RETURNED</b>	24/10/2011

<b>THE STUDY</b>	This is an original study that describes the prevalence of MRSA colonisation and evaluates the role of enhanced infection control education and practice on the on MRSA colonisation. However there are several issues that need to be addressed. 1. The MRSA prevalence was determined after testing an average of 46% of the residents. This is clearly insufficient to establish the true prevalence as it is possible that those who were not screened may have a different prevalence. I understand the difficulties in obtaining consent/assent but in the absence of screening a majority of the care home residents I don't think it is possible to establish the true prevalence. I suggest that a statistician is consulted. Furthermore
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	<p>the same patients were not necessarily retested, so no conclusions can be made about acquisitions or incidence of MRSA colonisation</p> <p>2. Thus MRSA prevalence may not be dependent on the infection control practices, and may indeed be a function of the patients admitted with MRSA colonisation and any reduction could be due to natural attrition following death of colonised patients.</p> <p>3. The increase in MRSA prevalence at the end of intervention may be correlated to increase in prevalence of the MRSA in hospitals. Given that a majority of the care home residents appear to use a single NHS Trust, it may be possible to see if there is an increase in prevalence in MRSA in the hospitals. In this context it will be interesting to see if the current decline in MRSA rates seen in hospitals is reflected in care homes.</p> <p>4. The authors aimed to impart infection control education to 80% of the care home staff but no information is provided if this was achieved</p> <p>5. Furthermore there is no description of the staff providing care, e.g. number of trained staff, Healthcare Assistants and Agency staff. This may have a bearing on the knowledge assessment and possibly on the MRSA rates.</p>
<b>RESULTS &amp; CONCLUSIONS</b>	<p>This study has demonstrated that ethical issues resulting in the inability to obtain screen residents who cannot give consent, need to maintain anonymity, and non-institution of control measures such as decolonisation and isolation, are a real challenge in designing a study to find out if education leading to better infection control practices makes a difference in MRSA colonisation rates in care homes.</p> <p>This is not criticism of the study but a comment on the real difficulties in designing the study where ethical considerations limit the design. I believe a study to determine the efficacy of the infection control measures is particularly challenging if informed consent is required of residents, who are unable to give it, anonymity and lack of infection control measures directly related to the residents. That said the study does demonstrate the high prevalence of MRSA colonisation in this group and the failure of Infection Control education alone in reducing the prevalence of MRSA. This information is useful to many Infection control practitioners who spend considerable time and effort in providing infection control education in care home setting.</p>
<b>GENERAL COMMENTS</b>	<p>In our study (your reference 31) we did evaluate the MRSA prevalence in the study groups but could not publish it because of methodological concerns not dissimilar to those stated in this paper. Will be happy to discuss.</p> <p>I believe it is important to publish with a section on difficulties and limitations of infection control trials in care homes</p>

<b>REVIEWER</b>	<p>Dr Stephanie Dancer Consultant Microbiologist</p> <p>NHS Lanarkshire Scotland</p>
<b>REVIEW RETURNED</b>	24/10/2011

