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Impact of isolation on hospitalised patients who are infectious: systematic review with quantitative analysis

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Abstract

Objective

To systematically review the literature exploring impact of isolation on hospitalised patients who are infectious: psychological and non-psychological outcomes

Design

Systematic review with quantification

Data Sources

Embase, Medline and Psychinfo were searched from inception until December 2018. Reference lists and Google Scholar were also handsearched.

Results

Twenty seven papers published from database inception until December 2018 were reviewed. A wide range of psychological and non-psychological outcomes were reported. There was a marked trend for isolated patients to exhibit higher risk of depression, anxiety and worse outcomes for a range of care-related factors but with significant variation.

Conclusion

The review indicates that isolation to contain risk of infection has negative consequences for segregated patients. Although strength of the evidence is weak, comprising primarily single centre convenience samples, consistency of the effects may strengthen this conclusion. More research needs to be undertaken to examine this relationship and develop and test interventions to reduce the negative effects of isolation.

Strengths and limitations of this study

- The isolation of those with infectious disease is common, and in the age of increased antimicrobial resistance may become more common and important.
- It is important to examine both psychological and non-psychological outcomes associated with isolation.
- This is a methodologically challenging area to examine, however consistency in the body of evidence might increase confidence in the findings.
- It is not known if any effects are temporary or how long they last.

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A competing interests statement

No authors have any competing interests to declare

Introduction

Isolation is an established part of any infection prevention programme. Its purpose is to prevent the transmission of antibiotic-resistant pathogens, those that are highly contagious or cause serious infection.[1] The effectiveness of isolation has been questioned however [2–5] and it can be challenging to undertake, especially if patients' lack of understanding of the need for segregation, boredom or distress result in uncooperative behaviour. [6] Although single rooms are assumed to reduce infection risk, evidence of ability to contain spread is equivocal [7,8] and a recent study conducted in an all-single-room hospital was unable to demonstrate lower infection rates than in hospitals where most care takes place in open wards. [9] This study identified advantages and disadvantages of single room accommodation, whereas isolating infectious patients is generally assumed to result in adverse outcomes.[10]

A systematic review reported eight years ago indicated higher levels of anxiety, depression, perceptions of stigmatisation and a higher incidence of falls, medication errors and other incidents that detract from patient safety among patients who were isolated compared to those who were not.[11] This review reported studies undertaken before 2010 and included patients whose experiences are unlikely to be comparable: children and adults and those isolated to reduce their own risk of infection as well as infectious patients. The review was not reported according to standards currently expected for systematic reviews [12] and presents a qualitative description of patient outcomes only. A more rigorous and up-to-date systematic review is indicated in view of increasing concern about satisfaction with health care and patient safety and

increasing emphasis on infection prevention as part of the global strategy to reduce risks of antimicrobial resistance.[13]

We undertook a systematic review of the literature to establish the effects of infection related isolation on psychological and non-psychological care-related outcomes in adults. This review is therefore more focussed than that previously undertaken which also included those in protective isolation, and contains a significant body of literature published since 2010.

Method

The eligibility criteria for inclusion was that studies should compare psychological or non-psychological outcomes in adult patients who are in infective isolation with those not isolated. Purely symptomatic/disease progression outcomes were not included, neither were those looking at those isolated due to immunosuppression. Studies not containing comparative data were also excluded. Information sources were Embase, Medline and Psychinfo, which were searched from inception until December 2018. Reference lists and Google Scholar were also handsearched. Full details of the search and PRISMA flow-chart together with excluded papers are given in the supplementary information. No protocol was published in advance.

Where available raw data were extracted and entered into a spreadsheet, and depending upon the nature of the data either the relative risk or standardised mean difference calculated. Results were then presented as forest plots. All calculations and plots were produced using the meta package in R.[14,15] Where raw data were not provided the summary results are given in the text but not the forest plots. Due to

the variety of different settings and methods it was deemed that the methodological and clinical heterogeneity was too broad to pool results; in particular outcomes were measured in a variety of different ways.

Patient and Public Involvement

As a secondary analysis patients and public were not involved in this work

Results

A total of 3 879 papers were retrieved from the three databases; 39 of which were screened and 12 excluded, leaving 26 in the final analysis. Of these 13 studies provided data suitable for the calculation of relative risks, 5 giving psychological outcomes,[16–20] and 12 non-physiological;[18,21–31] and 8 provided data for the calculation of standardised mean differences, 6 giving psychological outcomes,[20,29,32–35] and 3 non-psychological.[25,28,36] A further 6 studies did not provide raw data but are included in the results; 3 each giving psychological outcomes[37–39] and non-psychological outcomes.[16,40,41]

As it had been decided not to attempt statistical pooling of study results, the data from studies are shown as forest plots but without meta-analysis. The forest plots contain results from the studies where sufficient data were given to calculate either the relative risk or standardised mean difference. A number of studies provided data on those under contact precautions, but no comparative data and so were not included.[42–45]

Because of the large number of non-psychological outcomes for which RR could be calculated, it was decided that a change of 20% (i.e. a RR of 0.8 or less, or 1.2 or more) would be clinically significant, regardless of the statistical significance. Results are shown in Figures 1 to 5. Figure 5 contains results that did not meet our criteria for being clinically significant (see supplemental information).

The studies included were primarily single-centre and consisted of case-control, cross-sectional and cohort studies. Although these studies have limited generalisability, there did not appear to be significant cause for concern regarding bias within the limitation inherent in these study designs. Full details of each study is given in the supplementary information.

The data from the comparative studies suggest that although in many cases contact precautions makes little difference to psychological outcomes, where it does make a difference this is primarily negative. There were significant declines in mean scores related to control and self-esteem, and in many studies increases in the mean scores for risk of anxiety and depression. However, these findings were not consistent, and some larger studies showed little or no difference between the groups for these outcomes. These are shown in Figures 1 and 2 respectively.

[INSERT FIGURES 1 and 2 HERE]

Figure 1. Relative risk of psychological events in those isolated versus not isolated

Figure 2. Standardised mean difference of psychological scores in those isolated versus those not isolated

Studies not reporting the raw data showed that contact precautions were associated with depression OR 1.4 (95% CI 1.2 to 1.5) but not anxiety OR 0.8 (95% CI 0.7 to 1.1) in a non-ICU population.[40] There was also an association with delirium OR, 1.40 (95% CI 1.24 to 1.51); although this was primarily among those who were newly diagnosed as needing isolation OR, 1.75 (95% CI 1.60 to 1.92, $p<0.01$) rather than those who had been under contact precautions for their entire stay OR 0.97 (95% CI 0.86 to 1.09, $p=0.60$).[16] Another study showed no difference in the median values for the Hospital Anxiety and Depression Scale anxiety or depression scores (HADS-A and -D), or the EuroQol Visual Analogue Scale EQ VAS scores.[41]

For non-psychological outcomes, using a difference in the risk of +/- 20% of an event as being a measure of clinical significance it appears there was a trend for less attention to be given to, and for more errors to occur in those who were isolated. However, again there was wide variation between studies. Data on these outcomes are given in Figures 3 and 4, and the non-clinically significant risks in the supplementary information (Figure 5).

[INSERT FIGURES 3 and 4 HERE]

Figure 3. Relative risk of non-psychological events in those isolated versus not isolated

Figure 4. Standardised mean difference of non-psychological scores in those isolated versus those not isolated

A study not giving raw data which looked at the rates of falls and pressure ulcers before and after a policy change that resulted in the discontinuation of contact precautions for patients with methicillin resistant *Staphylcoccus aureus* (MRSA) or vancomycin resistant enterococci (VRE) found that falls and pressure ulcers were more common among those with MRSA or VRE both before the change (when they were in isolation) and afterwards (when they were not). Before the change the number of falls was 4.57 vs 2.04 per 1000 patient-days respectively ($p< 0.0001$) and pressure ulcers 4.87 vs 1.22 per 1000 patient-days ($p< 0.0001$). After the policy change the same numbers were falls 4.82 vs 2.10 ($p<0.0001$) and pressure ulcers 4.17 vs 1.19 per 1000 patient-days ($p<0.0001$).[38] Other studies found that staff spent less time with those on contact precautions: internal medicine interns spent less time with their isolated patients compared to non-isolated patients, the median times being 5.2 and 6.9 minutes respectively ($p<0.001$)[37]; while the mean number of contacts per hour with healthcare workers was 2.1 compared to 4.2 in those not isolated ($p=0.03$), although the duration was longer at 4.5 minutes compared to 2.8 ($p=0.6$).[39]

Discussion

Current recommendations say that contact precautions should include a single room, with personal protective equipment consisting of a gown and gloves for all patient contacts or contacts with potentially contaminated environmental areas.[1] This review has shown that there are a number of apparently negative aspects to contact

precautions, in particular with regards to psychological effects and a reduction in the quality of some aspects of care. These data come from studies carried out in a variety of countries and different types of facility; although there are few data from particularly vulnerable populations such as the elderly.

Although at times there are discussions as to the necessity of contact precautions for drug resistant organisms, with some arguing that that there is mixed evidence for or against their use[46] another recent review has concluded that they are of great importance in the control of epidemic and endemic multidrug-resistant microorganisms.[47] The ethics of using contact precautions and other forms of isolation rely on a positive assessment of the balance between the risks and benefits of this to the individual concerned and that of the broader population of patients and staff.[48] However, even when this assessment is positive, it is important to ensure that any harm to the individual is minimised.

One way of balancing the various priorities is to use the GRADE Evidence to Decision Framework, which provides criteria for making recommendations at the individual, group and policy-levels, and provides a number of highly patient focussed criteria for doing this. In addition to the certainty of evidence and resource requirements, it also requires consideration of: the balance of desirable and undesirable effects; the impact upon equity; and the feasibility and acceptability of the intervention.[49] The last two of these might have very different outcomes when considered at the population and individual levels; and there is certainly evidence here that for the individual patient the balance of desirable and undesirable effects might be very different to that of the broader population.

However, within the broad population of infected or potentially infected patients, some groups might have different needs. For example a study of people isolated for MERS found that while access to telephones reduced anxiety and anger; access to email, text and internet increased these.[50] This was not an area investigated in any depth in these studies. Another area where information may be lacking is that of age, as older people in particular might feel sadness and loneliness more; and gender, as women were more concerned about precautions and transmission while men were more resigned, rational and tended to cope better.[51]

In some countries, such as the United States single-rooms have become the standard for new hospitals and so one might expect fewer adverse effects if everyone is in a single room, this being the norm. However it may be that a single room is necessary but not sufficient for these findings, and that it is the combination of a single room with an infection that leads to these results. Certainly it is far from clear that the long list of advantages claimed for single rooms which include reduced stress, the ability to deliver better care, and a lower probability of dietary or medication errors apply to this group of patients.[52]

Caring for patients in single-rooms does have many challenges, but there is evidence that these can be mitigated in a general population;[9] however the expanding literature on how this can be done in a general population does not necessarily apply here due to the necessity of isolation procedures which are, by design, ‘a barrier’. Therefore patients’ needs for greater social interaction will need a solution quite

different from that which might be used for a different patient population, and the benefit of choice about this which single rooms offer does not apply here.[53] Although this review has quantified the extent of the problem, we have not been able to find solutions in the literature. Care might be improved through increased staff attention with more resources being allocated to these patients, although the extra cost of contact precautions is already considerable, one estimate being that it was an extra $158.90 (95% CI $124.90 to $192.80) per patient day.[54] Alternatively new ways of working might be developed, perhaps using technology to mitigate some of these problems. What these might be is not clear however.

Study strengths and limitations

This review suggests that infectious isolation has a number of negative effects on patients. Because this evidence is comprised of cohort and case-control studies, a claim for a causal relationship cannot be made on this evidence, although the strong and consistent effects across the studies may increase the confidence in this relationship. There are some qualitative data, although more in-depth mixed-methods data where those reporting negative effects are questioned about them would strengthen the evidence on this. In some cases large effect sizes were accompanied by very wide confidence intervals, suggesting that studies were underpowered, thus studies with larger sample sizes would be useful.

Although these data suggest that there is a problem, there is a clear gap both in what we know about improving the experience of isolation and what can be done in practical terms to make it more tolerable for patients and their families. In particular older people who may be most vulnerable to these negative effects were under-

represented in these studies; and this group are likely to represent an increasingly large proportion of those isolated. Lastly the use of isolation may need to increase if the current trends of antimicrobial resistance continue.

Contributors

EP, DG and JC conceived and conducted the review.

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A competing interests statement

No authors have any competing interests to declare

Data availability statement

No additional data available

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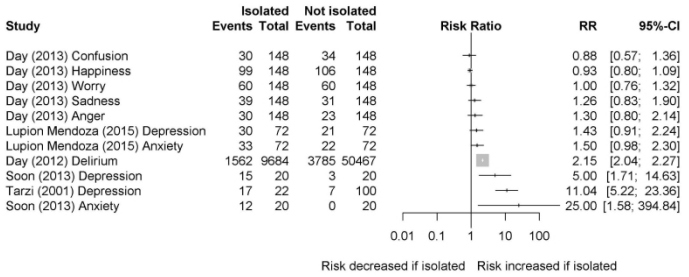

Figure 1. Relative risk of psychological events in those isolated versus not isolated

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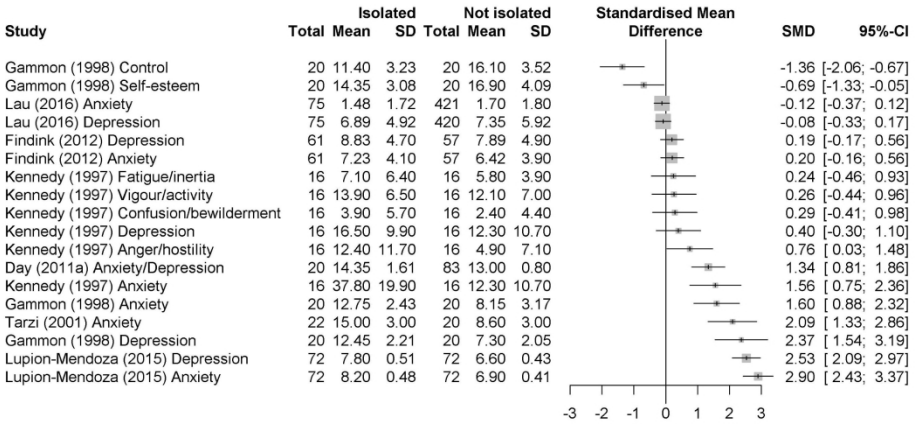

Figure 2. Standardised mean difference of psychological scores in those isolated versus those not isolated

251x114mm (300 x 300 DPI)

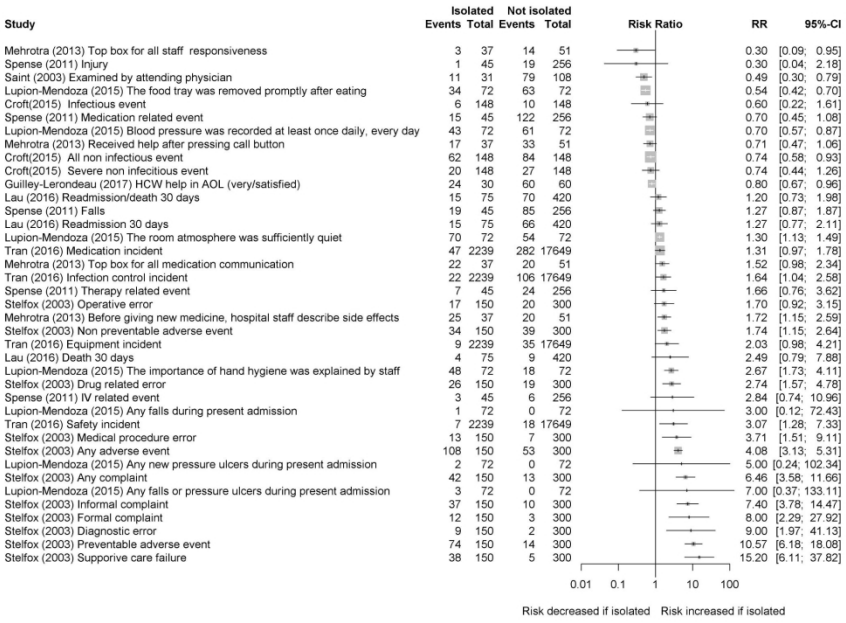

Figure 3. Relative risk of non-psychological events in those isolated versus not isolated

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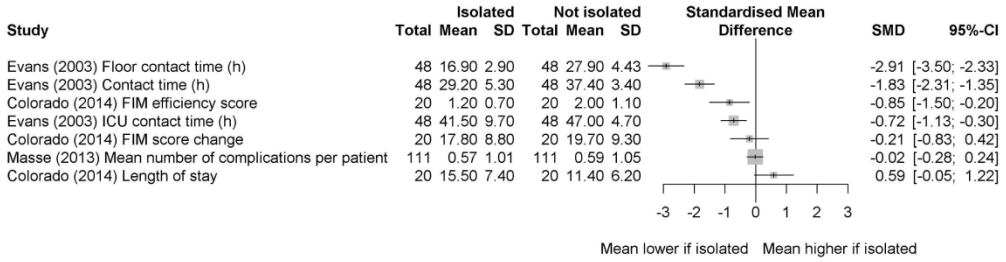


Figure 4. Standardised mean difference of non-psychological scores in those isolated versus those not isolated

251x114mm (300 x 300 DPI)