<b>GENERAL COMMENTS</b>	<p>Overview</p> <p>Thank you for inviting me to comment on this paper. It is a comprehensive account and analysis of a measured attempt to deliver an infection control programme to staff responsible for elderly</p>
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	<p>residents in the community. The intervention was assessed before and after hand hygiene intervention, which was introduced using a stepped-wedge design. This allowed control within and between each group of homes offered the intervention. In total, 65 care homes participated and completed the full programme. As well as auditing evaluation of the effect of education, prospective monitoring of outcome for residents with or acquiring MRSA was performed, including progression to infection and mortality data.</p> <p>The study involved nearly 2500 residents in the community, and for sheer numbers alone is arguably worth publishing. However, it does not offer any significant new data, given that similar prevalence data and outcomes following infection control interventions in care homes have already been reported. Indeed, the failure of several comparable infection control programmes to impact on MRSA prevalence in these settings perhaps even question why the study was performed, unless definitive trials were still underway at the time of application. Aside from this, it does provide an up-to-date estimate of MRSA colonisation among elderly people in northern English care homes. This could help other healthcare providers assess the infection risk attributable to MRSA in both acute and long-term care. It is also well written; accurate; interesting; and the authors recognise some of the main limitations and present these accordingly in the Discussion. References are well chosen. The decision to publish in BMJ Open is therefore borderline, but in my opinion, the study offers a useful and robust 'negative', which ought to dissuade future similar studies and potential waste of resources. Negative papers do not tend to get published as much as those with positive results and this skews the evidence base for the future.</p> <p><b>Specific points</b></p> <p>Should the paper be accepted, there are some additional points that require clarification. These are listed below:</p> <ol style="list-style-type: none"> <li>1. What is the definition of 'nursing capability'? Is this care home potential to look after bed bound patients, or maybe patients with invasive devices or requiring wound care? Provision of timely medical assessment? Employment of trained nurses?</li> <li>2. There is no mention of side-room availability; ensuite facilities; isolation; shared bedroom accommodation; bathroom and toilet availability per head of residents. If a home has no single rooms, and residents share sleeping accommodation and/or bathrooms, then MRSA is more likely to be transmitted.</li> <li>3. Related to the above, there is no mention of bed occupancies or turn around times for home spaces.</li> <li>4. No mention of staff to patient ratios or qualifications of carers.</li> <li>5. No mention of laundry facilities or provision for laundry services. Colonised patients contaminate clothes, bed linen and towels, and these items require hot temperature washes on a regular basis.</li> <li>6. No mention of cleaning services (routine and incident-related) or environmental assessment. At risk of boring the authors, who probably know the main interests of this reviewer, please may I draw attention to the importance of the environment in MRSA transmission? If MRSA survives cleaning regimens in hospitals, the organism will be even more persistent in the care home environment, where cleaning is not (usually) quite so strictly implemented. Indeed, the level of cleaning in a care home could arguably be the most important factor in MRSA prevalence amongst elderly residents, in conjunction with side-room provision, wounds,</li> </ol>
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	<p>catheters and overall MRSA colonisation pressures.</p> <p>7. As the authors point out, hand hygiene education requires regular repetition, reinforcement and monitoring, and the single targeted intervention would have had at best a short term effect. Also mentioned was concern over the proportion of staff attending the programme, because absentees could have compromised good practice by others. Were night shift workers invited, for example? Do the authors have additional data on attendance by 'key' personnel, as mentioned in the Discussion? Who are 'key' personnel, and how many attended the presentation? What support for workers towards the programme was provided by individuals recognised as influential?</p> <p>8. There is a useful statement or even paragraph missing which should be included in this report, and this concerns advice to infection control staff based in acute care settings as well as public health institutions. How can the risk of MRSA transmission from colonised care home residents be reduced for hospitals, given the findings from this study? Are there any policies or practices that can be set up, or amended, that would help those responsible for controlling infection both in hospital and in the community?</p> <p><b>Conclusion</b></p> <p>I wonder if the authors might like to consider changing the focus of their paper from prospective intervention to surveillance and outcome, with less emphasis on the effect of the intervention. The magnitude of the study justifies publication, if not in BMJ Open, then certainly elsewhere and I wish them the best of luck with this.</p> <p>I have one final comment. It is well known that the prevalence of permanent staphylococcal carriage among the general population is around 20%. The findings from this study suggest that in Leeds care homes at least, all those genetically predisposed to carry coagulase-positive staphylococci have had their meticillin-susceptible strains replaced by the meticillin-resistant version. It is likely that this will ultimately be the case for all of us, give or take a few years, and as such, could invalidate future attempts at control. Until such time, however, infection control activities should not be abandoned, and indeed, are currently justified, none the least by the increased infection risk for colonised residents as reported by this study.</p>
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## VERSION 1 – AUTHOR RESPONSE

Reviewer 1: Dr Clodna McNulty.

1.1 Abstract – line 17: It is not clear what each survey was (different times or the three different groups). AMENDMENT MADE.

1.2 Abstract – line 18: Need to say the three methods, presumably hand hygiene facilities, observation of hand hygiene and knowledge? AMENDMENT MADE (see Abstract lines 8 17).