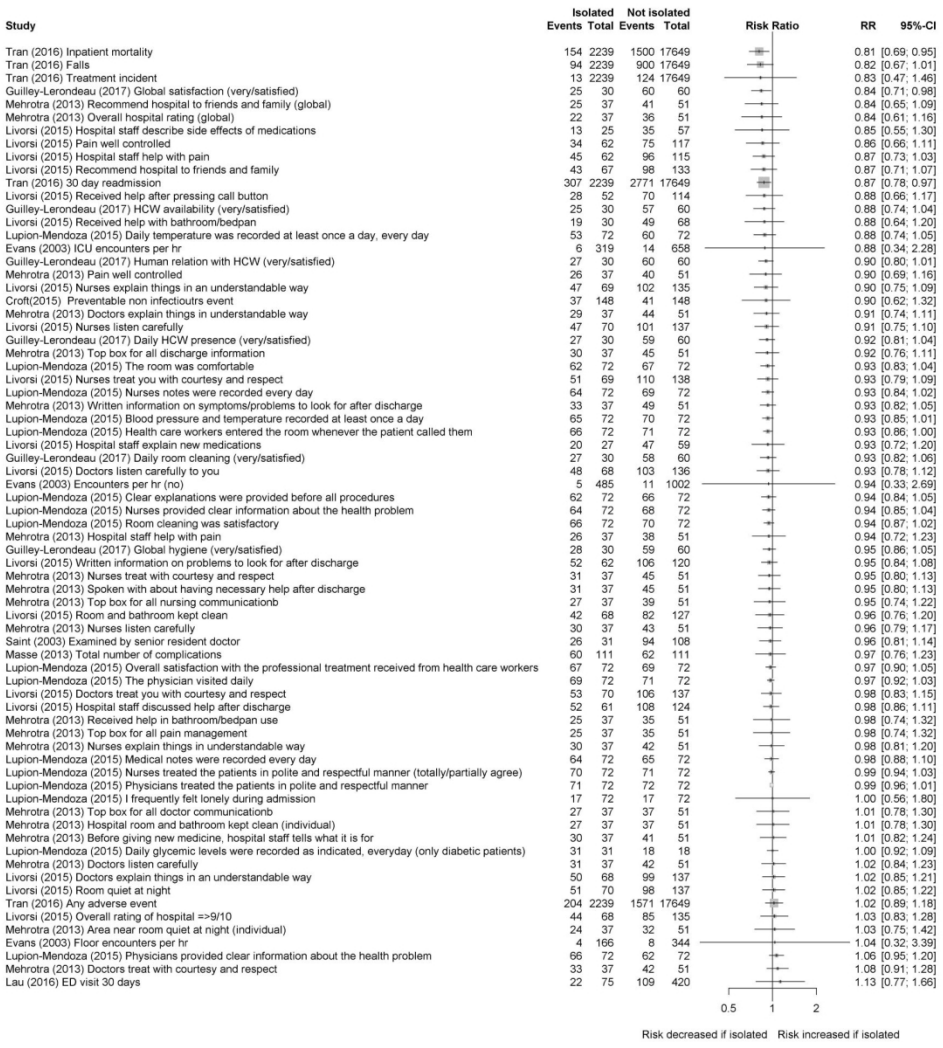
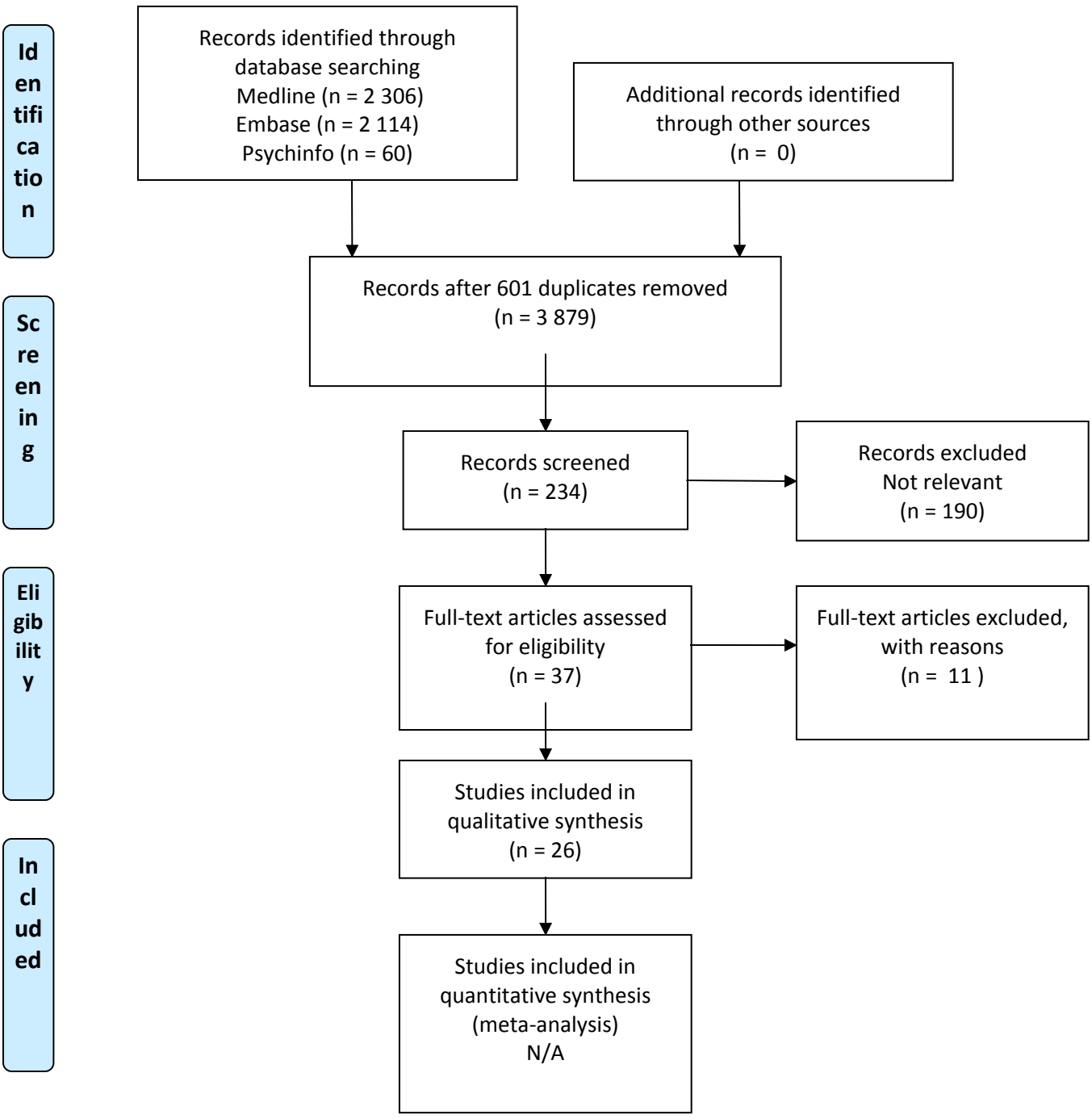


Figure 5. Relative risk of non-psychological events in those isolated versus not isolated (non clinically significant only)

153x187mm (300 x 300 DPI)

PRISMA 2009 Flow Diagram



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Characteristics of studies

Reference	Study type	Isolated	Non isolated
Chittick (2016)	Cross sectional survey. Response rate 48.7%. Tertiary centre, United States January 1, 2014 to December 31, 2014	Patients in contact isolation for >48 hours Demographics not given	
Colorado (2014)	Retrospective matched case control study. Rehabilitation facility- tertiary centre United States July 2009 to December 2010	N20 Patients in contact isolation	N=20 Matched to patients not in contact isolation based on age, rehabilitation diagnosis, and type of insurance
Croft (2015)	Prospective cohort Medical or surgical inpatients admitted to non–intensive care unit hospital wards, United States. January to November 2010.	N=148 Patients on contact precautions Age: 52 (13.8) % male: 53.4	N=148 Individually matched by after an initial 3-day length of stay to patients not on contact precautions. Age 52.3 (14.6) % male: 46.6
Dashiell-Earp (2014)	Collected real-time data on the location of 15 internal medicine interns, United States. October 1, 2012 to December 31, 2012	1156 encounters	2467 encounters
Day (2011)	Patients admitted to the general acute care units, United States. June 1, 2009 to October 30, 2009	N=20 Age: 68.5 (14.7) % male: 85.0	N=83 Age: 63.9 (12.6) % male: 95.2
Day (2011)	A two-year retrospective cohort Tertiary care, United States.. All general inpatients over 18 years hospitalized for >24 h February 1, 2007 to January 31, 2009.	Contact precautions private room when possible, can be cohorted General N = 3138 Age: 51.2 (17.5) % male 58.9 ITU N=1694 Age: 54.9 (17.5) % male 61.0	General N = 25 426 Age: 49.6 (19.0) % male 46.3% ICU N = 5 854 Age: 56.0 (17.7) % male 59.7
Day (2012)	2-year retrospective cohort study of all non-psychiatric hospital admissions >18 years, United States. February 1, 2007 to January 31, 2009	N = 9 684 Contact precautions as above Mean age: 50.1 (18.8) % male 51.4	N = 50 458 Mean age: 52.3 (16.9) % males 59.1
Day (2013)	Longitudinal frequency-matched	N = 148	N = 148

	cohort study of patients admitted to general medical and surgical units, United States. Day 0, day 3 then weekly. January to November 2010	Mean age: 52.0 (13.9) % male 58.1	Mean age: 52.3 (14.6) % male 50.7
Evans (2003)	Prospective observation; survey; retrospective review, United States. Tertiary care. June and July 2001	N 48 Mean age: 47.8 (2) % male 85%	N = 48 Mean age: 58.3 (2.4) % male 75%
Findink (2012)	Non-random quasi-experiment, Turkey Age 18 to 65 Administered day 5 January 1, 2009 to December 31, 2009	N = 60 Mean age: 53.95 (18.4) % male 75%	N = 57 Mean age: 56.14 (17.1) % male 76.3%
Gammon (1998)	Quasi experiment Selected if last two numbers on their case notes even. Two large District General Hospitals and one elderly care hospital, United Kingdom	N = 20 Placed in isolation for a minimum of 7days Mean age: 61 years % male: 65	N = 20 Mean age: 52 years % male: 55
Gandra (2014)	Retrospective hospital-wide cohort study, United States. All patients admitted to medical-surgical inpatient units November 1, 2009 to October 31, 2011	Falls N=77 Mean age: 66.1 (14.3) % male: 61% Pressure ulcers N=82 Mean age: 64.5 (15.5) % male: 63	Falls N=82 Mean age: 63.7 (15.8) % male: 51 (62%) Pressure ulcers N=71 Mean age: 65.7 (15) % male: 57
Guilley-Lerondeau (2017)	Matched cohort study with prospective inclusions Interview 3 days after commencing General sample. France March to July 2012	N=30 First prescription of isolation precaution Median age (range) 69 (32 to 91) % male 47	N=60 Median age (range) 64 (24 to 91) % male 53
Kennedy (1997)	Cross-sectional matched-control study, United Kingdom. May 1994 to November 1996	N = 16 Isolated as a result of being MRSA Mean age: 31.1 All male	N = 16 Matched for age, sex, level of injury, and time since admission or injury
Kirkland (1999)	Observational study - 7 months Medical intensive-care, United States	N=14	N=21
Lau (2016)	Prospective cohort study. Adult patients discharged from	N=75 Mean age 60.35 (17.83)	N=420 Mean age 63.31 (18.69)

	internal medicine wards, Canada October 2013 to November 2014,	% male 59	% male 48%
Livorsi (2015)	Case-control study Retrospective January 1, 2012 to May 31, 2012/prospective June 1, 2012 to March 31, 2013 'safety-net facility', United States	N = 70 On contact precautions for MRSA throughout their hospital stay. Found to be MRSA positive during a previous hospitalization or as an outpatient, not current case	N = 139 No significant differences between isolated and non-isolated patients
Lupión-Mendoza (2015)	Matched case-control study Tertiary hospital, Spain 2011 and 2012	N = 72 Adult patients admitted in isolation for =>5 days. Median age (range) 62 (21-93) % male 73%	N = 72 Median age (range) 69 (23-89), % male 68.1%
Massee (2013)	Retrospective case-control Tertiary care, Canada	N = 111 Matched MRSA patients with an admission diagnosis of heart failure or COPD to similar non-isolated controls Median age (IQR) 80.0 (69.0-86.0) % male 60.4%	N = 111 Median age (IQR) 80.0 (68.0–86.0) % male 60.4%
Mehrotra (2013)	Prospective cohort Admission and on days 3, 7, 14 Tertiary centre, United States	N = 238 Segregation into a private or cohorted room Mean age (SD) 52.4 (13.4) % male 55.7	N = 290 Mean age (SD) 52.9 (14.8) % male 48
Saint (2003)	Prospective cohort study 2 university-affiliated medical centers, United States. October 1999 to March 2000	N=31	N=108
Soon (2013)	Cross-sectional survey of cases and matched controls Teaching hospital Singapore June and August 2011	N=20 Contact isolation in a cohort cubicle for the first time because of colonization or infection with a MDRO for at least 3 days No statistically significant differences in age or gender	N=20
Spense (2011)	Retrospective evaluation of incident reports All patients admitted to acute care facility, United States January 1, 2008 to December 31, 2008.	N=45	N=256
Stelfox	Case control study	General N = 78	General N = 156

(2003)	Consecutive adults isolated for at least 2 days with MRSA. Canada and United States Controls patients admitted before and after. January 1, 1999,to January 1, 2000	Age: 69.6 (17.1) % male: 45% CHF N = 72 Age: 66.9 (14.7) % male: 58	Age: 65.4 (18.2) % male: 51% CHF N = 144 Age: 66.0 (14.5) % male: 54
Tarzi (2001)	Cross-sectional matched case-control study Care of the elderly rehabilitation wards, UK	N = 22 Had been in isolation for at least two weeks with MRSA Mean age (SD) 80 (8.4) % male 27.3	N = 20 Mean age (SD) 81 (9.1) % male 33.3
Tran (2017)	Propensity matched cohort study. General internal medicine services, 3 hospitals, Canada January 2010 to December 2012	MRSA Age: 69 % male 57% Respiratory Age: 71.7 % male: 53 Isolated for MRSA or respiratory illness	MRSA Age: 69 % male 58% Respiratory Age: 70.6 % male: 55
Wassenburg (2010)	Cross-sectional matched cohort study Single university hospital, Netherlands November 2006 to February 2007	N = 42 Age: 52 (19) % male: 52	N = 84 Age: 55 (16) % male: 55

Excluded papers

Reference	Reason for exclusion
Chittick et al (2016)	No comparative data
Godsell (2013)	Focussed on HCP
Jeong (2016)	MERS
MacKellaig (1986)	Qualitative
Madsden (2015)	Qualitative
Maunder (2003)	SARS
Moran (2009)	Focus on family centred care
Morgan (2011)	Focus on process measures

Rees (2000a)	No comparative data
Rees (2000a)	No comparative data
Simon (2016)	Before and after
Wilkins (1988)	No comparative data

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	4
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	4
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	4
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Suppl information
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	4
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	6
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	5
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	5

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	6
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	None
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	5
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Suppl information
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Suppl information
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Figures
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	None
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	6
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	None
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	9-10
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	11
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	11
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	None

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Impact of isolation on hospitalised patients who are infectious: systematic review with quantitative and meta-analysis

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Impact of isolation on hospitalised patients who are infectious: systematic review with quantitative and meta-analysis

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Word count - excluding title page, references, figures and tables – 3 220

Impact of isolation on hospitalised patients who are infectious: systematic review with quantitative and meta-analysis

Abstract

Objective

To systematically review the literature exploring impact of isolation on hospitalised patients who are infectious: psychological and non-psychological outcomes

Design

Systematic review with meta-analysis

Data Sources

Embase, Medline and Psychinfo were searched from inception until December 2018. Reference lists and Google Scholar were also handsearched.

Results

Twenty seven papers published from database inception until December 2018 were reviewed. A wide range of psychological and non-psychological outcomes were reported. There was a marked trend for isolated patients to exhibit higher levels of depression, the pooled standardised mean difference being 1.28 (95% CI: 0.47 to 2.09) and anxiety 1.45 (95% CI: 0.56 to 2.34), although both had high levels of heterogeneity; and worse outcomes for a range of care-related factors but with significant variation.

Conclusion

The review indicates that isolation to contain risk of infection has negative consequences for segregated patients. Although strength of the evidence is weak, comprising primarily single centre convenience samples, consistency of the effects may strengthen this conclusion. More research needs to be undertaken to examine this relationship and develop and test interventions to reduce the negative effects of isolation.

Strengths and limitations of this study

- This review covers a wide variety of literature from a range of different clinical areas.
- Data collected and the methods of collecting data on the impact of isolation is varied across studies.
- These data do not show if these effects are temporary, or in most cases if they are clinically significant.

Funding statement

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Competing interests statement

No authors have any competing interests to declare

Introduction

Isolation is an established part of any infection prevention programme. Its purpose is to prevent the transmission of antibiotic-resistant pathogens, those that are highly contagious or cause serious infection.[1] The effectiveness of isolation has been questioned however [2–5] and it can be challenging to undertake, especially if patients' lack of understanding of the need for segregation, boredom or distress result in uncooperative behaviour. [6] A recent survey exploring the care of patients isolated for infectious conditions suggests that in clinical practice the main issues are identifying which patients need to be isolated as quickly as possible and prioritising which patients should be segregated when isolation accommodation is in short supply. Infection preventionists were aware that isolation could have negative effects on patients such as increased risk of anxiety, depression and falls and felt that more should be done to prevent these risks.[6]

Although single rooms are assumed to reduce infection risk, evidence of ability to contain spread is equivocal [7,8] and a recent study conducted in an all-single-room hospital was unable to demonstrate lower infection rates than in hospitals where most care takes place in open wards. [9] This study identified advantages and disadvantages of single room accommodation, whereas isolating infectious patients is generally assumed to result in adverse outcomes.[10]

A systematic review reported eight years ago indicated higher levels of anxiety, depression, perceptions of stigmatisation and a higher incidence of falls, medication errors and other incidents that detract from patient safety among patients who were isolated compared to those who were not.[11] This review reported studies undertaken

before 2010 and included patients whose experiences are unlikely to be comparable: children and adults and those isolated to reduce their own risk of infection as well as infectious patients. The review was not reported according to standards currently expected for systematic reviews [12] and presents a qualitative description of patient outcomes only. A more rigorously reported and up-to-date systematic review is indicated in view of increasing concern about satisfaction with health care and patient safety and increasing emphasis on infection prevention as part of the global strategy to reduce risks of antimicrobial resistance.[13]

We undertook a systematic review of the literature to establish the effects of infection related isolation on psychological and non-psychological care-related outcomes in adults. This review is therefore more focussed than that previously undertaken which also included those in protective isolation, and contains a significant body of literature published since 2010.

Method

The eligibility criteria for inclusion was that studies should compare quantitative data on psychological or non-psychological outcomes in adult patients who are in infective isolation with those not isolated. Purely symptomatic/disease progression outcomes were not included, neither were those looking at patients isolated due to immunosuppression. Studies not containing comparative data between those isolated and not isolated were also excluded. Search terms were: Patient isolation; cross infection; contact isolation; respiratory, source or contact isolation; droplet, airborne or contact precautions; cubicle; MRSA or methicillin resistant *Staphylococcus aureus*; patient safety or harm; depression; anxiety; adaptation; stress; patient satisfaction;

quality of life. These were searched as free-text and index terms where these existed. The information sources used were Embase, Medline and Psychinfo, which were searched from inception until December 2018. Reference lists and Google Scholar were also handsearched. Characteristics of included and excluded papers are shown in Supplementary File 1. The PRISMA flow-chart together is given in Supplementary File 2. given in with details of excluded papers are given in No protocol was published in advance.

Studies were initially screened for relevance by one author (EP), with the final stage being undertaken by two (EP, DG). Data were extracted and checked by two authors (DG, EP); where there were disagreements data were rechecked for relevance and accuracy. Where available, raw data were extracted and entered into a spreadsheet, and depending upon the nature of the data either the risk ratio or standardised mean difference calculated. Results were then presented as forest plots. Due to the variety of different settings and methods it was deemed that the methodological and clinical heterogeneity was too broad to pool results; apart from those related to anxiety and depression, for which results were pooled using the random-effects model. All calculations and plots were produced using the meta and metafor packages in R.[14–16] Where raw data were not provided the summary results are given in the text but not the forest plots. All data relevant to the study are included in the article or uploaded as Supplementary File 3.

Patient and Public Involvement

No patient involved.

Results

A total of 3 879 papers were retrieved from the three databases; of which 34 were assessed for eligibility by reading the full text. Of these 13 studies provided data suitable for the calculation of risk ratio, 5 giving psychological outcomes,[17–21] and 12 non-psychological;[19,22–32] and 8 provided data for the calculation of standardised mean differences, 6 giving psychological outcomes,[21,30,33–36] and 2 non-psychological.[29,37] A further 6 studies did not provide raw data but are included in the results; 3 each giving psychological outcomes[38–40] and non-psychological outcomes.[17,41,42] Meta-analyses were possible on two outcomes: anxiety and depression from 8 studies using standardised mean difference. [19–21,30,33–36] Where only risk ratio data were given[20,21] conversion to standardised mean difference was undertaken using the Campbell Collaboration calculator (https://campbellcollaboration.org/research-resources/effect-size-calculator.html).[43]

Where it was not possible to pool outcome data because of methodological and clinical heterogeneity, the data from studies are shown as forest plots but without meta-analysis. The forest plots contain results from the studies where sufficient data were given to calculate either the risk ratio or standardised mean difference. A number of studies provided data on those under contact precautions, but no comparative data and so were not included.[44–47]

Because of the large number of non-psychological outcomes for which RR could be calculated, it was decided that a change of 20% (i.e. a RR of 0.8 or less, or 1.2 or more) would be clinically significant, regardless of the statistical significance. This

was a pragmatic decision, and all results are shown in Supplementary File 3. Results are shown in Figures 1 to 6. Supplementary Figure 1 contains results that did not meet our criteria for being clinically significant. Outcomes were classified into one of three categories: those to do with quality of care; satisfaction of care; and adverse events from which median values and interquartile ranges were calculated.

The studies included were primarily single-centre and consisted of case-control, cross-sectional and cohort studies. Risk of bias was assessed using the Newcastle-Ottowa scale, full details of each study and its risk of bias are in the Supplementary File 4.[48] Overall, although these studies have limited generalisability, there did not appear to be significant cause for concern regarding bias within the limitations inherent in these study designs. Most studies used established or validated tools[17–21,23–25,27,29,30,33–37] or clinical outcomes.[22,26,28,31,32]

The data from the comparative studies suggest that although in many cases infective isolation precautions make little difference to psychological outcomes, where it does make a difference this is primarily negative. There were significant declines in mean scores related to control and self-esteem, and in many studies increases in the mean scores for risk of anxiety and depression. However, these findings were not consistent, and some larger studies showed little or no difference between the groups for these outcomes. These are shown in Figures 1 and 2 respectively.

[INSERT FIGURES 1 and 2 HERE]

Figure 1. Risk ratio of psychological events in those isolated versus not isolated

Figure 2. Standardised mean difference of psychological scores in those isolated versus those not isolated

For the 8 studies reporting data on anxiety the pooled SMD was 1.45 (95% CI: 0.56 to 2.34); although within this there was significant heterogeneity ($Q = 168.11$, $df = 7$, $p < 0.0001$; $I^2 = 95.84\%$). This was primarily caused by two studies [30,34] which showed lower levels of anxiety than the remaining studies. For depression the SMD was 1.28 (95% CI: 0.47 to 2.09); again with significant heterogeneity ($Q = 154.5$, $df = 7$, $p < 0.0001$; $I^2 = 95.47\%$), in this case the studies falling into two categories, those with lower [30,34,35] and higher depression scores among those isolated.[19,20,33,36] The forest plots for these outcomes are shown in Figures 3 and 4 respectively.

[INSERT FIGURES 3 and 4 HERE]

Figure 3. Meta-analysis of the standardised mean difference of anxiety in those isolated versus those not isolated

Figure 4. Meta-analysis of the standardised mean difference of depression in those isolated versus those not isolated

Studies not reporting the raw data showed that contact precautions were associated with depression OR 1.4 (95% CI 1.2 to 1.5) but not anxiety OR 0.8 (95% CI 0.7 to 1.1) in a non-ICU population.[41] There was also an association with delirium OR

1.40 (95% CI 1.24 to 1.51); although this was primarily among those who were newly diagnosed as needing isolation OR 1.75 (95% CI 1.60 to 1.92, p<0.01) rather than those who had been under contact precautions for their entire stay OR 0.97 (95% CI 0.86 to 1.09, p=0.60).[17] Another study showed no difference in the median values for the Hospital Anxiety and Depression Scale anxiety or depression scores (HADS-A and -D), or the EuroQol Visual Analogue Scale EQ VAS scores.[42]

For non-psychological outcomes, using a difference in the risk of +/- 20% of an event as being a measure of clinical significance it appears there was a trend for less attention to be given to, and for more errors to occur in those who were isolated. However, again there was wide variation between studies. Data on these outcomes are given in Figures 5 and 6, and the non-clinically significant risks in the Supplementary Figure 1. For those outcomes associated with quality, the median risk ratio (with positive outcomes reversed so a higher risk ratio is associated with a worse outcome) was 0.94 (IQR 0.92 to 0.98), satisfaction 0.95 (IQR 0.89 to 1.01) and adverse events was 1.27 (0.91 to 2.5). The minimum and maximum risk ratio for each category was 0.49 and 1.72; 0.3 and 8; and 0.3 and 18 respectively.

[INSERT FIGURES 5 and 6 HERE]

Figure 5. Risk ratio of non-psychological events in those isolated versus not isolated with a RR of < =0.8 or > =1.2

* outcome was measured in rate per 100 admissions

Figure 6. Standardised mean difference of non-psychological scores in those isolated versus those not isolated

FIM – functional independence measure

A study not giving raw data which looked at the rates of falls and pressure ulcers before and after a policy change that resulted in the discontinuation of contact precautions for patients with methicillin resistant *Staphylcoccus aureus* (MRSA) or vancomycin resistant enterococci (VRE) found that falls and pressure ulcers were more common among those with MRSA or VRE both before the change (when they were in isolation) and afterwards (when they were not). Before the change the number of falls was 4.57 vs 2.04 per 1000 patient-days respectively ($p< 0.0001$) and pressure ulcers 4.87 vs 1.22 per 1000 patient-days ($p< 0.0001$). After the policy change the same numbers were falls 4.82 vs 2.10 ($p<0.0001$) and pressure ulcers 4.17 vs 1.19 per 1000 patient-days ($p<0.0001$).[39] Other studies found that staff spent less time with those on contact precautions: internal medicine interns spent less time with their isolated patients compared to non-isolated patients, the median times being 5.2 and 6.9 minutes respectively ($p<0.001$)[38]; while the mean number of contacts per hour with healthcare workers was 2.1 compared to 4.2 in those not isolated ($p=0.03$), although the duration was longer at 4.5 minutes compared to 2.8 ($p=0.6$).[40]

Discussion

Current recommendations say that contact precautions should include a single room, with personal protective equipment consisting of a gown and gloves for all patient contacts or contacts with potentially contaminated environmental areas.[1] This review has shown that there are a number of apparently negative aspects to contact

precautions, in particular with regards to psychological effects and a reduction in the quality of some aspects of care. These data come from studies carried out in a variety of countries and different types of facilities; although there are few data from particularly vulnerable populations such as the elderly.

Although at times there are discussions as to the necessity of contact precautions for drug resistant organisms, with some arguing that that there is mixed evidence for or against their use[49] another recent review has concluded that they are of great importance in the control of epidemic and endemic multidrug-resistant microorganisms.[50] The ethics of using contact precautions and other forms of isolation rely on a positive assessment of the balance between the risks and benefits of this to the individual concerned and that of the broader population of patients and staff.[51] However, even when this assessment is positive, it is important to ensure that any harm to the individual is minimised.

One way of balancing the various priorities is to use the GRADE Evidence to Decision Framework, which provides criteria for making recommendations at the individual, group and policy-levels, and provides a number of highly patient focussed criteria for doing this. In addition to the certainty of evidence and resource requirements, it also requires consideration of: the balance of desirable and undesirable effects; the impact upon equity; and the feasibility and acceptability of the intervention.[52] The last two of these might have very different outcomes when considered at the population and individual levels; and there is certainly evidence here that for the individual patient the balance of desirable and undesirable effects might be very different to that of the broader population.

However, within the broad population of infected or potentially infected patients, some groups might have different needs. For example a study of people isolated for MERS found that while access to telephones reduced anxiety and anger; access to email, text and internet increased these.[53] This was not an area investigated in any depth in these studies. Another area where information may be lacking is that of age, as older people in particular might feel sadness and loneliness more; and gender, as qualitative data suggest that women in isolation were more concerned about precautions and transmission while men were more resigned, rational and tended to cope better.[54]

In some countries, such as the United States single-rooms have become the standard for new hospitals and so one might expect fewer adverse effects if everyone is in a single room, this being the norm. However it may be that a single room is necessary but not sufficient for these findings, and that it is the combination of a single room with an infection that leads to these results. Certainly it is far from clear that the long list of advantages claimed for single rooms which include reduced stress, the ability to deliver better care, and a lower probability of dietary or medication errors apply to this group of patients.[55]

Caring for patients in single-rooms does have many challenges, but there is evidence that these can be mitigated in a general population;[9] however the expanding literature on how this can be done in a general population does not necessarily apply here due to the necessity of isolation procedures which are, by design, 'a barrier'. Therefore patients' needs for greater social interaction will need a solution quite

different from that which might be used for a different patient population, and the benefit of choice about this which single rooms offer does not apply here.[56]

Although this review has quantified the extent of the problem, we have not been able to find solutions in the literature. Care might be improved through increased staff attention with more resources being allocated to these patients, although the extra cost of contact precautions is already considerable, one estimate being that it was an extra $158.90 (95% CI $124.90 to $192.80) per patient day.[57] Alternatively new ways of working might be developed, perhaps using technology to mitigate some of these problems. Technology might be particularly useful in reducing adverse events such as medication or clinical errors; although increasing satisfaction and some areas of quality are more likely to be achieved by increasing the availability of staff and other people.

Study strengths and limitations

This review suggests that infectious isolation has a number of negative effects on patients. Because this evidence is comprised of cohort and case-control studies, a claim for a causal relationship can not be made on this evidence, although the strong and consistent effects across the studies may increase the confidence in this relationship. There are some qualitative data, although more in-depth mixed-methods data where those reporting negative effects are questioned about them would strengthen the evidence on this. In some cases large effect sizes were accompanied by very wide confidence intervals, suggesting that studies were underpowered, thus studies with larger sample sizes would be useful. It would also be useful if there were more consistent methods of examining and reporting these data, particularly outside

of the realms of depression and anxiety where the variety of methods makes analysis of the body of evidence difficult.

Although these data suggest that there is a problem, there is a clear gap both in what we know about improving the experience of isolation and what can be done in practical terms to make it more tolerable for patients and their families. In particular older people who may be most vulnerable to these negative effects were under-represented in these studies; and this group are likely to represent an increasingly large proportion of those isolated. Lastly the use of isolation may need to increase if the current trends of antimicrobial resistance continue.

Contributors

EP, DG and JC conceived the review, EP conducted the search, EP and DG examined the studies and extracted data, EP undertook the quantitative analysis, EP, DG and JC undertook the qualitative analysis and wrote the discussion.

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Competing interests statement

No authors have any competing interests to declare.

Data Availability

All data relevant to the study are included in the article or uploaded as supplementary information.

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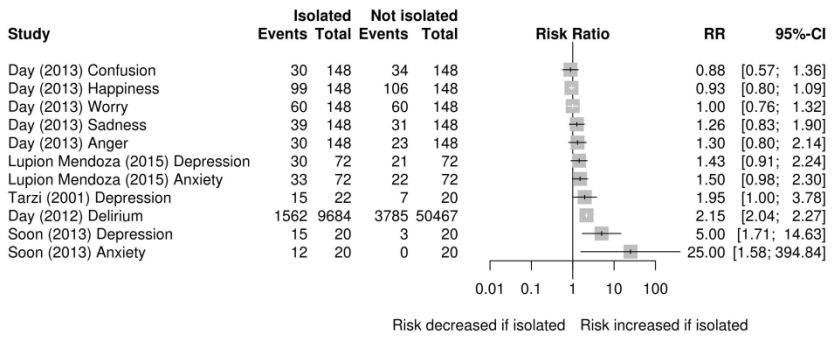

Figure 1. Risk ratio of psychological events in those isolated versus not isolated

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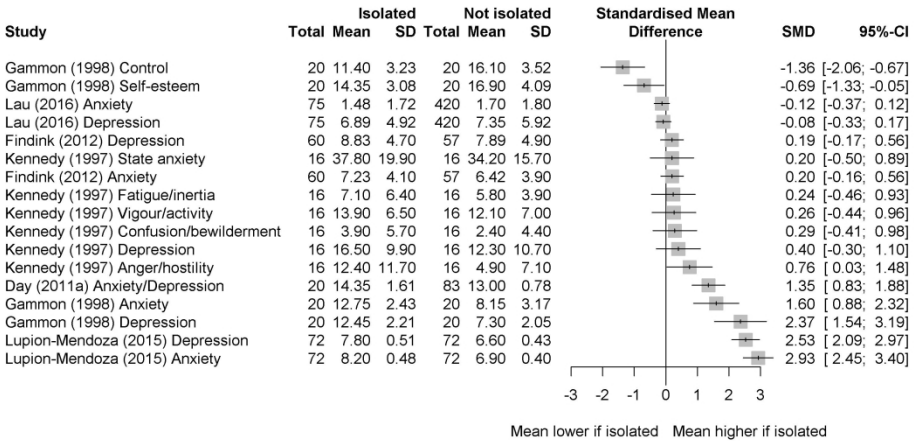

Figure 2. Standardised mean difference of psychological scores in those isolated versus those not isolated

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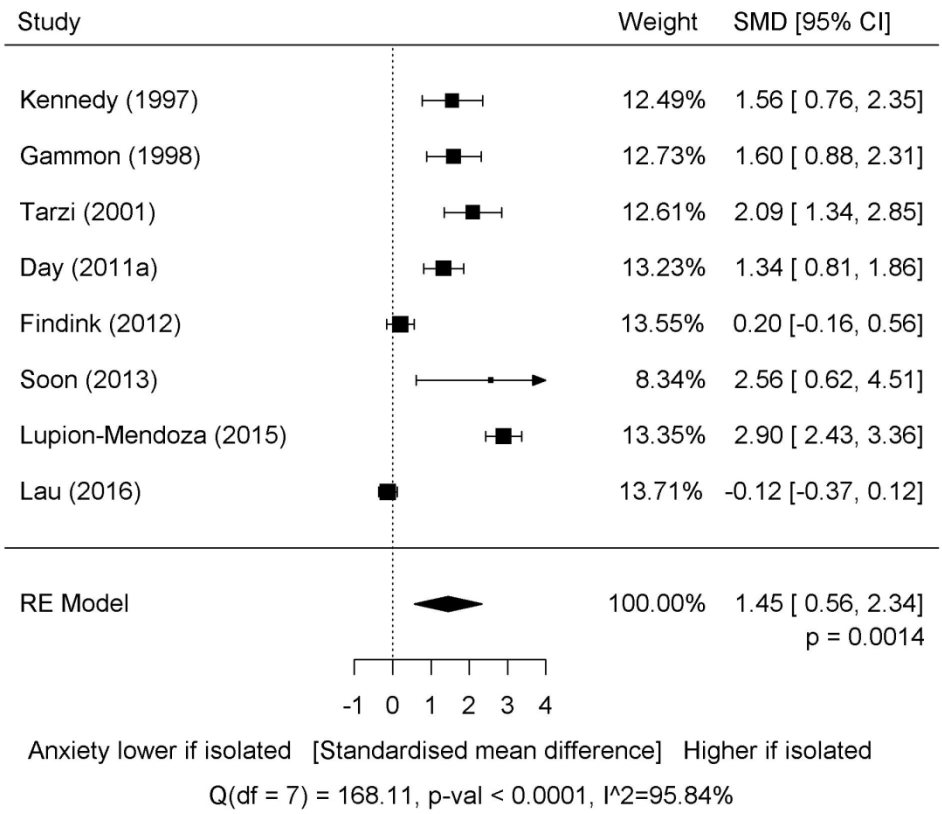

Figure 3. Meta-analysis of the standardised mean difference of anxiety in those isolated versus those not isolated

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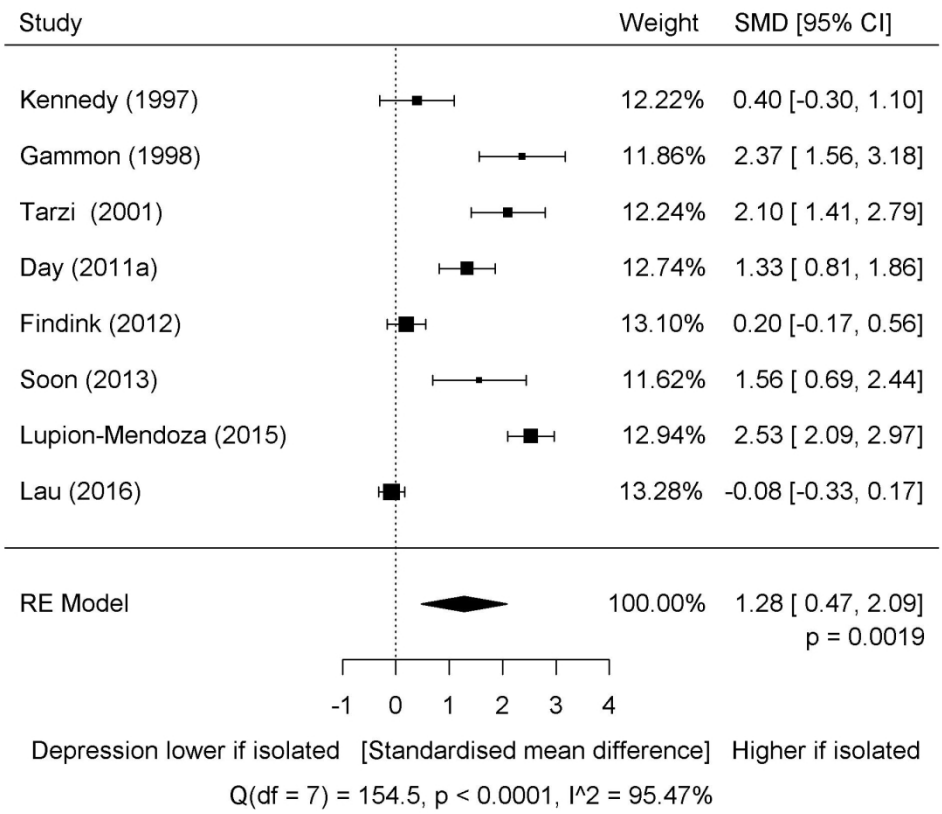

Figure 4. Meta-analysis of the standardised mean difference of depression in those isolated versus those not isolated

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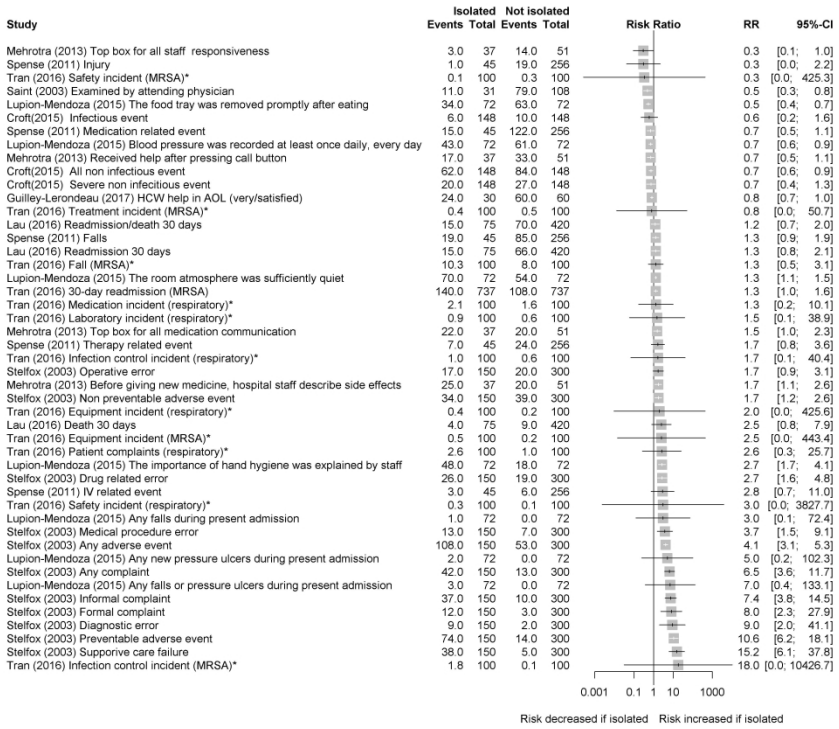

Figure 5. Risk ratio of non-psychological events in those isolated versus not isolated with a RR of < =0.8 or > =1.2

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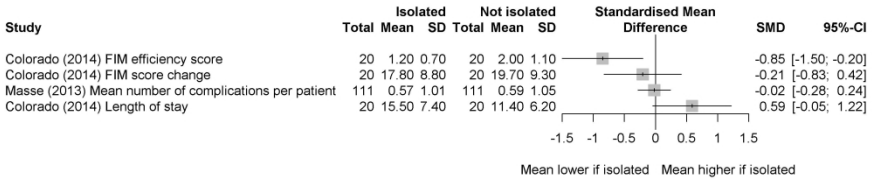


Figure 6. Standardised mean difference of non-psychological scores in those isolated versus those not isolated

321x127mm (300 x 300 DPI)

Characteristics of studies

Reference	Study type	Isolated	Non isolated
Colorado (2014)	Retrospective matched case control study. Rehabilitation facility- tertiary centre United States July 2009 to December 2010	N20 Patients in contact isolation	N=20 Matched to patients not in contact isolation based on age, rehabilitation diagnosis, and type of insurance
Croft (2015)	Prospective cohort Medical or surgical inpatients admitted to non–intensive care unit hospital wards, United States. January to November 2010.	N=148 Patients on contact precautions Age: 52 (13.8) % male: 53.4	N=148 Individually matched by after an initial 3-day length of stay to patients not on contact precautions. Age 52.3 (14.6) % male: 46.6
Dashiell-Earp (2014)	Collected real-time data on the location of 15 internal medicine interns, United States. October 1, 2012 to December 31, 2012	1156 encounters	2467 encounters
Day (2011)	Patients admitted to the general acute care units, United States. June 1, 2009 to October 30, 2009	N=20 Age: 68.5 (14.7) % male: 85.0	N=83 Age: 63.9 (12.6) % male: 95.2
Day (2011)	A two-year retrospective cohort Tertiary care, United States.. All general inpatients over 18 years hospitalized for >24 h February 1, 2007 to January 31, 2009.	Contact precautions private room when possible, can be cohorted General N = 3138 Age: 51.2 (17.5) % male 58.9 ITU N=1694 Age: 54.9 (17.5) % male 61.0	General N = 25 426 Age: 49.6 (19.0) % male 46.3% ICU N = 5 854 Age: 56.0 (17.7) % male 59.7
Day (2012)	2-year retrospective cohort study of all non-psychiatric hospital admissions >18 years, United States. February 1, 2007 to January 31, 2009	N = 9 684 Contact precautions as above Mean age: 50.1 (18.8) % male 51.4	N = 50 458 Mean age: 52.3 (16.9) % males 59.1
Day (2013)	Longitudinal frequency-matched cohort study of patients admitted to general medical and surgical units, United States. Day 0, day 3 then weekly. January to November 2010	N = 148 Mean age: 52.0 (13.9) % male 58.1	N = 148 Mean age: 52.3 (14.6) % male 50.7