1.3 Abstract – line 25: Typo 'by' should be 'to'. DONE (see Abstract lines 8 17).

1.4 What this study adds – page 8 lines 8-9: This is not new information. SECTION REMOVED.

1.4 Introduction – page 7 line 12: 'are likely to be' – suggest better to say 'more likely' or 'at greater risk'. DONE (see page 8, line 12).

1.5 Methods – page 9 line 10: Did you exclude care homes for residents with dementia?

COMMENT: Care homes for residents with dementia were not specifically excluded from the study; however, residents with dementia were excluded. Please see page 28, line 2 3.

1.6 Methods – page 11 table 1: This table is not very intuitive/easy to interpret. It may be better to have a time line with the intervention marked on an arrow representing times of surveys.

AMENDMENT MADE (See page 12).

1.7 Page 26: A weakness of the study is the 46% swabbing rate in the care homes, due to incapacity to give consent because of dementia, or severe health problems. The former has no influence on MRSA rates but the latter will influence results. Do you have details of the number who refused because of being too ill and was this similar in the three groups?

COMMENT: Information was not collected about reasons for non participation; however, it is acknowledged that residents may not have participated due to a number of reasons (see manuscript page 2, lines 1 5 for further details).

1.8 Page 26 – line 5: Do you have any information on turnover of staff?

COMMENT: Information about the turnover of staff in each home was only collected at the beginning of the study (November 2006) from the preceding 12 month period (n=62 homes submitted information). Fourteen homes reported that no staff had left employment in the preceding 12 months; 28 homes reported that up to 10 members of staff had left within the preceding 12 months, and 20 homes reported that more than 10 staff had left within the preceding 12 months. Information about the grade of staff and reasons for leaving were not collected. We have mentioned this issue on page 28, line 10.

1.9 Discussion: You say that the hand hygiene education did not reduce MRSA. There is a danger that this may be interpreted by some that hand hygiene is, therefore, not worthwhile pursuing. Were there any other tangible benefits seen i.e. reductions in other infections, improved quality of care, staff morale etc?

COMMENT. We do not believe that just because hand hygiene education did not lead to a reduction in the prevalence of MRSA that this will be interpreted as a reason not to do this. Without hand hygiene it is plausible that transmission of MRSA and other pathogens would increase. We did not collect information on other infections, improved quality of care, staff morale. We have further addressed these issues on page 29 of the revised manuscript (Lines 21 23).

1.10 Did the care homes take ownership of the project, as was seen in the hand hygiene initiatives in hospitals? Comparing and contrasting the interventions used to reduce MRSA in hospitals may give some insight into why this didn't work.

COMMENT. It is difficult to answer this point. Three-quarters of the care homes that were approached to participate in the study did so, and appeared to welcome the additional input. Despite lasting 52 months, only 3/68 (4%) of homes withdrew during the study. We are unable to compare and contrast practice in hospitals as the environments, staff and current health status clientele often differ markedly.

1.11 Many interventions use a cognitive behavioural theory. Just telling staff what to do may possibly be a reason it didn't work. Could you mention the theory of Planned Behaviour or Normalisation Theory in the discussion?

COMMENT. We appreciate the suggestion and have made a brief mention of this point on page 29 (lines 23 25).

Reviewer 2: Dr G Gopal Rao

2.1a The MRSA prevalence was determined after testing an average of 46% of the residents. This is clearly insufficient to establish the true prevalence as it is possible that those who were not screened may have a different prevalence. I understand the difficulties in obtaining consent/assent but in the absence of screening a majority of the care home residents I don't think it is possible to establish the true prevalence. I suggest that a statistician is consulted.

COMMENT: An experienced statistician was consulted in the analysis of the data. The recorded prevalence of MRSA is a true reflection of those residents that participated in the study. Without making participation compulsory, inclusion of all residents in participating homes is not possible. Information was not collected about reasons for non participation; however, it is acknowledged that residents may not have participated due to a number of reasons (see manuscript page 28, lines 1 5 for further details).

2.1b Furthermore the same patients were not necessarily retested, so no conclusions can be made about acquisitions or incidence of MRSA colonisation.