Evans (2003)	Prospective observation; survey; retrospective review, United States. Tertiary care. June and July 2001	N 48 Mean age: 47.8 (2) % male 85%	N = 48 Mean age: 58.3 (2.4) % male 75%
Findink (2012)	Non-random quasi-experiment, Turkey Age 18 to 65 Administered day 5 January 1, 2009 to December 31, 2009	N = 60 Mean age: 53.95 (18.4) % male 75%	N = 57 Mean age: 56.14 (17.1) % male 76.3%
Gammon (1998)	Quasi experiment Selected if last two numbers on their case notes even. Two large District General Hospitals and one elderly care hospital, United Kingdom	N = 20 Placed in isolation for a minimum of 7days Mean age: 61 years % male: 65	N = 20 Mean age: 52 years % male: 55
Gandra (2014)	Retrospective hospital-wide cohort study, United States. All patients admitted to medical-surgical inpatient units November 1, 2009 to October 31, 2011	Falls N=77 Mean age: 66.1 (14.3) % male: 61% Pressure ulcers N=82 Mean age: 64.5 (15.5) % male: 63	Falls N=82 Mean age: 63.7 (15.8) % male: 51 (62%) Pressure ulcers N=71 Mean age: 65.7 (15) % male: 57
Guilley-Lerondeau (2017)	Matched cohort study with prospective inclusions Interview 3 days after commencing General sample. France March to July 2012	N=30 First prescription of isolation precaution Median age (range) 69 (32 to 91) % male 47	N=60 Median age (range) 64 (24 to 91) % male 53
Kennedy (1997)	Cross-sectional matched-control study, United Kingdom. May 1994 to November 1996	N = 16 Isolated as a result of being MRSA Mean age: 31.1 All male	N = 16 Matched for age, sex, level of injury, and time since admission or injury
Kirkland (1999)	Observational study - 7 months Medical intensive-care, United States	N=14	N=21
Lau (2016)	Prospective cohort study. Adult patients discharged from internal medicine wards, Canada October 2013 to November 2014,	N=75 Mean age 60.35 (17.83) % male 59	N=420 Mean age 63.31 (18.69) % male 48%
Livorsi (2015)	Case-control study Retrospective January 1, 2012 to	N = 70 On contact precautions for MRSA throughout	N = 139 No significant differences between isolated and

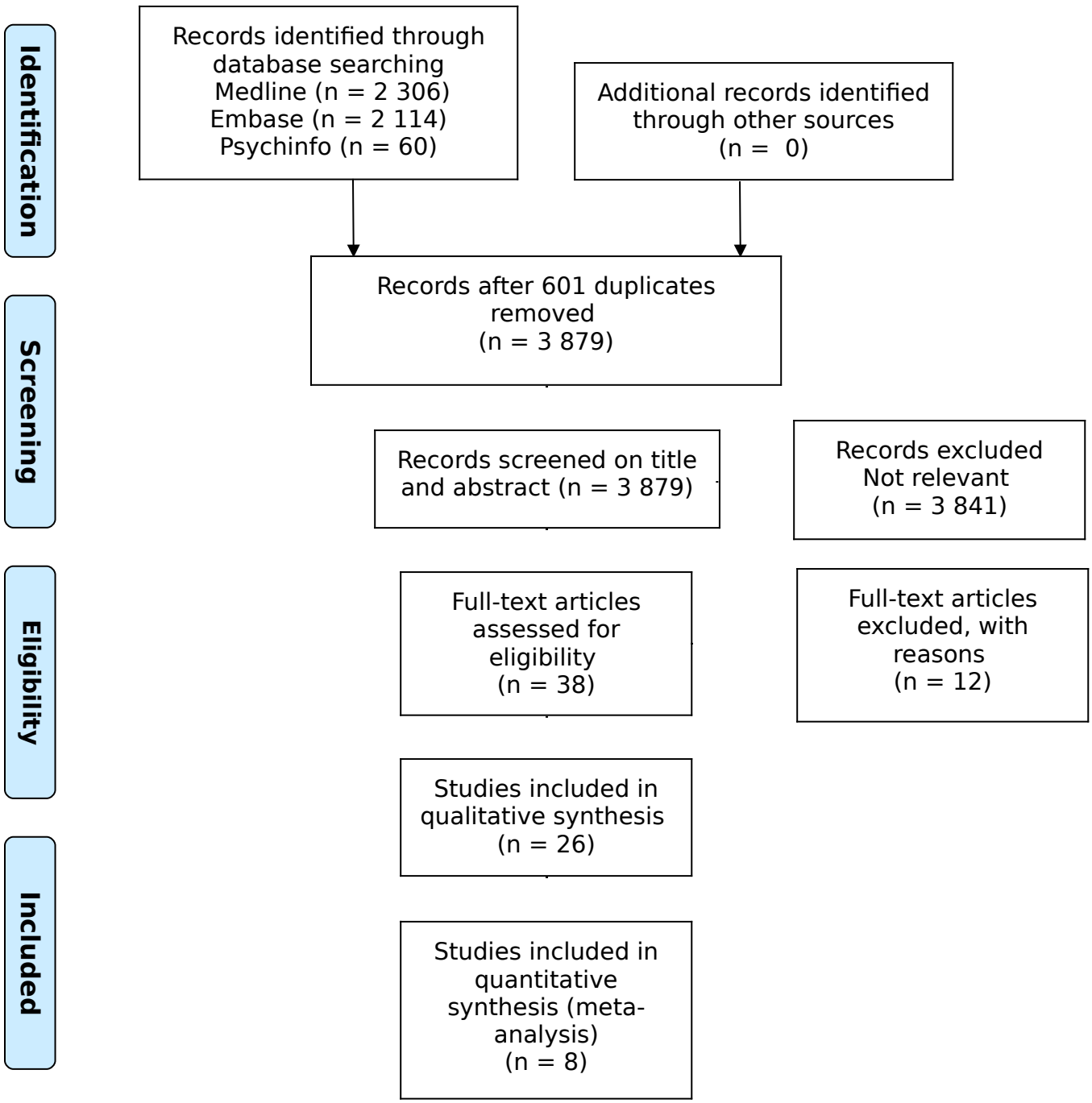
	May 31, 2012/prospective June 1, 2012 to March 31, 2013 'safety-net facility', United States	their hospital stay. Found to be MRSA positive during a previous hospitalization or as an outpatient, not current case	non-isolated patients
Lupión-Mendoza (2015)	Matched case-control study Tertiary hospital, Spain 2011 and 2012	N = 72 Adult patients admitted in isolation for =>5 days. Median age (range) 62 (21-93) % male 73%	N = 72 Median age (range) 69 (23-89), % male 68.1%
Massee (2013)	Retrospective case-control Tertiary care, Canada	N = 111 Matched MRSA patients with an admission diagnosis of heart failure or COPD to similar non-isolated controls Median age (IQR) 80.0 (69.0-86.0) % male 60.4%	N = 111 Median age (IQR) 80.0 (68.0–86.0) % male 60.4%
Mehrotra (2013)	Prospective cohort Admission and on days 3, 7, 14 Tertiary centre, United States	N = 238 Segregation into a private or cohorted room Mean age (SD) 52.4 (13.4) % male 55.7	N = 290 Mean age (SD) 52.9 (14.8) % male 48
Saint (2003)	Prospective cohort study 2 university-affiliated medical centers, United States. October 1999 to March 2000	N=31	N=108
Soon (2013)	Cross-sectional survey of cases and matched controls Teaching hospital Singapore June and August 2011	N=20 Contact isolation in a cohort cubicle for the first time because of colonization or infection with a MDRO for at least 3 days No statistically significant differences in age or gender	N=20
Spense (2011)	Retrospective evaluation of incident reports All patients admitted to acute care facility, United States January 1, 2008 to December 31, 2008.	N=45	N=256
Stelfox (2003)	Case control study Consecutive adults isolated for at least 2 days with MRSA. Canada and United States Controls patients admitted before	General N = 78 Age: 69.6 (17.1) % male: 45% CHF N = 72 Age: 66.9 (14.7)	General N = 156 Age: 65.4 (18.2) % male: 51% CHF N = 144 Age: 66.0 (14.5)

	and after. January 1, 1999,to January 1, 2000	% male: 58	% male: 54
Tarzi (2001)	Cross-sectional matched case-control study Care of the elderly rehabilitation wards, UK	N = 22 Had been in isolation for at least two weeks with MRSA Mean age (SD) 80 (8.4) % male 27.3	N = 20 Mean age (SD) 81 (9.1) % male 33.3
Tran (2017)	Propensity matched cohort study. General internal medicine services, 3 hospitals, Canada January 2010 to December 2012	MRSA Age: 69 % male 57% Respiratory Age: 71.7 % male: 53 Isolated for MRSA or respiratory illness	MRSA Age: 69 % male 58% Respiratory Age: 70.6 % male: 55
Wassenburg (2010)	Cross-sectional matched cohort study Single university hospital, Netherlands November 2006 to February 2007	N = 42 Age: 52 (19) % male: 52	N = 84 Age: 55 (16) % male: 55

Excluded papers

Reference	Reason for exclusion
Chittick et al (2016)	No comparative data
Godsell (2013)	Focussed on HCP
Jeong (2016)	MERS
MacKellaig (1986)	Qualitative
Madsden (2015)	Qualitative
Maunder (2003)	SARS
Moran (2009)	Focus on family centred care
Morgan (2011)	Focus on process measures
Rees (2000a)	No comparative data
Rees (2000a)	No comparative data
Simon (2016)	Before and after
Wilkins (1988)	No comparative data

PRISMA 2009 Flow Diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

All RR data

	Reference	Year
1	Croft(2015)	2015
2	Croft(2015)	2015
4	Croft(2015)	2015
9	Guilley-Lerondeau (2017)	2017
15	Lau (2016)	2016
16	Lau (2016)	2016
18	Lau (2016)	2016
43	Lupion-Mendoza (2015)	2015
48	Lupion-Mendoza (2015)	2015
50	Lupion-Mendoza (2015)	2015
54	Lupion-Mendoza (2015)	2015
57	Lupion-Mendoza (2015)	2015
58	Lupion-Mendoza (2015)	2015
59	Lupion-Mendoza (2015)	2015
69	Mehrotra (2013)	2013
71	Mehrotra (2013)	2013
76	Mehrotra (2013)	2013
77	Mehrotra (2013)	2013
85	Stelfox (2003)	2003
86	Stelfox (2003)	2003
87	Stelfox (2003)	2003
88	Stelfox (2003)	2003
89	Stelfox (2003)	2003
90	Stelfox (2003)	2003
91	Stelfox (2003)	2003
92	Stelfox (2003)	2003
93	Stelfox (2003)	2003
94	Stelfox (2003)	2003
95	Stelfox (2003)	2003
96	Spense (2011)	2011
97	Spense (2011)	2011
98	Spense (2011)	2011
99	Spense (2011)	2011
100	Spense (2011)	2011
102	Saint (2003)	2003
103	Tran (2016)	2016
106	Tran (2016)	2016
107	Tran (2016)	2016
108	Tran (2016)	2016
109	Tran (2016)	2016
113	Tran (2016)	2016
114	Tran (2016)	2016
116	Tran (2016)	2016
117	Tran (2016)	2016
118	Tran (2016)	2016
120	Tran (2016)	2016
122	Tran (2016)	2016
3	Croft(2015)	2015
5	Evans (2003)	2003
6	Evans (2003)	2003
7	Evans (2003)	2003
8	Guilley-Lerondeau (2017)	2017
10	Guilley-Lerondeau (2017)	2017
11	Guilley-Lerondeau (2017)	2017

All RR data

12	Guilley-Lerondeau (2017)	2017
13	Guilley-Lerondeau (2017)	2017
14	Guilley-Lerondeau (2017)	2017
17	Lau (2016)	2016
19	Livorsi (2015)	2015
20	Livorsi (2015)	2015
21	Livorsi (2015)	2015
22	Livorsi (2015)	2015
23	Livorsi (2015)	2015
24	Livorsi (2015)	2015
25	Livorsi (2015)	2015
26	Livorsi (2015)	2015
27	Livorsi (2015)	2015
28	Livorsi (2015)	2015
29	Livorsi (2015)	2015
30	Livorsi (2015)	2015
31	Livorsi (2015)	2015
32	Livorsi (2015)	2015
33	Livorsi (2015)	2015
34	Livorsi (2015)	2015
35	Livorsi (2015)	2015
36	Livorsi (2015)	2015
37	Lupion-Mendoza (2015)	2015
38	Lupion-Mendoza (2015)	2015
39	Lupion-Mendoza (2015)	2015
40	Lupion-Mendoza (2015)	2015
41	Lupion-Mendoza (2015)	2015
42	Lupion-Mendoza (2015)	2015
44	Lupion-Mendoza (2015)	2015
45	Lupion-Mendoza (2015)	2015
46	Lupion-Mendoza (2015)	2015
47	Lupion-Mendoza (2015)	2015
49	Lupion-Mendoza (2015)	2015
51	Lupion-Mendoza (2015)	2015
52	Lupion-Mendoza (2015)	2015
53	Lupion-Mendoza (2015)	2015
55	Lupion-Mendoza (2015)	2015
56	Lupion-Mendoza (2015)	2015
60	Masse (2013)	2013
61	Mehrotra (2013)	2013
62	Mehrotra (2013)	2013
63	Mehrotra (2013)	2013
64	Mehrotra (2013)	2013
65	Mehrotra (2013)	2013
66	Mehrotra (2013)	2013
67	Mehrotra (2013)	2013
68	Mehrotra (2013)	2013
70	Mehrotra (2013)	2013
72	Mehrotra (2013)	2013
73	Mehrotra (2013)	2013
74	Mehrotra (2013)	2013
75	Mehrotra (2013)	2013
78	Mehrotra (2013)	2013
79	Mehrotra (2013)	2013
80	Mehrotra (2013)	2013

All RR data

81	Mehrotra (2013)	2013
82	Mehrotra (2013)	2013
83	Mehrotra (2013)	2013
84	Mehrotra (2013)	2013
101	Saint (2003)	2003
104	Tran (2016)	2016
105	Tran (2016)	2016
110	Tran (2016)	2016
111	Tran (2016)	2016
112	Tran (2016)	2016
115	Tran (2016)	2016
119	Tran (2016)	2016
121	Tran (2016)	2016
123	Tran (2016)	2016
124	Tran (2016)	2016
125	Tran (2016)	2016
126	Tran (2016)	2016
127	Tran (2016)	2016
128	Tran (2016)	2016

All RR data

Outcome	Isolated
All non infectious event	62
Severe non infecitious event	20
Infectious event	6
HCW help in AOL (very/satisfied)	24
Readmission/death 30 days	15
Readmission 30 days	15
Death 30 days	4
The importance of hand hygiene was explained by staff	48
The food tray was removed promptly after eating	34
The room atmosphere was sufficiently quiet	70
Blood pressure was recorded at least once daily, every day	43
Any falls during present admission	1
Any new pressure ulcers during present admission	2
Any falls or pressure ulcers during present admission	3
Received help after pressing call button	17
Top box for all staff responsiveness	3
Before giving new medicine, hospital staff describe side effects	25
Top box for all medication communication	22
Any complaint	42
Informal complaint	37
Formal complaint	12
Any adverse event	108
Non preventable adverse event	34
Preventable adverse event	74
Supporive care failure	38
Diagnostic error	9
Operative error	17
Medical procedure error	13
Drug related error	26
Falls	19
Injury	1
IV related event	3
Medication related event	15
Therapy related event	7
Examined by attending physician	11
Fall (MRSA)*	10.3
Treatment incident (MRSA)*	0.4
Infection control incident (MRSA)*	1.8
Safety incident (MRSA)*	0.1
Equipment incident (MRSA)*	0.5
Medication incident (respiratory)*	2.1
Laboratory incident (respiratory)*	0.9
Infection control incident (respiratory)*	1
Safety incident (respiratory)*	0.3
Equipment incident (respiratory)*	0.4
Patient complaints (respiratory)*	2.6
30-day readmission (MRSA)	140
Preventable non infectioutrs event	37
Encounters per hr (no)	5
ICU encounters per hr	6
Floor encounters per hr	4
Global hygiene (very/satisfied)	28
Daily room cleaning (very/satisfied)	27
HCW availability (very/satisfied)	25

All RR data

Daily HCW presence (very/satisfied)	27
Human relation with HCW (very/satisfied)	27
Global satisfaction (very/satisfied)	25
ED visit 30 days	22
Overall rating of hospital =>9/10	44
Nurses treat you with courtesy and respect	51
Nurses listen carefully	47
Nurses explain things in an understandable way	47
Received help after pressing call button	28
Doctors treat you with courtesy and respect	53
Doctors listen carefully to you	48
Doctors explain things in an understandable way	50
Room and bathroom kept clean	42
Room quiet at night	51
Received help with bathroom/bedpan	19
Pain well controlled	34
Hospital staff help with pain	45
Hospital staff explain new medications	20
Hospital staff describe side effects of medications	13
Hospital staff discussed help after discharge	52
Written information on problems to look for after discharge	52
Recommend hospital to friends and family	43
Overall satisfaction with the professional treatment received from health care workers	67
Nurses treated the patients in polite and respectful manner (totally/partially agree)	70
Physicians treated the patients in polite and respectful manner	71
Nurses provided clear information about the health problem	64
Physicians provided clear information about the health problem	66
Clear explanations were provided before all procedures	62
Health care workers entered the room whenever the patient called them	66
Blood pressure and temperature recorded at least once a day	65
The physician visited daily	69
The room was comfortable	62
Room cleaning was satisfactory	66
I frequently felt lonely during admission	17
Medical notes were recorded every day	64
Nurses notes were recorded every day	64
Daily temperature was recorded at least once a day, every day	53
Daily glycemic levels were recorded as indicated, everyday (only diabetic patients)	31
Total number of complications	60
Nurses treat with courtesy and respect	31
Nurses listen carefully	30
Nurses explain things in understandable way	30
Top box for all nursing communication	27
Doctors treat with courtesy and respect	33
Doctors listen carefully	31
Doctors explain things in understandable way	29
Top box for all doctor communication	27
Received help in bathroom/bedpan use	25
Pain well controlled	26
Hospital staff help with pain	26
Top box for all pain management	25
Before giving new medicine, hospital staff tells what it is for	30
Spoken with about having necessary help after discharge	31
Written information on symptoms/problems to look for after discharge	33
Top box for all discharge information	30

All RR data

Hospital room and bathroom kept clean (individual)	27
Area near room quiet at night (individual)	24
Recommend hospital to friends and family (global)	25
Overall hospital rating (global)	22
Examined by senior resident doctor	26
Medication incident (MRSA)*	2.2
Laboratory incident (MRSA)*	0.3
Any adverse event (MRSA)*	12.4
Patient complaints (MRSA)*	1.1
Fall (respiratory)*	4.2
Treatment incident (respiratory)*	0.6
Any adverse event (respiratory)*	9.1
Inpatient mortality (MRSA)	59
30-day ED visit (MRSA)	84
Readmission or ED visit (respiratory)	167
Inpatient mortality (respiratory)	104
30-day readmission (respiratory)	206
30-day ED visit (respiratory)	164
Readmission or ED visit (respiratory)	261

All RR data

Isolated.N	Control	Control.N	RI	RC	RR	inout	Type
148	84	148	0.418918919	0.567567568	0.738095238	a	AE
148	27	148	0.135135135	0.182432432	0.740740741	a	AE
148	10	148	0.040540541	0.067567568	0.6	a	AE
30	60	60	0.8	1	1.25	a	Satisfaction
75	70	420	0.2	0.166666667	1.2	a	AE
75	66	420	0.2	0.157142857	1.272727273	a	AE
75	9	420	0.053333333	0.021428571	2.488888889	a	AE
72	18	72	0.666666667	0.25	0.375	a	Satisfaction
72	63	72	0.472222222	0.875	1.852941177	a	Satisfaction
72	54	72	0.972222222	0.75	0.771428572	a	Satisfaction
72	61	72	0.597222222	0.847222222	0.704918033	a	Quality
72	0	72	0.013888889	0	#DIV/0!	a	AE
72	0	72	0.027777778	0	#DIV/0!	a	AE
72	0	72	0.041666667	0	#DIV/0!	a	AE
37	33	51	0.459459459	0.647058824	1.408304501	a	Quality
37	14	51	0.081081081	0.274509804	3.385620919	a	Satisfaction
37	20	51	0.675675676	0.392156863	0.580392157	a	Quality
37	20	51	0.594594595	0.392156863	0.659536542	a	Quality
150	13	300	0.28	0.043333333	6.461538462	a	Satisfaction
150	10	300	0.246666667	0.033333333	7.4	a	Satisfaction
150	3	300	0.08	0.01	8	a	Satisfaction
150	53	300	0.72	0.176666667	4.075471698	a	Satisfaction
150	39	300	0.226666667	0.13	1.743589744	a	AE
150	14	300	0.493333333	0.046666667	10.57142857	a	AE
150	5	300	0.253333333	0.016666667	15.2	a	AE
150	2	300	0.06	0.006666667	9	a	AE
150	20	300	0.113333333	0.066666667	1.7	a	AE
150	7	300	0.086666667	0.023333333	3.714285714	a	AE
150	19	300	0.173333333	0.063333333	2.736842105	a	AE
45	85	256	0.422222222	0.33203125	1.271633987	a	AE
45	19	256	0.022222222	0.07421875	0.299415205	a	AE
45	6	256	0.066666667	0.0234375	2.844444444	a	AE
45	122	256	0.333333333	0.4765625	0.699453552	a	AE
45	24	256	0.155555556	0.09375	1.659259259	a	AE
31	79	108	0.35483871	0.731481481	2.061447808	a	Quality
100	8	100	0.103	0.08	1.2875	a	AE
100	0.5	100	0.004	0.005	0.8	a	AE
100	0.1	100	0.018	0.0011	16.36363636	a	AE
100	0.3	100	0.001	0.003	0.333333333	a	AE
100	0.2	100	0.005	0.002	2.5	a	AE
100	1.6	100	0.021	0.016	1.3125	a	AE
100	0.6	100	0.009	0.006	1.5	a	AE
100	0.6	100	0.01	0.006	1.666666667	a	AE
100	0.1	100	0.003	0.001	3	a	AE
100	0.2	100	0.004	0.002	2	a	AE
100	1	100	0.026	0.01	2.6	a	Satisfaction
737	108	737	0.19	0.147	1.292517007	a	AE
148	41	148	0.25	0.277027027	0.902439024	b	AE
485	11	1002	0.010309278	0.010978044	1.064870304	b	Quality
319	14	658	0.018808777	0.021276596	1.131205713	b	Quality
166	8	344	0.024096386	0.023255814	0.965116263	b	Quality
30	59	60	0.933333333	0.983333333	1.053571429	b	Satisfaction
30	58	60	0.9	0.966666667	1.074074074	b	Satisfaction
30	57	60	0.833333333	0.95	1.14	b	Satisfaction

All RR data

30	59	60	0.9	0.983333333	1.092592592	b	Satisfaction
30	60	60	0.9	1	1.111111111	b	Satisfaction
30	60	60	0.833333333	1	1.2	b	Satisfaction
75	109	420	0.293333333	0.25952381	1.130275229	b	AE
68	85	135	0.647058824	0.62962963	0.973063973	b	Satisfaction
69	110	138	0.739130435	0.797101449	1.078431372	b	Satisfaction
70	101	137	0.671428571	0.737226277	1.097996583	b	Satisfaction
69	102	135	0.68115942	0.755555556	1.109219859	b	Satisfaction
52	70	114	0.538461538	0.614035088	1.140350879	b	Satisfaction
70	106	137	0.757142857	0.773722628	1.021897811	b	Satisfaction
68	103	136	0.705882353	0.757352941	1.072916666	b	Satisfaction
68	99	137	0.735294118	0.722627737	0.982773722	b	Satisfaction
68	82	127	0.617647059	0.645669291	1.045369328	b	Satisfaction
70	98	137	0.728571429	0.715328467	0.981823386	b	Satisfaction
30	49	68	0.633333333	0.720588235	1.137770898	b	Satisfaction
62	75	117	0.548387097	0.641025641	1.16892911	b	Satisfaction
62	96	115	0.725806452	0.834782609	1.150144927	b	Satisfaction
27	47	59	0.740740741	0.796610169	1.075423728	b	Satisfaction
25	35	57	0.52	0.614035088	1.180836708	b	Satisfaction
61	108	124	0.852459016	0.870967742	1.021712159	b	Satisfaction
62	106	120	0.838709677	0.883333333	1.053205128	b	Satisfaction
67	98	133	0.641791045	0.736842105	1.148102814	b	Satisfaction
72	69	72	0.930555556	0.958333333	1.029850745	b	Satisfaction
72	71	72	0.972222222	0.986111111	1.014285714	b	Satisfaction
72	72	72	0.986111111	1	1.014084507	b	Satisfaction
72	68	72	0.888888889	0.944444444	1.062499999	b	Satisfaction
72	62	72	0.916666667	0.861111111	0.939393939	b	Satisfaction
72	66	72	0.861111111	0.916666667	1.06451613	b	Satisfaction
72	71	72	0.916666667	0.986111111	1.075757575	b	Satisfaction
72	70	72	0.902777778	0.972222222	1.076923076	b	Quality
72	71	72	0.958333333	0.986111111	1.028985507	b	Quality
72	67	72	0.861111111	0.930555556	1.080645162	b	Satisfaction
72	70	72	0.916666667	0.972222222	1.06060606	b	Quality
72	17	72	0.236111111	0.236111111	1	b	Satisfaction
72	65	72	0.888888889	0.902777778	1.015625	b	Quality
72	69	72	0.888888889	0.958333333	1.078124999	b	Quality
72	60	72	0.736111111	0.833333333	1.132075471	b	Quality
31	18	18	1	1	1	b	Quality
111	62	111	0.540540541	0.558558559	0.967741935	b	Satisfaction
37	45	51	0.837837838	0.882352941	1.053130929	b	Satisfaction
37	43	51	0.810810811	0.843137255	1.039869281	b	Satisfaction
37	42	51	0.810810811	0.823529412	1.015686275	b	Satisfaction
37	39	51	0.72972973	0.764705882	1.047930282	b	Satisfaction
37	42	51	0.891891892	0.823529412	0.923351159	b	Satisfaction
37	42	51	0.837837838	0.823529412	0.982922201	b	Satisfaction
37	44	51	0.783783784	0.862745098	1.100743745	b	Satisfaction
37	37	51	0.72972973	0.725490196	0.994190268	b	Satisfaction
37	35	51	0.675675676	0.68627451	1.015686274	b	Quality
37	40	51	0.702702703	0.784313725	1.116138762	b	Quality
37	38	51	0.702702703	0.745098039	1.060331824	b	Quality
37	35	51	0.675675676	0.68627451	1.015686274	b	Quality
37	41	51	0.810810811	0.803921569	0.991503268	b	Quality
37	45	51	0.837837838	0.882352941	1.053130929	b	Quality
37	49	51	0.891891892	0.960784314	1.077243019	b	Quality
37	45	51	0.810810811	0.882352941	1.088235294	b	Quality

All RR data

37	37	51	0.72972973	0.725490196	0.994190268	b	Quality
37	32	51	0.648648649	0.62745098	0.96732026	b	Satisfaction
37	41	51	0.675675676	0.803921569	1.189803922	b	Satisfaction
37	36	51	0.594594595	0.705882353	1.187165775	b	Satisfaction
31	94	108	0.838709677	0.87037037	1.037749288	b	Quality
100	2.4	100	0.022	0.024	0.916666667	b	AE
100	0.3	100	0.0027	0.0033	0.818181818	b	AE
100	10.7	100	0.124	0.107	1.158878505	b	AE
100	1.3	100	0.0109	0.0125	0.872	b	Satisfaction
100	5.1	100	0.042	0.051	0.823529412	b	AE
100	0.7	100	0.006	0.007	0.857142857	b	AE
100	8.9	100	0.091	0.089	1.02247191	b	AE
737	52	737	0.08	0.07	1.142857143	b	AE
737	86	737	0.114	0.117	0.974358974	b	AE
737	142	737	0.227	0.193	1.176165803	b	AE
1502	128	1502	0.069	0.085	0.811764706	b	AE
1502	236	1502	0.137	0.157	0.872611465	b	AE
1502	168	1502	0.109	0.112	0.973214286	b	AE
1502	278	1502	0.174	0.185	0.940540541	b	AE

All RR data

Good/bad	exp yi	yi	vi
Bad	0.74	-0.303682414	0.014520281
Bad	0.74	-0.300104592	0.073523524
Bad	0.60	-0.510825624	0.253153153
Good	0.80	-0.227083588	0.008693745
Bad	1.20	0.182321557	0.065238095
Bad	1.27	0.241162057	0.066103896
Bad	2.49	0.911836382	0.345396825
Good	2.67	0.980829253	0.048611111
Good	0.54	-0.616774202	0.017507003
Good	1.30	0.259511195	0.005026455
Good	0.70	-0.349673748	0.011871479
Bad	3.00	1.098612289	2.639269406
Bad	5.00	1.609437912	2.37260274
Bad	7.00	1.945910149	2.258317025
Good	0.71	-0.342386497	0.04249169
Good	0.30	-1.219537321	0.358127035
Good	1.72	0.544051271	0.04336513
Good	1.52	0.4162179	0.048819675
Bad	6.46	1.865867441	0.090732601
Bad	7.40	2.00148	0.117027027
Bad	8.00	2.079441542	0.406666667
Bad	4.08	1.404986494	0.018127184
Bad	1.74	0.555946059	0.04505279
Bad	10.57	2.358154944	0.074942085
Bad	15.20	2.721295428	0.216315789
Bad	9.00	2.197224577	0.601111111
Bad	1.70	0.530628251	0.098823529
Bad	3.71	1.312186389	0.20978022
Bad	2.74	1.006804739	0.081093117
Bad	1.27	0.240302677	0.038267813
Bad	0.30	-1.205924024	1.026503107
Bad	2.84	1.045367774	0.473871528
Bad	0.70	-0.357455889	0.048734916
Bad	1.66	0.506371273	0.158395337
Good	0.49	-0.723408557	0.062049995
Bad	1.29	0.252702354	0.202087379
Bad	0.80	-0.223143551	4.48
Bad	18.00	2.890371758	10.53555556
Bad	0.33	-1.098612289	13.31333333
Bad	2.50	0.916290732	6.98
Bad	1.31	0.271933715	1.081190476
Bad	1.50	0.405465108	2.757777778
Bad	1.67	0.510825624	2.646666667
Bad	3.00	1.098612289	13.31333333
Bad	2.00	0.693147181	7.48
Bad	2.60	0.955511445	1.364615385
Bad	1.30	0.259511195	0.013688412
Bad	0.90	-0.102654154	0.037903757
Good	0.94	-0.06285297	0.287849231
Good	0.88	-0.123284032	0.233440685
Good	1.04	0.035506688	0.366068927
Good	0.95	-0.052185753	0.002663438
Good	0.93	-0.071458964	0.004278416
Good	0.88	-0.131028262	0.00754386

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Good	0.92	-0.088553397	0.00398619
Good	0.89	-0.111570701	0.004241055
Good	0.83	-0.187078253	0.007093105
Bad	1.13	0.122461169	0.038914572
Good	1.03	0.027305451	0.012378689
Good	0.93	-0.075507553	0.006959622
Good	0.91	-0.093487231	0.009592601
Good	0.90	-0.103656938	0.009180356
Good	0.88	-0.131336002	0.021997301
Good	0.98	-0.021661497	0.006716902
Good	0.93	-0.070380797	0.008483248
Good	1.02	0.017376376	0.008095858
Good	0.96	-0.044370248	0.013424748
Good	1.02	0.018343838	0.00822694
Good	0.88	-0.129070995	0.025000527
Good	0.86	-0.156088039	0.018069057
Good	0.87	-0.139887958	0.007814204
Good	0.93	-0.07271475	0.017290406
Good	0.85	-0.166223261	0.047950646
Good	0.98	-0.021479807	0.00403207
Good	0.95	-0.051838018	0.004202366
Good	0.87	-0.138110854	0.011015725
Good	0.97	-0.029413885	0.001640349
Good	0.99	-0.014184635	0.000592444
Good	0.99	-0.013889112	0.000381857
Good	0.94	-0.060624622	0.002553105
Good	1.06	0.062520357	0.00350277
Good	0.94	-0.062520357	0.00350277
Good	0.93	-0.073025135	0.001458244
Good	0.93	-0.074107972	0.001892552
Good	0.97	-0.028573372	0.000799483
Good	0.93	-0.077558234	0.003276628
Good	0.94	-0.0588405	0.001659452
Bad	1.00	0	0.089869281
Good	0.98	-0.015504187	0.003231838
Good	0.93	-0.075223421	0.002339976
Good	0.88	-0.124052649	0.007756813
Good	1.01	0.01091989	0.001918507
Bad	0.97	-0.032789823	0.014777681
Good	0.95	-0.051767565	0.007845417
Good	0.96	-0.039095014	0.009954277
Good	0.98	-0.015564517	0.010507987
Good	0.95	-0.04681706	0.016043193
Good	1.08	0.079745663	0.007477684
Good	1.02	0.017225306	0.009432718
Good	0.91	-0.095986084	0.010575161
Good	1.01	0.005826673	0.017429194
Good	0.98	-0.015564517	0.021936558
Good	0.90	-0.109875196	0.016826668
Good	0.94	-0.058581902	0.018142458
Good	0.98	-0.015564517	0.021936558
Good	1.01	0.008533035	0.011088707
Good	0.95	-0.051767565	0.007845417
Good	0.93	-0.074405017	0.004076323
Good	0.92	-0.084557388	0.008920685

All RR data

Good	1.01	0.005826673	0.017429194
Good	1.03	0.033225648	0.026281797
Good	0.84	-0.173788522	0.017755374
Good	0.84	-0.171568765	0.026597453
Good	0.96	-0.037054222	0.007582513
Bad	0.92	-0.087011377	0.851212121
Bad	1.00	0	6.646666667
Bad	1.16	0.147452731	0.154103105
Bad	0.85	-0.167054085	1.658321678
Bad	0.82	-0.194156014	0.414173669
Bad	0.86	-0.15415068	3.075238095
Bad	1.02	0.022223137	0.20224966
Bad	1.13	0.126293725	0.033466218
Bad	0.98	-0.023530497	0.020818965
Bad	1.18	0.162166755	0.010316573
Bad	0.81	-0.207639365	0.016096327
Bad	0.87	-0.135955636	0.007760099
Bad	0.98	-0.024097552	0.010718384
Bad	0.94	-0.063100706	0.006096982

	Reference	Year	Outcome	Isolated	IsolatedSD	Isolated.N	Control	ControlSD
2	Kennedy (1	1997	Anxiety	37.8	19.9	16	12.3	10.7
9	Gammon (1	1998	Anxiety	12.75	2.43	20	8.15	3.17
15	Tarzi (2001	2001	Anxiety	15	3	22	8.6	3
16	Day (2011a	2011	Anxiety/De	14.35	1.61	20	13	0.8
13	Findink (20	2012	Anxiety	7.23	4.1	61	6.42	3.9
	Soon (2013	2013	Anxiety					
17	Lupion-Mer	2015	Anxiety	8.2	0.48	72	6.9	0.41
8	Lau (2016)	2016	Anxiety	1.48	1.72	75	1.7	1.8

Control.N	yi	vi
16	1.5558	0.1628
20	1.5963	0.1319
20	2.093	0.1476
83	1.3351	0.0707
57	0.201	0.0341
	2.5649	0.986
72	2.8969	0.0569
421	-0.1228	0.0157

	Reference	Year	Outcome	Isolated	IsolatedSD	Isolated.N	Control	ControlSD
1	Kennedy (1	1997	Depression	16.5	9.9	16	12.3	10.7
10	Gammon (1	1998	Depression	12.45	2.21	20	7.3	2.05
	Tarzi (200	2001	Depression					
16	Day (2011a	2011	Anxiety/De	14.3	1.61	20	13	0.8
14	Findink (20	2012	Depression	8.83	4.7	61	7.89	4.9
	Soon (2013	2013	Depression					
18	Lupion-Mer	2015	Depression	7.8	0.51	72	6.6	0.43
7	Lau (2016)	2016	Depression	6.89	4.92	75	7.35	5.92

Control.N	yi	vi
16	0.397	0.127
20	2.368	0.17
	2.101	0.125
83	1.335	0.071
57	0.195	0.034
	1.562	0.2
72	2.531	0.05
420	-0.079	0.016

Case-control studies

	Colorado (2014)	Kennedy (1997)	Livorsi (2015)	Lupion (2015)	Masse (2013)	Soon (2013)	Tarzi (2001)
1) Is the case definition adequate? a) yes, with independent validation * b) yes, eg record linkage or based on self reports c) no description	*	*	*	*	*	*	*
2) Representativeness of the cases a) consecutive or obviously representative series of cases * b) potential for selection biases or not stated	b	b	*	b	b	*	*
3) Selection of Controls a) community controls (studies of hospital patients) * b) hospital controls c) no description	*	*	*	*	*	*	*
4) Definition of Controls a) no history of disease (endpoint) * b) no description of source	*			*			
Comparability							
1) Comparability of cases and controls on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *	* * (l)	* * (l, g)		* * (g)	* *(g)	* * (l, g)	* *(l, g)
Outcome							
1) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview where blind to case/control status * c) interview not blinded to case/control status d) written self report or medical record only e) no description	*	*	*	*	*	*	*
2) Same method of ascertainment for cases and controls a) yes * b) no	Functional Independence Measure ## *	Functional Independence Measure; Beck Inventory Depression; State Anxiety Inventory; Profile Mood States ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Charlston Comorbidity Index ## *	Hospital Anxiety and Depression Scale ## *	Geriatric Depression Scale; Profile of Mood States; Abbreviated Mental Test Score; Barthel Index ## *
3) Non-Response rate a) same rate for both groups * b) non respondents described c) rate different and no designation	*	*	*	*			*

Cohort studies (1)

Selection	Croft (2015)	Day (2011) a	Day (2011) b	Day (2012)	Day (2013)	Evans (2003)	Findink (2012)	Guilley (2017)
1) Representativeness of the exposed cohort a) truly representative of the average patient in the community * b) somewhat representative of the average patient in the community * c) selected group of users eg nurses, volunteers d) no description of the derivation of the cohort	*	*	*	*	* b	c	*b	*b
2) Selection of the non exposed cohort a) drawn from the same community as the exposed cohort * b) drawn from a different source c) no description of the derivation of the non exposed cohort	*	*	*	*	*	*	*	*
3) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview * c) written self report d) no description	*	*	*	*	*	*	*	*
4) Demonstration that outcome of interest was not present at start of study a) yes * b) no	*	b	b	*	*	*		*
Comparability								
1) Comparability of cohorts on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *	* * (l,g)		* * (l,g)	* * (l,g)	* * (l,g)			* (g)
Outcome								
1) Assessment of outcome a) independent blind assessment * b) record linkage * c) self report d) no description	Global Trigger Tool ## *	Hospital Anxiety and Depression Scale ## *	*	Clinical diagnosis of delirium *	Hospital Anxiety and Depression Scale ## *	Clinical encounters per hour *	Hospital Anxiety and Depression Scale ## *	State-Trait Anxiety Inventory ## *
2) Was follow-up long enough for outcomes to occur a) yes (during hospitalisation or immediately afterwards) * b) no	*	*	*	*	* 3 days	*	*	
3) Adequacy of follow up of cohorts a) complete follow up - all subjects accounted for * b) subjects lost to follow up unlikely to introduce bias - small number lost - > 90 % follow up, or description provided of those lost) * c) follow up rate < 90% and no description of those lost d) no statement	*	*	*	*	*	*	*	*

Community – was hospital population
Time to outcome of interest – question is regarding outcome during isolation

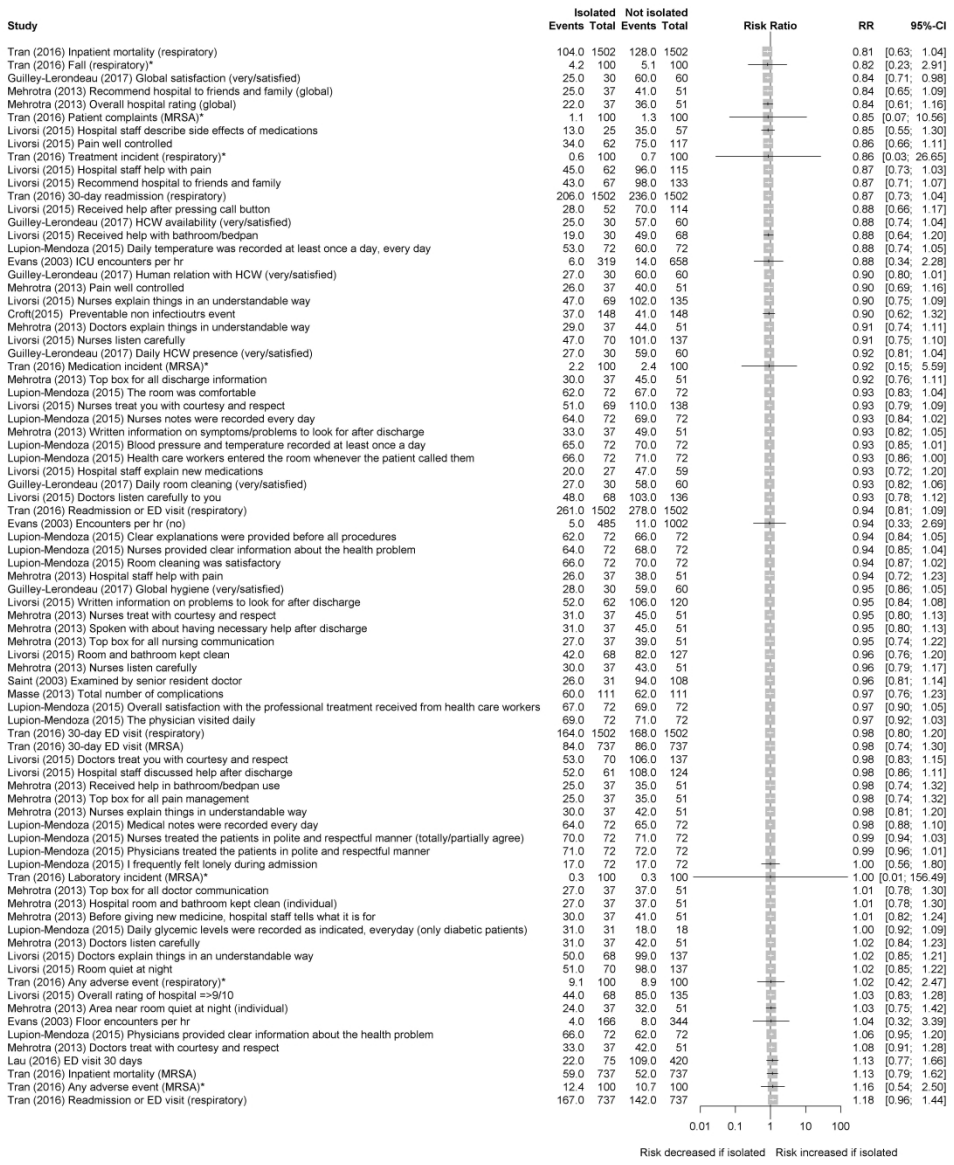
a – age
g- gender
l – LOS

own scale
validated scale/s used appropriately

Cohort studies (2)