COMMENT: A proportion of residents were screened in more than one survey (see page 17, lines 19-21). A separate manuscript, which reports in detail the epidemiology of the MRSA isolated and summarises the acquisition of MRSA colonisation in care homes, is being prepared.

2.2 Thus MRSA prevalence may not be dependent on the infection control practices, and may indeed be a function of the patients admitted with MRSA colonisation and any reduction could be due to natural attrition following death of colonised patients.

COMMENT: Addressed above and below.

2.3 The increase in MRSA prevalence at the end of intervention may be correlated to increase in prevalence of the MRSA in hospitals. Given that a majority of the care home residents appear to use a single NHS Trust, it may be possible to see if there is an increase in prevalence in MRSA in the hospitals. In this context it will be interesting to see if the current decline in MRSA rates seen in hospitals is reflected in care homes.

COMMENT: This was not the case. Additional information has been added to the discussion (Page 25, lines 19-23).

2.4 The authors aimed to impart infection control education to 80% of the care home staff but no information is provided if this was achieved.

COMMENT: The study assessed the infection prevention knowledge of over 1000 members of staff and the infection prevention practice of more than 300 individuals. It was not possible to calculate the proportion of the workforce that received training, as the denominator data, the number of employees in each home at the time of the intervention, were not available. Using the number of staff employed by homes given at the beginning of the study (n = 7326), although some of these may represent part time workers, the 1341 individuals that were trained only represents 18% of the total workforce. Please also see additional information added to the manuscript (page 28, line 16).

2.5 Furthermore there is no description of the staff providing care, e.g. number of trained staff, Healthcare Assistants and Agency staff. This may have a bearing on the knowledge assessment and possibly on the MRSA rates.

COMMENT: Information about the type of staff providing care was only collected at the beginning of the study (November 2006) about the preceding 12 month period (n=62 homes submitted data). There were 7326 members of staff employed at the time of data collection. Employees working directly with residents (n = 2558) were listed as registered nurses; carers and agency staff. The remaining personnel (n = 4768) were not categorised and may represent management and domestic staff that were not working directly with residents.

2.6 I believe it is important to publish with a section on difficulties and limitations of infection control trials in care homes.

COMMENT: Additional discussion has been added (see page 28).

Reviewer 3: Dr Stephanie Dancer

3.1. What is the definition of 'nursing capability'? Is this care home potential to look after bed bound patients, or maybe patients with invasive devices or requiring wound care? Provision of timely medical assessment? Employment of trained nurses?

COMMENT: In the present study, a care home without nursing capability was defined as a home that provided residents with accommodation, social and personal care. A home with nursing capability was defined as a home that employed registered nurses and provided nursing care in addition to accommodation, social and personal care to residents. Care homes with nursing capability were listed on the CQC register as a nursing home. These definitions have been added to the methods section of the manuscript (see page 10, lines 8-13).

3.2. There is no mention of side-room availability; en-suite facilities; isolation; shared bedroom accommodation; bathroom and toilet availability per head of residents. If a home has no single rooms, and residents share sleeping accommodation and/or bathrooms, then MRSA is more likely to be transmitted.

COMMENT: This information was not collected; however, this limitation has been acknowledged in the revised manuscript (see page 28).

3.3 Related to the above, there is no mention of bed occupancies or turn around times for home

spaces.

COMMENT: This information was only collected at the beginning of the study (November 2006) for the preceding 12 months. During a 12 month period, there were 3004 admissions to the participating care homes; 20 homes had up to 10 admissions, whereas the majority of homes (n = 41) had over 10 admissions within a 12 month period. The number of residents discharged was 2108. There were 31 homes that had up to 10 residents discharged and 30 homes with more than 10 residents discharged within a 12 month period. The total number of deaths recorded by participating care homes was 716. There were 38 homes that had up to 10 resident deaths and 23 homes that had more than 10 deaths within a 12 month period.