Selection	Kirkland (1999)	Lau (2016)	Mehotra (2013)	Stelfox (2003)	Spense (2011)	Saint (2003)	Tran (2016)	Wassenberg (2010)
1) Representativeness of the exposed cohort a) truly representative of the average patient in the community * b) somewhat representative of the average patient in the community * c) selected group of users eg nurses, volunteers d) no description of the derivation of the cohort	*b	*	*	*	b	*	*	*
2) Selection of the non exposed cohort a) drawn from the same community as the exposed cohort * b) drawn from a different source c) no description of the derivation of the non exposed cohort	*	*	*	*	*	*	*	*
3) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview * c) written self report d) no description	*	*b	*b	*	*	*	*	*
4) Demonstration that outcome of interest was not present at start of study a) yes * b) no	*	*	*	*	*	*	*	*
Comparability								
1) Comparability of cohorts on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *		* (g)	* * (l,g)	* * (l,g)		*	* * (l,g)	(l,g)
Outcome								
1) Assessment of outcome a) independent blind assessment * b) record linkage * c) self report d) no description	* #	Patient Health Quetionnaire-9; CQ-5D c telephone /health records ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Clinical satisfaction # *	Clinical outcomes *	Observation of doctors *	Clinical outcomes *	EQ5-D; Hospital Anxiety and Depression Scale ## *
2) Was follow-up long enough for outcomes to occur a) yes (during hospitalisation or immediately afterwards) * b) no	*		*	*	*	*	*	*
3) Adequacy of follow up of cohorts a) complete follow up - all subjects accounted for * b) subjects lost to follow up unlikely to introduce bias - small number lost - > 90 % follow up, or description provided of those lost) * c) follow up rate < 90% and no description of those lost d) no statement	*		37/278 contact; 51/290 non	*	*		*	*

General notes
Community – the population of interest was a hospital population
Time to outcome of interest – question is regarding outcome during isolation or shortly afterwards



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Impact of isolation on hospitalised patients who are infectious: systematic review with meta-analysis

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Impact of isolation on hospitalised patients who are infectious: systematic review with quantitative and meta-analysis

Abstract

Objective

To systematically review the literature exploring impact of isolation on hospitalised patients who are infectious: psychological and non-psychological outcomes

Design

Systematic review with meta-analysis

Data Sources

Embase, Medline and Psychinfo were searched from inception until December 2018. Reference lists and Google Scholar were also handsearched.

Results

Twenty six papers published from database inception until December 2018 were reviewed. A wide range of psychological and non-psychological outcomes were reported. There was a marked trend for isolated patients to exhibit higher levels of depression, the pooled standardised mean difference being 1.28 (95% CI: 0.47 to 2.09) and anxiety 1.45 (95% CI: 0.56 to 2.34), although both had high levels of heterogeneity; and worse outcomes for a range of care-related factors but with significant variation.

Conclusion

The review indicates that isolation to contain risk of infection has negative consequences for segregated patients. Although strength of the evidence is weak, comprising primarily single centre convenience samples, consistency of the effects may strengthen this conclusion. More research needs to be undertaken to examine this relationship and develop and test interventions to reduce the negative effects of isolation.

Strengths and limitations of this study

- This review covers a wide variety of literature from a range of different clinical areas.
- Data collected and the methods of collecting data on the impact of isolation is varied across studies.
- These data do not show if these effects are temporary, or in most cases if they are clinically significant.

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Competing interests statement

No authors have any competing interests to declare

Introduction

Isolation is an established part of any infection prevention programme. Its purpose is to prevent the transmission of antibiotic-resistant pathogens, those that are highly contagious or cause serious infection.[1] The effectiveness of isolation has been questioned however [2–5] and it can be challenging to undertake, especially if patients' lack of understanding of the need for segregation, boredom or distress result in uncooperative behaviour. [6] A recent survey exploring the care of patients isolated for infectious conditions suggests that in clinical practice the main issues are identifying which patients need to be isolated as quickly as possible and prioritising which patients should be segregated when isolation accommodation is in short supply. Infection preventionists were aware that isolation could have negative effects on patients such as increased risk of anxiety, depression and falls and felt that more should be done to prevent these risks.[6]

Although single rooms are assumed to reduce infection risk, evidence of ability to contain spread is equivocal [7,8] and a recent study conducted in an all-single-room hospital was unable to demonstrate lower infection rates than in hospitals where most care takes place in open wards. [9] This study identified advantages and disadvantages of single room accommodation, whereas isolating infectious patients is generally assumed to result in adverse outcomes.[10]

A systematic review reported eight years ago indicated higher levels of anxiety, depression, perceptions of stigmatisation and a higher incidence of falls, medication errors and other incidents that detract from patient safety among patients who were isolated compared to those who were not.[11] This review reported studies undertaken

before 2010 and included patients whose experiences are unlikely to be comparable: children and adults and those isolated to reduce their own risk of infection as well as infectious patients. The review was not reported according to standards currently expected for systematic reviews [12] and presents a qualitative description of patient outcomes only. A more rigorously reported and up-to-date systematic review is indicated in view of increasing concern about satisfaction with health care and patient safety and increasing emphasis on infection prevention as part of the global strategy to reduce risks of antimicrobial resistance.[13]

We undertook a systematic review of the literature to establish the effects of infection related isolation on psychological and non-psychological care-related outcomes in adults. This review is therefore more focussed than that previously undertaken which also included those in protective isolation, and contains a significant body of literature published since 2010.

Method

The eligibility criteria for inclusion was that studies should compare quantitative data on psychological or non-psychological outcomes in adult patients who are in infective isolation with those not isolated. Purely symptomatic/disease progression outcomes were not included, neither were those looking at patients isolated due to immunosuppression. Studies not containing comparative data between those isolated and not isolated were also excluded. Search terms were: Patient isolation; cross infection; contact isolation; respiratory, source or contact isolation; droplet, airborne or contact precautions; cubicle; MRSA or methicillin resistant *Staphylococcus aureus*; patient safety or harm; depression; anxiety; adaptation; stress; patient satisfaction;

quality of life. These were searched as free-text and index terms where these existed. The information sources used were Embase, Medline and Psychinfo, which were searched from inception until December 2018. Reference lists and Google Scholar were also handsearched. Characteristics of included and excluded papers are shown in Supplementary File 1. The PRISMA flow-chart is given in Supplementary File 2. No protocol was published in advance.

Studies were initially screened for relevance by one author (EP), with the final stage being undertaken by two (EP, DG). Data were extracted and checked by two authors (DG, EP); where there were disagreements data were rechecked for relevance and accuracy. Where available, raw data were extracted and entered into a spreadsheet, and depending upon the nature of the data either the risk ratio (where numbers of patients were given) or standardised mean difference (where other statistics were given) calculated. Results were then presented as forest plots.

Due to the variety of different settings and methods it was deemed that the methodological and clinical heterogeneity was too broad to pool results; apart from those related to anxiety and depression, for which results were pooled using the random-effects model. This model assumes that the observed effect from each study is estimating a related but different true effect, allowing for between-study variation to be calculated in the form of heterogeneity statistics. All calculations and plots were produced using the meta and metafor packages in R.[14–16] Where raw data were not provided the summary results are given in the text but not the forest plots. All data relevant to the study are included in the article or uploaded as Supplementary File 3.

Patient and Public Involvement

No patient involved.

Results

A total of 3 879 papers were retrieved from the three databases; of which 34 were assessed for eligibility by reading the full text. Of these 13 studies provided data suitable for the calculation of risk ratio, 5 giving psychological outcomes,[17–21] and 12 non-psychological;[19,22–32] and 8 provided data for the calculation of standardised mean differences, 6 giving psychological outcomes,[21,30,33–36] and 2 non-psychological.[29,37] A further 6 studies did not provide raw data but are included in the results; 3 each giving psychological outcomes[38–40] and non-psychological outcomes.[17,41,42] Meta-analyses were possible on two outcomes: anxiety and depression from 8 studies using standardised mean difference. [19–21,30,33–36] Where only risk ratio data were given[20,21] conversion to standardised mean difference was undertaken using the Campbell Collaboration calculator (https://campbellcollaboration.org/research-resources/effect-size-calculator.html).[43]

Where it was not possible to pool outcome data because of methodological and clinical heterogeneity, the data from studies are shown as forest plots but without meta-analysis. The forest plots contain results from the studies where sufficient data were given to calculate either the risk ratio or standardised mean difference. A number of studies provided data on those under contact precautions, but no comparative data and so were not included.[44–47]

Because of the large number of non-psychological outcomes for which RR could be calculated, it was decided that a change of 20% (i.e. a RR of 0.8 or less, or 1.2 or more) would be clinically significant, regardless of the statistical significance. This was a pragmatic decision, and all results are shown in Supplementary File 3. Results are shown in Figures 1 to 6. Supplementary Figure 1 contains results that did not meet our criteria for being clinically significant. Outcomes were classified into one of three categories: those to do with quality of care; satisfaction of care; and adverse events from which median values and interquartile ranges were calculated.

The studies included were primarily single-centre and consisted of case-control, cross-sectional and cohort studies. Risk of bias was assessed using the Newcastle-Ottowa scale, full details of each study and its risk of bias are in the Supplementary File 4.[48] Overall, although these studies have limited generalisability, there did not appear to be significant cause for concern regarding bias within the limitations inherent in these study designs. Most studies used established or validated tools[17–21,23–25,27,29,30,33–37] or clinical outcomes.[22,26,28,31,32]

The data from the comparative studies suggest that although in many cases infective isolation precautions make little difference to psychological outcomes, where it does make a difference this is primarily negative. There were significant declines in mean scores related to control and self-esteem, and in many studies increases in the mean scores for risk of anxiety and depression. However, these findings were not consistent, and some larger studies showed little or no difference between the groups for these outcomes. These are shown in Figures 1 and 2 respectively.

[INSERT FIGURES 1 and 2 HERE]

Figure 1. Risk ratio of psychological events in those isolated versus not isolated

Figure 2. Standardised mean difference of psychological scores in those isolated versus those not isolated

For the 8 studies reporting data on anxiety the pooled SMD was 1.45 (95% CI: 0.56 to 2.34); although within this there was significant heterogeneity ($Q = 168.11$, $df = 7$, $p < 0.0001$; $I^2 = 95.84\%$). This was primarily caused by two studies [30,34] which showed lower levels of anxiety than the remaining studies. For depression the SMD was 1.28 (95% CI: 0.47 to 2.09); again with significant heterogeneity ($Q = 154.5$, $df = 7$, $p < 0.0001$; $I^2 = 95.47\%$), in this case the studies falling into two categories, those with lower [30,34,35] and higher depression scores among those isolated.[19,20,33,36] The forest plots for these outcomes are shown in Figures 3 and 4 respectively.

[INSERT FIGURES 3 and 4 HERE]

Figure 3. Meta-analysis of the standardised mean difference of anxiety in those isolated versus those not isolated

Figure 4. Meta-analysis of the standardised mean difference of depression in those isolated versus those not isolated

Studies not reporting the raw data showed that contact precautions were associated with depression OR 1.4 (95% CI 1.2 to 1.5) but not anxiety OR 0.8 (95% CI 0.7 to 1.1) in a non-ICU population.[41] There was also an association with delirium OR 1.40 (95% CI 1.24 to 1.51); although this was primarily among those who were newly diagnosed as needing isolation OR 1.75 (95% CI 1.60 to 1.92, p<0.01) rather than those who had been under contact precautions for their entire stay OR 0.97 (95% CI 0.86 to 1.09, p=0.60).[17] Another study showed no difference in the median values for the Hospital Anxiety and Depression Scale anxiety or depression scores (HADS-A and -D), or the EuroQol Visual Analogue Scale EQ VAS scores.[42]

For non-psychological outcomes, using a difference in the risk of +/- 20% of an event as being a measure of clinical significance it appears there was a trend for less attention to be given to, and for more errors to occur in those who were isolated. However, again there was wide variation between studies. Data on these outcomes are given in Figures 5 and 6, and the non-clinically significant risks in the Supplementary Figure 1. For those outcomes associated with quality, the median risk ratio (with positive outcomes reversed so a higher risk ratio is associated with a worse outcome) was 0.94 (IQR 0.92 to 0.98), satisfaction 0.95 (IQR 0.89 to 1.01) and adverse events was 1.27 (0.91 to 2.5). The minimum and maximum risk ratio for each category was 0.49 and 1.72; 0.3 and 8; and 0.3 and 18 respectively.

[INSERT FIGURES 5 and 6 HERE]

Figure 5. Risk ratio of non-psychological events in those isolated versus not isolated with a RR of < =0.8 or > =1.2

* outcome was measured in rate per 100 admissions

Figure 6. Standardised mean difference of non-psychological scores in those isolated versus those not isolated

FIM – functional independence measure

A study not giving raw data which looked at the rates of falls and pressure ulcers before and after a policy change that resulted in the discontinuation of contact precautions for patients with methicillin resistant *Staphylcoccus aureus* (MRSA) or vancomycin resistant enterococci (VRE) found that falls and pressure ulcers were more common among those with MRSA or VRE both before the change (when they were in isolation) and afterwards (when they were not). Before the change the number of falls was 4.57 vs 2.04 per 1000 patient-days respectively ($p< 0.0001$) and pressure ulcers 4.87 vs 1.22 per 1000 patient-days ($p< 0.0001$). After the policy change the same numbers were falls 4.82 vs 2.10 ($p<0.0001$) and pressure ulcers 4.17 vs 1.19 per 1000 patient-days ($p<0.0001$).[39] Other studies found that staff spent less time with those on contact precautions: internal medicine interns spent less time with their isolated patients compared to non-isolated patients, the median times being 5.2 and 6.9 minutes respectively ($p<0.001$)[38]; while the mean number of contacts per hour with healthcare workers was 2.1 compared to 4.2 in those not isolated ($p=0.03$), although the duration was longer at 4.5 minutes compared to 2.8 ($p=0.6$).[40]

Discussion

Current recommendations say that contact precautions should include a single room, with personal protective equipment consisting of a gown and gloves for all patient

contacts or contacts with potentially contaminated environmental areas.[1] This review has shown that there are a number of apparently negative aspects to contact precautions, in particular with regards to psychological effects and a reduction in the quality of some aspects of care. These data come from studies carried out in a variety of countries and different types of facilities; although there are few data from particularly vulnerable populations such as the elderly.

Although at times there are discussions as to the necessity of contact precautions for drug resistant organisms, with some arguing that that there is mixed evidence for or against their use[49] another recent review has concluded that they are of great importance in the control of epidemic and endemic multidrug-resistant microorganisms.[50] The ethics of using contact precautions and other forms of isolation rely on a positive assessment of the balance between the risks and benefits of this to the individual concerned and that of the broader population of patients and staff.[51] However, even when this assessment is positive, it is important to ensure that any harm to the individual is minimised.

One way of balancing the various priorities is to use the GRADE Evidence to Decision Framework, which provides criteria for making recommendations at the individual, group and policy-levels, and provides a number of highly patient focussed criteria for doing this. In addition to the certainty of evidence and resource requirements, it also requires consideration of: the balance of desirable and undesirable effects; the impact upon equity; and the feasibility and acceptability of the intervention.[52] The last two of these might have very different outcomes when considered at the population and individual levels; and there is certainly evidence here

that for the individual patient the balance of desirable and undesirable effects might be very different to that of the broader population.

However, within the broad population of infected or potentially infected patients, some groups might have different needs. For example a study of people isolated for MERS found that while access to telephones reduced anxiety and anger; access to email, text and internet increased these.[53] This was not an area investigated in any depth in these studies. Another area where information may be lacking is that of age, as older people in particular might feel sadness and loneliness more; and gender, as qualitative data suggest that women in isolation were more concerned about precautions and transmission while men were more resigned, rational and tended to cope better.[54]

In some countries, such as the United States single-rooms have become the standard for new hospitals and so one might expect fewer adverse effects if everyone is in a single room, this being the norm. However it may be that a single room is necessary but not sufficient for these findings, and that it is the combination of a single room with an infection that leads to these results. Certainly it is far from clear that the long list of advantages claimed for single rooms which include reduced stress, the ability to deliver better care, and a lower probability of dietary or medication errors apply to this group of patients.[55]

Caring for patients in single-rooms does have many challenges, but there is evidence that these can be mitigated in a general population;[9] however the expanding literature on how this can be done in a general population does not necessarily apply

here due to the necessity of isolation procedures which are, by design, 'a barrier'. Therefore patients' needs for greater social interaction will need a solution quite different from that which might be used for a different patient population, and the benefit of choice about this which single rooms offer does not apply here.[56]

Although this review has quantified the extent of the problem, we have not been able to find solutions in the literature. Care might be improved through increased staff attention with more resources being allocated to these patients, although the extra cost of contact precautions is already considerable, one estimate being that it was an extra $158.90 (95% CI $124.90 to $192.80) per patient day.[57] Alternatively new ways of working might be developed, perhaps using technology to mitigate some of these problems. Technology might be particularly useful in reducing adverse events such as medication or clinical errors; although increasing satisfaction and some areas of quality are more likely to be achieved by increasing the availability of staff and other people. The extent to which scarce resources are allocated to this may be driven in part by the longevity of any negative effects; which current literature is not really able to clarify. To understand this longituduinal studies are needed.

Study strengths and limitations

This review suggests that infectious isolation has a number of negative effects on patients. Because this evidence is comprised of cohort and case-control studies, a claim for a causal relationship can not be made on this evidence, although the strong and consistent effects across the studies may increase the confidence in this relationship. There are some qualitative data, although more in-depth mixed-methods data where those reporting negative effects are questioned about them would

strengthen the evidence on this. In some cases large effect sizes were accompanied by very wide confidence intervals, suggesting that studies were underpowered, thus studies with larger sample sizes would be useful. It would also be useful if there were more consistent methods of examining and reporting these data, particularly outside of the realms of depression and anxiety where the variety of methods makes analysis of the body of evidence difficult. We were also unable to assess whether these effects varied according to reason for isolation; or to understand if they are likely to be long-term or simply temporary phenomena.

Although these data suggest that there is a problem, there is a clear gap both in what we know about improving the experience of isolation and what can be done in practical terms to make it more tolerable for patients and their families. In particular older people who may be most vulnerable to these negative effects were under-represented in these studies; and this group are likely to represent an increasingly large proportion of those isolated.

Contributors

EP, DG and JC conceived the review, EP conducted the search, EP and DG examined the studies and extracted data, EP undertook the quantitative analysis, EP, DG and JC wrote the discussion.

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Competing interests statement

No authors have any competing interests to declare.

Data Availability

All data relevant to the study are included in the article or uploaded as supplementary information.