3.4. No mention of staff to patient ratios or qualifications of carers.

COMMENT: Information about the type of staff providing care was only collected at the beginning of the study (November 2006) about the preceding 12 month period (n=62 homes submitted data). There were 7326 members of staff employed at the time of data collection. Employees working directly with residents (n = 2558) were listed as registered nurses; carers and agency staff. The remaining personnel (n = 4768) were not categorised and may represent management and domestic staff that were not working directly with residents. The majority of homes (n = 58) had one carer per one or two beds; however, there were four homes that had more than two beds per carer. Nineteen homes with nursing capability (65%) had a nurse to bed ratio of one nurse to six or less beds. There were 13 homes that had one nurse for more than six beds.

The national minimum standard that 50% of carers (including agency staff but excluding registered nurses) employed by a home should have a Level 2 National Vocation Qualification (NVQ 2) or equivalent was measured. The proportion of carers that did not have a Level 2 NVQ was 42% (n = 666) and 16 homes (26%) did not meet the minimum standard.

3.5. No mention of laundry facilities or provision for laundry services. Colonised patients contaminate clothes, bed linen and towels, and these items require hot temperature washes on a regular basis.

COMMENT: This information was not collected; however, this limitation has been acknowledged in the revised manuscript (see page 28).

3.6. No mention of cleaning services (routine and incident-related) or environmental assessment. At risk of boring the authors, who probably know the main interests of this reviewer, please may I draw attention to the importance of the environment in MRSA transmission? If MRSA survives cleaning regimens in hospitals, the organism will be even more persistent in the care home environment, where cleaning is not (usually) quite so strictly implemented. Indeed, the level of cleaning in a care home could arguably be the most important factor in MRSA prevalence amongst elderly residents, in conjunction with side-room provision, wounds, catheters and overall MRSA colonisation pressures.

COMMENT: This information was not collected; however, this limitation has been acknowledged in the revised manuscript (see page 28).

3.7. As the authors point out, hand hygiene education requires regular repetition, reinforcement and monitoring, and the single targeted intervention would have had at best a short term effect. Also mentioned was concern over the proportion of staff attending the programme, because absentees could have compromised good practice by others. Were night shift workers invited, for example? Do the authors have additional data on attendance by 'key' personnel, as mentioned in the Discussion? Who are 'key' personnel, and how many attended the presentation? What support for workers towards the programme was provided by individuals recognised as influential?

COMMENT: The study assessed the infection prevention knowledge of over 1000 members of staff and the infection prevention practice of more than 300 individuals. Key personnel are defined as those providing direct care to residents (carers and registered nurses). Additional information has been added to the manuscript (page 28, line 19). All staff received the same training; further support/training was not provided to specific members of staff.

3.8. There is a useful statement or even paragraph missing which should be included in this report, and this concerns advice to infection control staff based in acute care settings as well as public health institutions. How can the risk of MRSA transmission from colonised care home residents be reduced for hospitals, given the findings from this study? Are there any policies or practices that can be set up,



or amended, that would help those responsible for controlling infection both in hospital and in the community?

COMMENT. Four sentences to cover these points have been added at the end of the manuscript (see page 31).

3.9 I wonder if the authors might like to consider changing the focus of their paper from prospective intervention to surveillance and outcome, with less emphasis on the effect of the intervention.

COMMENT. This would mean changing the a priori intent of the study and we believe that this would be disingenuous to the reader.

## VERSION 2 – REVIEW

<b>REVIEWER</b>	Dr G Gopal Rao North West London Hospitals NHS Trust  No conflicting interests
<b>REVIEW RETURNED</b>	26/11/2011

<b>GENERAL COMMENTS</b>	The principal aim of the control measures is to prevent transmission of MRSA. I think by not including MRSA acquisition rates in the current paper, the message to the reader is incomplete. This paper will be substantially enhanced with information regarding acquisition, especially if it includes information regarding typing of the strains.
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<b>REVIEWER</b>	Dr Clodna McNulty Head, Primary Care Unit Health Protection Agency Microbiology Department Gloucestershire Royal Hospital Great Western Road Gloucester GL1 3NN UK  I do not have any conflicts of interest.
<b>REVIEW RETURNED</b>	05/12/2011

<b>GENERAL COMMENTS</b>	This paper now contains all the information that is required and is a very useful contribution to the scientific literature.
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