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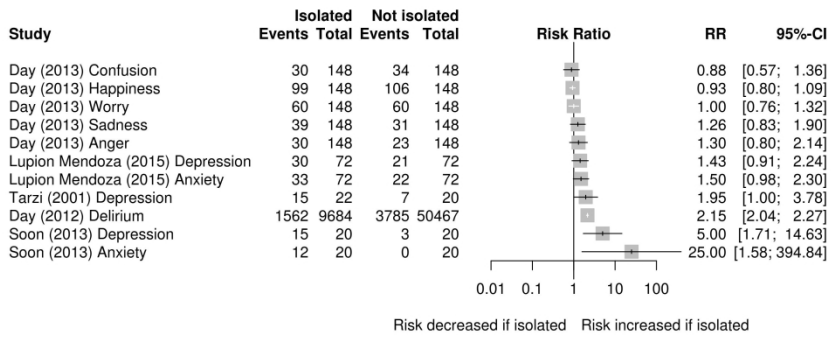

Figure 1. Risk ratio of psychological events in those isolated versus not isolated

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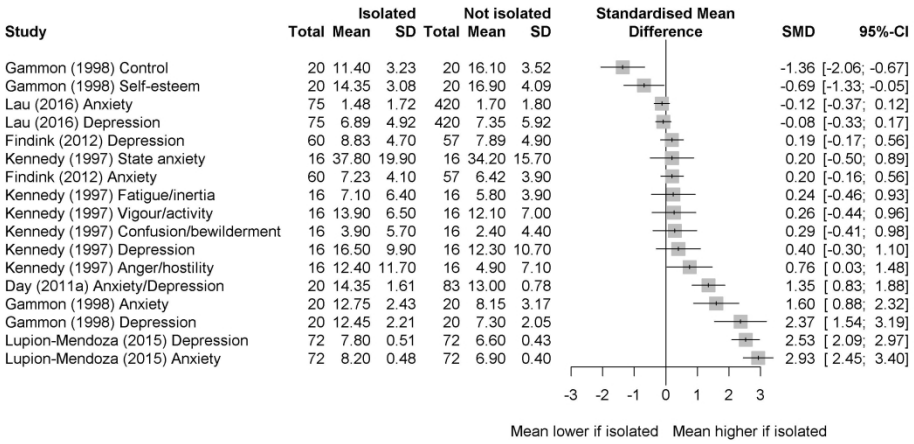

Figure 2. Standardised mean difference of psychological scores in those isolated versus those not isolated

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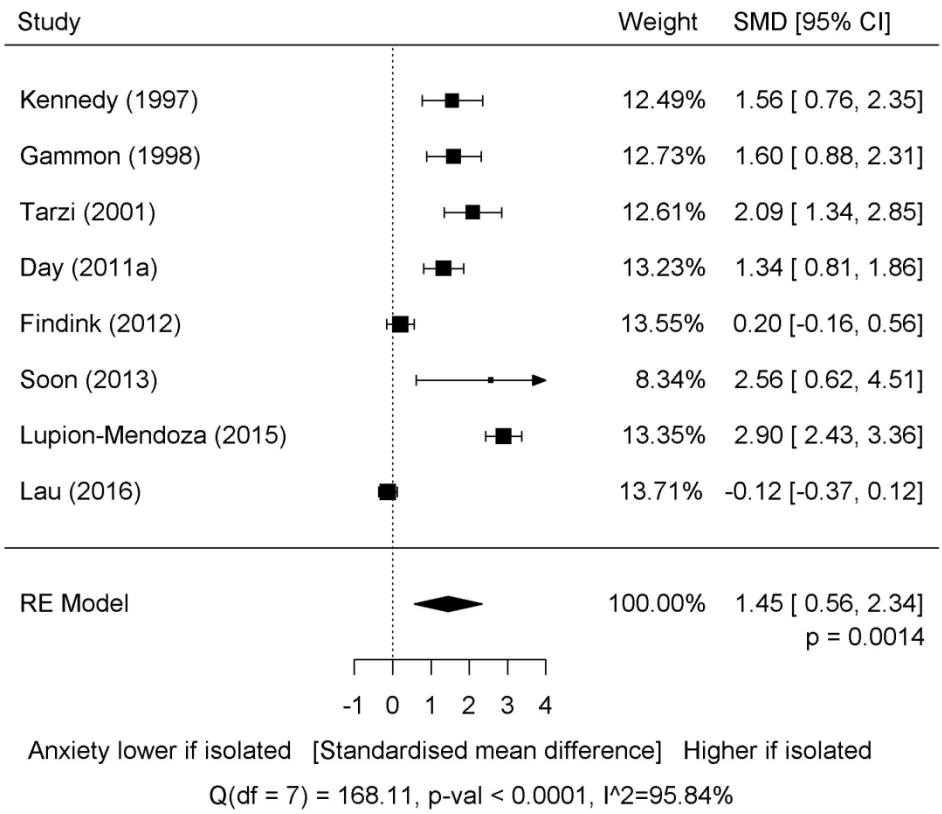

Figure 3. Meta-analysis of the standardised mean difference of anxiety in those isolated versus those not isolated

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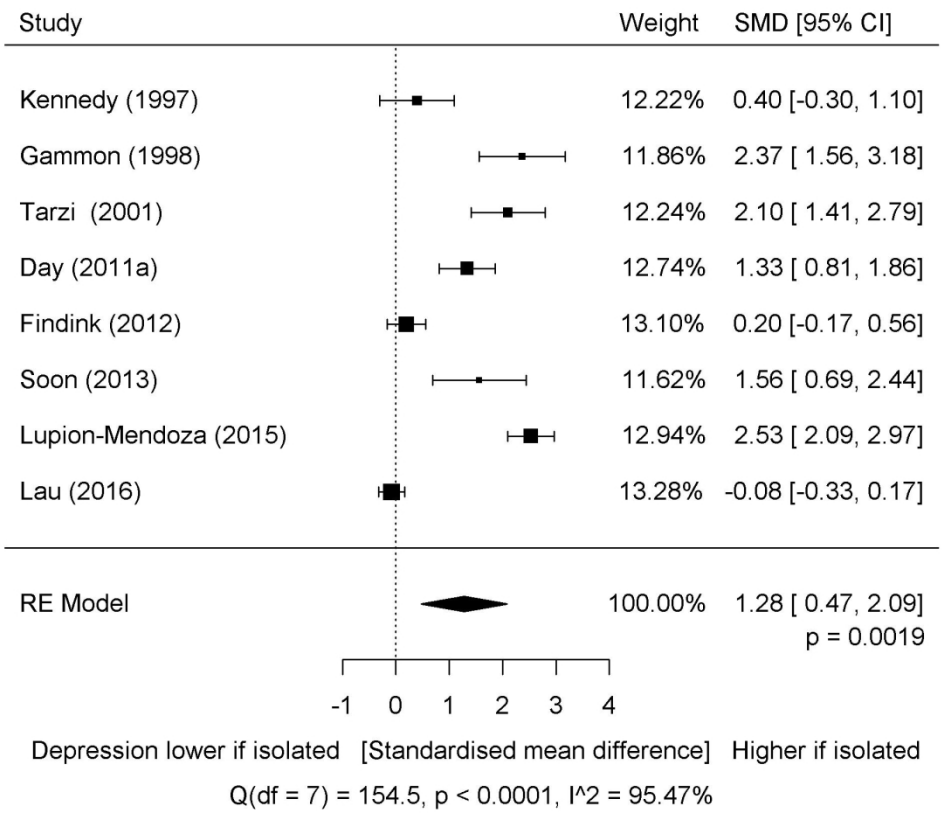

Figure 4. Meta-analysis of the standardised mean difference of depression in those isolated versus those not isolated

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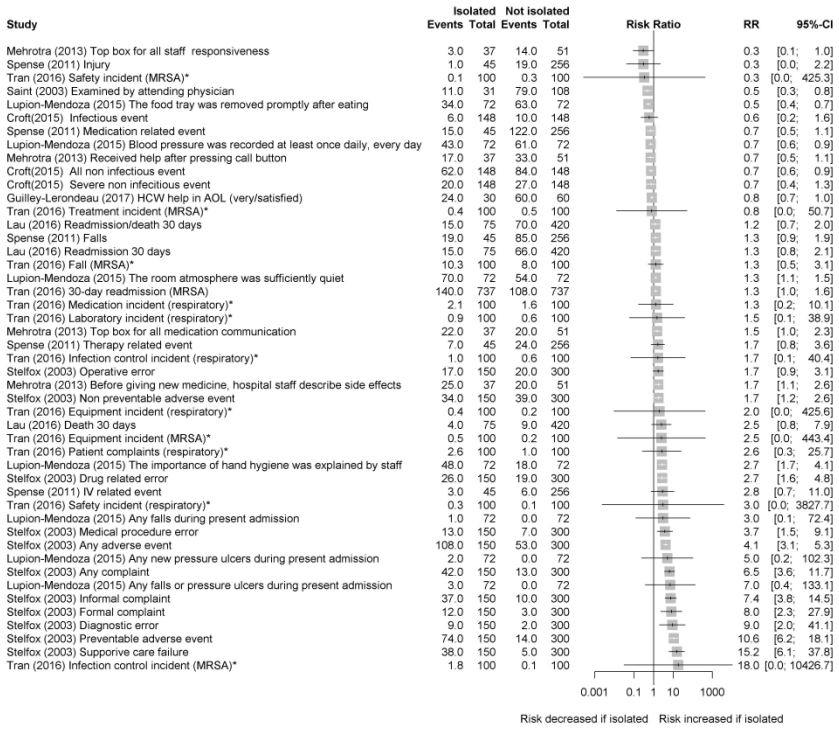

Figure 5. Risk ratio of non-psychological events in those isolated versus not isolated with a RR of < =0.8 or > =1.2

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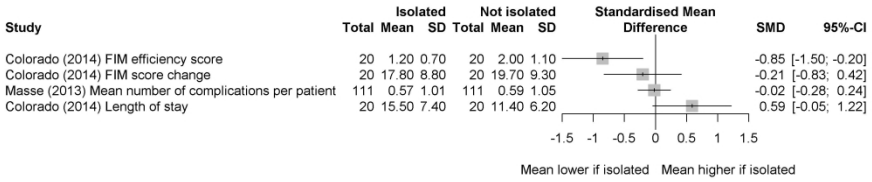


Figure 6. Standardised mean difference of non-psychological scores in those isolated versus those not isolated

321x127mm (300 x 300 DPI)

Characteristics of studies

Reference	Study type	Isolated	Non isolated
Colorado (2014)	Retrospective matched case control study. Rehabilitation facility- tertiary centre United States July 2009 to December 2010	N20 Patients in contact isolation	N=20 Matched to patients not in contact isolation based on age, rehabilitation diagnosis, and type of insurance
Croft (2015)	Prospective cohort Medical or surgical inpatients admitted to non–intensive care unit hospital wards, United States. January to November 2010.	N=148 Patients on contact precautions Age: 52 (13.8) % male: 53.4	N=148 Individually matched by after an initial 3-day length of stay to patients not on contact precautions. Age 52.3 (14.6) % male: 46.6
Dashiell-Earp (2014)	Collected real-time data on the location of 15 internal medicine interns, United States. October 1, 2012 to December 31, 2012	1156 encounters	2467 encounters
Day (2011)	Patients admitted to the general acute care units, United States. June 1, 2009 to October 30, 2009	N=20 Age: 68.5 (14.7) % male: 85.0	N=83 Age: 63.9 (12.6) % male: 95.2
Day (2011)	A two-year retrospective cohort Tertiary care, United States.. All general inpatients over 18 years hospitalized for >24 h February 1, 2007 to January 31, 2009.	Contact precautions private room when possible, can be cohorted General N = 3138 Age: 51.2 (17.5) % male 58.9 ITU N=1694 Age: 54.9 (17.5) % male 61.0	General N = 25 426 Age: 49.6 (19.0) % male 46.3% ICU N = 5 854 Age: 56.0 (17.7) % male 59.7
Day (2012)	2-year retrospective cohort study of all non-psychiatric hospital admissions >18 years, United States. February 1, 2007 to January 31, 2009	N = 9 684 Contact precautions as above Mean age: 50.1 (18.8) % male 51.4	N = 50 458 Mean age: 52.3 (16.9) % males 59.1
Day (2013)	Longitudinal frequency-matched cohort study of patients admitted to general medical and surgical units, United States. Day 0, day 3 then weekly. January to November 2010	N = 148 Mean age: 52.0 (13.9) % male 58.1	N = 148 Mean age: 52.3 (14.6) % male 50.7

Evans (2003)	Prospective observation; survey; retrospective review, United States. Tertiary care. June and July 2001	N 48 Mean age: 47.8 (2) % male 85%	N = 48 Mean age: 58.3 (2.4) % male 75%
Findink (2012)	Non-random quasi-experiment, Turkey Age 18 to 65 Administered day 5 January 1, 2009 to December 31, 2009	N = 60 Mean age: 53.95 (18.4) % male 75%	N = 57 Mean age: 56.14 (17.1) % male 76.3%
Gammon (1998)	Quasi experiment Selected if last two numbers on their case notes even. Two large District General Hospitals and one elderly care hospital, United Kingdom	N = 20 Placed in isolation for a minimum of 7days Mean age: 61 years % male: 65	N = 20 Mean age: 52 years % male: 55
Gandra (2014)	Retrospective hospital-wide cohort study, United States. All patients admitted to medical-surgical inpatient units November 1, 2009 to October 31, 2011	Falls N=77 Mean age: 66.1 (14.3) % male: 61% Pressure ulcers N=82 Mean age: 64.5 (15.5) % male: 63	Falls N=82 Mean age: 63.7 (15.8) % male: 51 (62%) Pressure ulcers N=71 Mean age: 65.7 (15) % male: 57
Guilley-Lerondeau (2017)	Matched cohort study with prospective inclusions Interview 3 days after commencing General sample. France March to July 2012	N=30 First prescription of isolation precaution Median age (range) 69 (32 to 91) % male 47	N=60 Median age (range) 64 (24 to 91) % male 53
Kennedy (1997)	Cross-sectional matched-control study, United Kingdom. May 1994 to November 1996	N = 16 Isolated as a result of being MRSA Mean age: 31.1 All male	N = 16 Matched for age, sex, level of injury, and time since admission or injury
Kirkland (1999)	Observational study - 7 months Medical intensive-care, United States	N=14	N=21
Lau (2016)	Prospective cohort study. Adult patients discharged from internal medicine wards, Canada October 2013 to November 2014,	N=75 Mean age 60.35 (17.83) % male 59	N=420 Mean age 63.31 (18.69) % male 48%
Livorsi (2015)	Case-control study Retrospective January 1, 2012 to	N = 70 On contact precautions for MRSA throughout	N = 139 No significant differences between isolated and

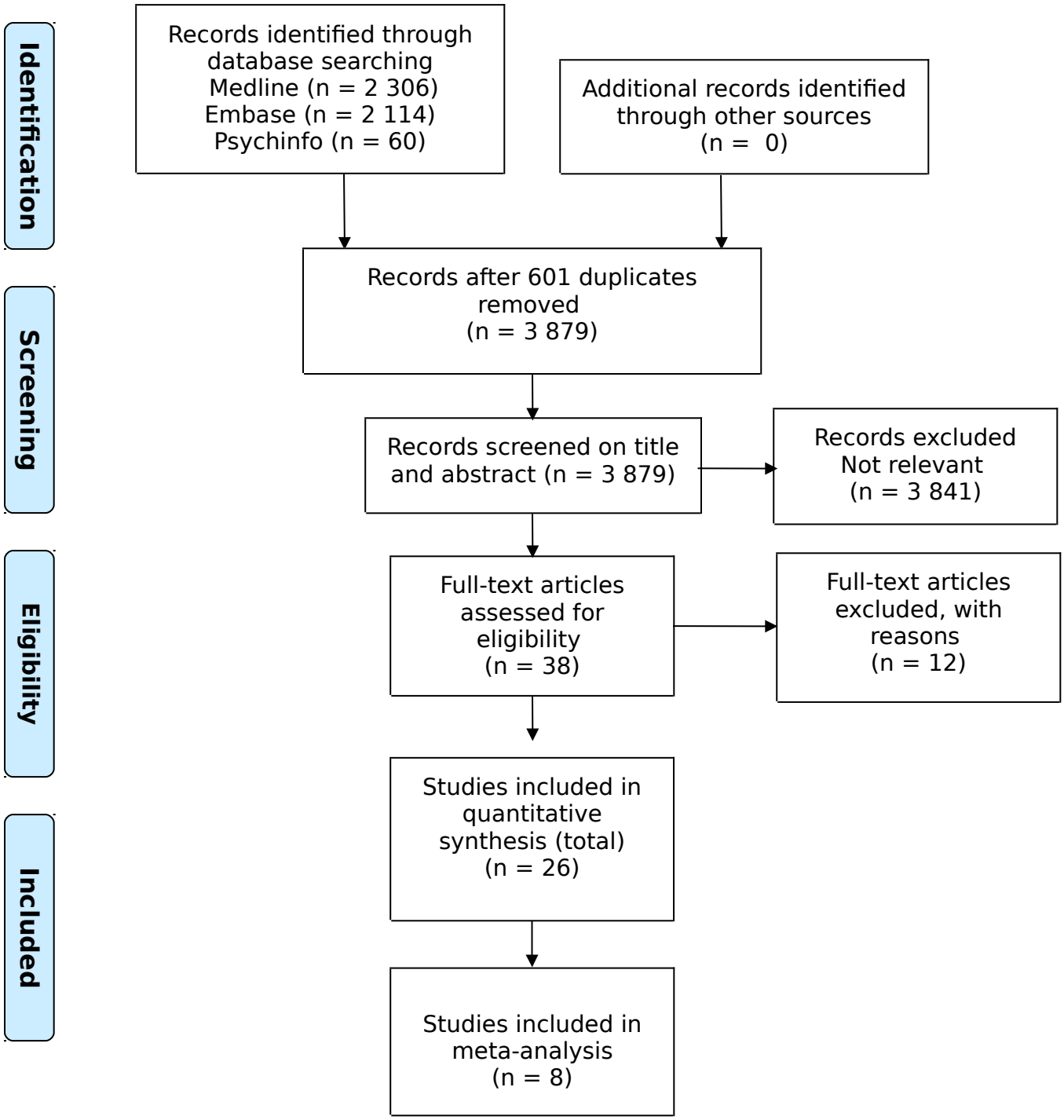
	May 31, 2012/prospective June 1, 2012 to March 31, 2013 'safety-net facility', United States	their hospital stay. Found to be MRSA positive during a previous hospitalization or as an outpatient, not current case	non-isolated patients
Lupión-Mendoza (2015)	Matched case-control study Tertiary hospital, Spain 2011 and 2012	N = 72 Adult patients admitted in isolation for =>5 days. Median age (range) 62 (21-93) % male 73%	N = 72 Median age (range) 69 (23-89), % male 68.1%
Massee (2013)	Retrospective case-control Tertiary care, Canada	N = 111 Matched MRSA patients with an admission diagnosis of heart failure or COPD to similar non-isolated controls Median age (IQR) 80.0 (69.0-86.0) % male 60.4%	N = 111 Median age (IQR) 80.0 (68.0–86.0) % male 60.4%
Mehrotra (2013)	Prospective cohort Admission and on days 3, 7, 14 Tertiary centre, United States	N = 238 Segregation into a private or cohorted room Mean age (SD) 52.4 (13.4) % male 55.7	N = 290 Mean age (SD) 52.9 (14.8) % male 48
Saint (2003)	Prospective cohort study 2 university-affiliated medical centers, United States. October 1999 to March 2000	N=31	N=108
Soon (2013)	Cross-sectional survey of cases and matched controls Teaching hospital Singapore June and August 2011	N=20 Contact isolation in a cohort cubicle for the first time because of colonization or infection with a MDRO for at least 3 days No statistically significant differences in age or gender	N=20
Spense (2011)	Retrospective evaluation of incident reports All patients admitted to acute care facility, United States January 1, 2008 to December 31, 2008.	N=45	N=256
Stelfox (2003)	Case control study Consecutive adults isolated for at least 2 days with MRSA. Canada and United States Controls patients admitted before	General N = 78 Age: 69.6 (17.1) % male: 45% CHF N = 72 Age: 66.9 (14.7)	General N = 156 Age: 65.4 (18.2) % male: 51% CHF N = 144 Age: 66.0 (14.5)

	and after. January 1, 1999,to January 1, 2000	% male: 58	% male: 54
Tarzi (2001)	Cross-sectional matched case-control study Care of the elderly rehabilitation wards, UK	N = 22 Had been in isolation for at least two weeks with MRSA Mean age (SD) 80 (8.4) % male 27.3	N = 20 Mean age (SD) 81 (9.1) % male 33.3
Tran (2017)	Propensity matched cohort study. General internal medicine services, 3 hospitals, Canada January 2010 to December 2012	MRSA Age: 69 % male 57% Respiratory Age: 71.7 % male: 53 Isolated for MRSA or respiratory illness	MRSA Age: 69 % male 58% Respiratory Age: 70.6 % male: 55
Wassenburg (2010)	Cross-sectional matched cohort study Single university hospital, Netherlands November 2006 to February 2007	N = 42 Age: 52 (19) % male: 52	N = 84 Age: 55 (16) % male: 55

Excluded papers

Reference	Reason for exclusion
Chittick et al (2016)	No comparative data
Godsell (2013)	Focussed on HCP
Jeong (2016)	MERS
MacKellaig (1986)	Qualitative
Madsden (2015)	Qualitative
Maunder (2003)	SARS
Moran (2009)	Focus on family centred care
Morgan (2011)	Focus on process measures
Rees (2000a)	No comparative data
Rees (2000a)	No comparative data
Simon (2016)	Before and after
Wilkins (1988)	No comparative data

PRISMA 2009 Flow Diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

All RR data

	Reference	Year
1	Croft(2015)	2015
2	Croft(2015)	2015
4	Croft(2015)	2015
9	Guilley-Lerondeau (2017)	2017
15	Lau (2016)	2016
16	Lau (2016)	2016
18	Lau (2016)	2016
43	Lupion-Mendoza (2015)	2015
48	Lupion-Mendoza (2015)	2015
50	Lupion-Mendoza (2015)	2015
54	Lupion-Mendoza (2015)	2015
57	Lupion-Mendoza (2015)	2015
58	Lupion-Mendoza (2015)	2015
59	Lupion-Mendoza (2015)	2015
69	Mehrotra (2013)	2013
71	Mehrotra (2013)	2013
76	Mehrotra (2013)	2013
77	Mehrotra (2013)	2013
85	Stelfox (2003)	2003
86	Stelfox (2003)	2003
87	Stelfox (2003)	2003
88	Stelfox (2003)	2003
89	Stelfox (2003)	2003
90	Stelfox (2003)	2003
91	Stelfox (2003)	2003
92	Stelfox (2003)	2003
93	Stelfox (2003)	2003
94	Stelfox (2003)	2003
95	Stelfox (2003)	2003
96	Spense (2011)	2011
97	Spense (2011)	2011
98	Spense (2011)	2011
99	Spense (2011)	2011
100	Spense (2011)	2011
102	Saint (2003)	2003
103	Tran (2016)	2016
106	Tran (2016)	2016
107	Tran (2016)	2016
108	Tran (2016)	2016
109	Tran (2016)	2016
113	Tran (2016)	2016
114	Tran (2016)	2016
116	Tran (2016)	2016
117	Tran (2016)	2016
118	Tran (2016)	2016
120	Tran (2016)	2016
122	Tran (2016)	2016
3	Croft(2015)	2015
5	Evans (2003)	2003
6	Evans (2003)	2003
7	Evans (2003)	2003
8	Guilley-Lerondeau (2017)	2017
10	Guilley-Lerondeau (2017)	2017
11	Guilley-Lerondeau (2017)	2017

All RR data

12	Guilley-Lerondeau (2017)	2017
13	Guilley-Lerondeau (2017)	2017
14	Guilley-Lerondeau (2017)	2017
17	Lau (2016)	2016
19	Livorsi (2015)	2015
20	Livorsi (2015)	2015
21	Livorsi (2015)	2015
22	Livorsi (2015)	2015
23	Livorsi (2015)	2015
24	Livorsi (2015)	2015
25	Livorsi (2015)	2015
26	Livorsi (2015)	2015
27	Livorsi (2015)	2015
28	Livorsi (2015)	2015
29	Livorsi (2015)	2015
30	Livorsi (2015)	2015
31	Livorsi (2015)	2015
32	Livorsi (2015)	2015
33	Livorsi (2015)	2015
34	Livorsi (2015)	2015
35	Livorsi (2015)	2015
36	Livorsi (2015)	2015
37	Lupion-Mendoza (2015)	2015
38	Lupion-Mendoza (2015)	2015
39	Lupion-Mendoza (2015)	2015
40	Lupion-Mendoza (2015)	2015
41	Lupion-Mendoza (2015)	2015
42	Lupion-Mendoza (2015)	2015
44	Lupion-Mendoza (2015)	2015
45	Lupion-Mendoza (2015)	2015
46	Lupion-Mendoza (2015)	2015
47	Lupion-Mendoza (2015)	2015
49	Lupion-Mendoza (2015)	2015
51	Lupion-Mendoza (2015)	2015
52	Lupion-Mendoza (2015)	2015
53	Lupion-Mendoza (2015)	2015
55	Lupion-Mendoza (2015)	2015
56	Lupion-Mendoza (2015)	2015
60	Masse (2013)	2013
61	Mehrotra (2013)	2013
62	Mehrotra (2013)	2013
63	Mehrotra (2013)	2013
64	Mehrotra (2013)	2013
65	Mehrotra (2013)	2013
66	Mehrotra (2013)	2013
67	Mehrotra (2013)	2013
68	Mehrotra (2013)	2013
70	Mehrotra (2013)	2013
72	Mehrotra (2013)	2013
73	Mehrotra (2013)	2013
74	Mehrotra (2013)	2013
75	Mehrotra (2013)	2013
78	Mehrotra (2013)	2013
79	Mehrotra (2013)	2013
80	Mehrotra (2013)	2013

All RR data

81	Mehrotra (2013)	2013
82	Mehrotra (2013)	2013
83	Mehrotra (2013)	2013
84	Mehrotra (2013)	2013
101	Saint (2003)	2003
104	Tran (2016)	2016
105	Tran (2016)	2016
110	Tran (2016)	2016
111	Tran (2016)	2016
112	Tran (2016)	2016
115	Tran (2016)	2016
119	Tran (2016)	2016
121	Tran (2016)	2016
123	Tran (2016)	2016
124	Tran (2016)	2016
125	Tran (2016)	2016
126	Tran (2016)	2016
127	Tran (2016)	2016
128	Tran (2016)	2016

All RR data

Outcome	Isolated
All non infectious event	62
Severe non infecitious event	20
Infectious event	6
HCW help in AOL (very/satisfied)	24
Readmission/death 30 days	15
Readmission 30 days	15
Death 30 days	4
The importance of hand hygiene was explained by staff	48
The food tray was removed promptly after eating	34
The room atmosphere was sufficiently quiet	70
Blood pressure was recorded at least once daily, every day	43
Any falls during present admission	1
Any new pressure ulcers during present admission	2
Any falls or pressure ulcers during present admission	3
Received help after pressing call button	17
Top box for all staff responsiveness	3
Before giving new medicine, hospital staff describe side effects	25
Top box for all medication communication	22
Any complaint	42
Informal complaint	37
Formal complaint	12
Any adverse event	108
Non preventable adverse event	34
Preventable adverse event	74
Supporive care failure	38
Diagnostic error	9
Operative error	17
Medical procedure error	13
Drug related error	26
Falls	19
Injury	1
IV related event	3
Medication related event	15
Therapy related event	7
Examined by attending physician	11
Fall (MRSA)*	10.3
Treatment incident (MRSA)*	0.4
Infection control incident (MRSA)*	1.8
Safety incident (MRSA)*	0.1
Equipment incident (MRSA)*	0.5
Medication incident (respiratory)*	2.1
Laboratory incident (respiratory)*	0.9
Infection control incident (respiratory)*	1
Safety incident (respiratory)*	0.3
Equipment incident (respiratory)*	0.4
Patient complaints (respiratory)*	2.6
30-day readmission (MRSA)	140
Preventable non infectioutrs event	37
Encounters per hr (no)	5
ICU encounters per hr	6
Floor encounters per hr	4
Global hygiene (very/satisfied)	28
Daily room cleaning (very/satisfied)	27
HCW availability (very/satisfied)	25

All RR data

Daily HCW presence (very/satisfied)	27
Human relation with HCW (very/satisfied)	27
Global satisfaction (very/satisfied)	25
ED visit 30 days	22
Overall rating of hospital =>9/10	44
Nurses treat you with courtesy and respect	51
Nurses listen carefully	47
Nurses explain things in an understandable way	47
Received help after pressing call button	28
Doctors treat you with courtesy and respect	53
Doctors listen carefully to you	48
Doctors explain things in an understandable way	50
Room and bathroom kept clean	42
Room quiet at night	51
Received help with bathroom/bedpan	19
Pain well controlled	34
Hospital staff help with pain	45
Hospital staff explain new medications	20
Hospital staff describe side effects of medications	13
Hospital staff discussed help after discharge	52
Written information on problems to look for after discharge	52
Recommend hospital to friends and family	43
Overall satisfaction with the professional treatment received from health care workers	67
Nurses treated the patients in polite and respectful manner (totally/partially agree)	70
Physicians treated the patients in polite and respectful manner	71
Nurses provided clear information about the health problem	64
Physicians provided clear information about the health problem	66
Clear explanations were provided before all procedures	62
Health care workers entered the room whenever the patient called them	66
Blood pressure and temperature recorded at least once a day	65
The physician visited daily	69
The room was comfortable	62
Room cleaning was satisfactory	66
I frequently felt lonely during admission	17
Medical notes were recorded every day	64
Nurses notes were recorded every day	64
Daily temperature was recorded at least once a day, every day	53
Daily glycemic levels were recorded as indicated, everyday (only diabetic patients)	31
Total number of complications	60
Nurses treat with courtesy and respect	31
Nurses listen carefully	30
Nurses explain things in understandable way	30
Top box for all nursing communication	27
Doctors treat with courtesy and respect	33
Doctors listen carefully	31
Doctors explain things in understandable way	29
Top box for all doctor communication	27
Received help in bathroom/bedpan use	25
Pain well controlled	26
Hospital staff help with pain	26
Top box for all pain management	25
Before giving new medicine, hospital staff tells what it is for	30
Spoken with about having necessary help after discharge	31
Written information on symptoms/problems to look for after discharge	33
Top box for all discharge information	30

All RR data

Hospital room and bathroom kept clean (individual)	27
Area near room quiet at night (individual)	24
Recommend hospital to friends and family (global)	25
Overall hospital rating (global)	22
Examined by senior resident doctor	26
Medication incident (MRSA)*	2.2
Laboratory incident (MRSA)*	0.3
Any adverse event (MRSA)*	12.4
Patient complaints (MRSA)*	1.1
Fall (respiratory)*	4.2
Treatment incident (respiratory)*	0.6
Any adverse event (respiratory)*	9.1
Inpatient mortality (MRSA)	59
30-day ED visit (MRSA)	84
Readmission or ED visit (respiratory)	167
Inpatient mortality (respiratory)	104
30-day readmission (respiratory)	206
30-day ED visit (respiratory)	164
Readmission or ED visit (respiratory)	261

All RR data

Isolated.N	Control	Control.N	RI	RC	RR	inout	Type
148	84	148	0.418918919	0.567567568	0.738095238	a	AE
148	27	148	0.135135135	0.182432432	0.740740741	a	AE
148	10	148	0.040540541	0.067567568	0.6	a	AE
30	60	60	0.8	1	1.25	a	Satisfaction
75	70	420	0.2	0.166666667	1.2	a	AE
75	66	420	0.2	0.157142857	1.272727273	a	AE
75	9	420	0.053333333	0.021428571	2.488888889	a	AE
72	18	72	0.666666667	0.25	0.375	a	Satisfaction
72	63	72	0.472222222	0.875	1.852941177	a	Satisfaction
72	54	72	0.972222222	0.75	0.771428572	a	Satisfaction
72	61	72	0.597222222	0.847222222	0.704918033	a	Quality
72	0	72	0.013888889	0	#DIV/0!	a	AE
72	0	72	0.027777778	0	#DIV/0!	a	AE
72	0	72	0.041666667	0	#DIV/0!	a	AE
37	33	51	0.459459459	0.647058824	1.408304501	a	Quality
37	14	51	0.081081081	0.274509804	3.385620919	a	Satisfaction
37	20	51	0.675675676	0.392156863	0.580392157	a	Quality
37	20	51	0.594594595	0.392156863	0.659536542	a	Quality
150	13	300	0.28	0.043333333	6.461538462	a	Satisfaction
150	10	300	0.246666667	0.033333333	7.4	a	Satisfaction
150	3	300	0.08	0.01	8	a	Satisfaction
150	53	300	0.72	0.176666667	4.075471698	a	Satisfaction
150	39	300	0.226666667	0.13	1.743589744	a	AE
150	14	300	0.493333333	0.046666667	10.57142857	a	AE
150	5	300	0.253333333	0.016666667	15.2	a	AE
150	2	300	0.06	0.006666667	9	a	AE
150	20	300	0.113333333	0.066666667	1.7	a	AE
150	7	300	0.086666667	0.023333333	3.714285714	a	AE
150	19	300	0.173333333	0.063333333	2.736842105	a	AE
45	85	256	0.422222222	0.33203125	1.271633987	a	AE
45	19	256	0.022222222	0.07421875	0.299415205	a	AE
45	6	256	0.066666667	0.0234375	2.844444444	a	AE
45	122	256	0.333333333	0.4765625	0.699453552	a	AE
45	24	256	0.155555556	0.09375	1.659259259	a	AE
31	79	108	0.35483871	0.731481481	2.061447808	a	Quality
100	8	100	0.103	0.08	1.2875	a	AE
100	0.5	100	0.004	0.005	0.8	a	AE
100	0.1	100	0.018	0.0011	16.36363636	a	AE
100	0.3	100	0.001	0.003	0.333333333	a	AE
100	0.2	100	0.005	0.002	2.5	a	AE
100	1.6	100	0.021	0.016	1.3125	a	AE
100	0.6	100	0.009	0.006	1.5	a	AE
100	0.6	100	0.01	0.006	1.666666667	a	AE
100	0.1	100	0.003	0.001	3	a	AE
100	0.2	100	0.004	0.002	2	a	AE
100	1	100	0.026	0.01	2.6	a	Satisfaction
737	108	737	0.19	0.147	1.292517007	a	AE
148	41	148	0.25	0.277027027	0.902439024	b	AE
485	11	1002	0.010309278	0.010978044	1.064870304	b	Quality
319	14	658	0.018808777	0.021276596	1.131205713	b	Quality
166	8	344	0.024096386	0.023255814	0.965116263	b	Quality
30	59	60	0.933333333	0.983333333	1.053571429	b	Satisfaction
30	58	60	0.9	0.966666667	1.074074074	b	Satisfaction
30	57	60	0.833333333	0.95	1.14	b	Satisfaction

All RR data

30	59	60	0.9	0.983333333	1.092592592	b	Satisfaction
30	60	60	0.9	1	1.111111111	b	Satisfaction
30	60	60	0.833333333	1	1.2	b	Satisfaction
75	109	420	0.293333333	0.25952381	1.130275229	b	AE
68	85	135	0.647058824	0.62962963	0.973063973	b	Satisfaction
69	110	138	0.739130435	0.797101449	1.078431372	b	Satisfaction
70	101	137	0.671428571	0.737226277	1.097996583	b	Satisfaction
69	102	135	0.68115942	0.755555556	1.109219859	b	Satisfaction
52	70	114	0.538461538	0.614035088	1.140350879	b	Satisfaction
70	106	137	0.757142857	0.773722628	1.021897811	b	Satisfaction
68	103	136	0.705882353	0.757352941	1.072916666	b	Satisfaction
68	99	137	0.735294118	0.722627737	0.982773722	b	Satisfaction
68	82	127	0.617647059	0.645669291	1.045369328	b	Satisfaction
70	98	137	0.728571429	0.715328467	0.981823386	b	Satisfaction
30	49	68	0.633333333	0.720588235	1.137770898	b	Satisfaction
62	75	117	0.548387097	0.641025641	1.16892911	b	Satisfaction
62	96	115	0.725806452	0.834782609	1.150144927	b	Satisfaction
27	47	59	0.740740741	0.796610169	1.075423728	b	Satisfaction
25	35	57	0.52	0.614035088	1.180836708	b	Satisfaction
61	108	124	0.852459016	0.870967742	1.021712159	b	Satisfaction
62	106	120	0.838709677	0.883333333	1.053205128	b	Satisfaction
67	98	133	0.641791045	0.736842105	1.148102814	b	Satisfaction
72	69	72	0.930555556	0.958333333	1.029850745	b	Satisfaction
72	71	72	0.972222222	0.986111111	1.014285714	b	Satisfaction
72	72	72	0.986111111	1	1.014084507	b	Satisfaction
72	68	72	0.888888889	0.944444444	1.062499999	b	Satisfaction
72	62	72	0.916666667	0.861111111	0.939393939	b	Satisfaction
72	66	72	0.861111111	0.916666667	1.06451613	b	Satisfaction
72	71	72	0.916666667	0.986111111	1.075757575	b	Satisfaction
72	70	72	0.902777778	0.972222222	1.076923076	b	Quality
72	71	72	0.958333333	0.986111111	1.028985507	b	Quality
72	67	72	0.861111111	0.930555556	1.080645162	b	Satisfaction
72	70	72	0.916666667	0.972222222	1.06060606	b	Quality
72	17	72	0.236111111	0.236111111	1	b	Satisfaction
72	65	72	0.888888889	0.902777778	1.015625	b	Quality
72	69	72	0.888888889	0.958333333	1.078124999	b	Quality
72	60	72	0.736111111	0.833333333	1.132075471	b	Quality
31	18	18	1	1	1	b	Quality
111	62	111	0.540540541	0.558558559	0.967741935	b	Satisfaction
37	45	51	0.837837838	0.882352941	1.053130929	b	Satisfaction
37	43	51	0.810810811	0.843137255	1.039869281	b	Satisfaction
37	42	51	0.810810811	0.823529412	1.015686275	b	Satisfaction
37	39	51	0.72972973	0.764705882	1.047930282	b	Satisfaction
37	42	51	0.891891892	0.823529412	0.923351159	b	Satisfaction
37	42	51	0.837837838	0.823529412	0.982922201	b	Satisfaction
37	44	51	0.783783784	0.862745098	1.100743745	b	Satisfaction
37	37	51	0.72972973	0.725490196	0.994190268	b	Satisfaction
37	35	51	0.675675676	0.68627451	1.015686274	b	Quality
37	40	51	0.702702703	0.784313725	1.116138762	b	Quality
37	38	51	0.702702703	0.745098039	1.060331824	b	Quality
37	35	51	0.675675676	0.68627451	1.015686274	b	Quality
37	41	51	0.810810811	0.803921569	0.991503268	b	Quality
37	45	51	0.837837838	0.882352941	1.053130929	b	Quality
37	49	51	0.891891892	0.960784314	1.077243019	b	Quality
37	45	51	0.810810811	0.882352941	1.088235294	b	Quality

All RR data

37	37	51	0.72972973	0.725490196	0.994190268	b	Quality
37	32	51	0.648648649	0.62745098	0.96732026	b	Satisfaction
37	41	51	0.675675676	0.803921569	1.189803922	b	Satisfaction
37	36	51	0.594594595	0.705882353	1.187165775	b	Satisfaction
31	94	108	0.838709677	0.87037037	1.037749288	b	Quality
100	2.4	100	0.022	0.024	0.916666667	b	AE
100	0.3	100	0.0027	0.0033	0.818181818	b	AE
100	10.7	100	0.124	0.107	1.158878505	b	AE
100	1.3	100	0.0109	0.0125	0.872	b	Satisfaction
100	5.1	100	0.042	0.051	0.823529412	b	AE
100	0.7	100	0.006	0.007	0.857142857	b	AE
100	8.9	100	0.091	0.089	1.02247191	b	AE
737	52	737	0.08	0.07	1.142857143	b	AE
737	86	737	0.114	0.117	0.974358974	b	AE
737	142	737	0.227	0.193	1.176165803	b	AE
1502	128	1502	0.069	0.085	0.811764706	b	AE
1502	236	1502	0.137	0.157	0.872611465	b	AE
1502	168	1502	0.109	0.112	0.973214286	b	AE
1502	278	1502	0.174	0.185	0.940540541	b	AE

All RR data

Good/bad	exp yi	yi	vi
Bad	0.74	-0.303682414	0.014520281
Bad	0.74	-0.300104592	0.073523524
Bad	0.60	-0.510825624	0.253153153
Good	0.80	-0.227083588	0.008693745
Bad	1.20	0.182321557	0.065238095
Bad	1.27	0.241162057	0.066103896
Bad	2.49	0.911836382	0.345396825
Good	2.67	0.980829253	0.048611111
Good	0.54	-0.616774202	0.017507003
Good	1.30	0.259511195	0.005026455
Good	0.70	-0.349673748	0.011871479
Bad	3.00	1.098612289	2.639269406
Bad	5.00	1.609437912	2.37260274
Bad	7.00	1.945910149	2.258317025
Good	0.71	-0.342386497	0.04249169
Good	0.30	-1.219537321	0.358127035
Good	1.72	0.544051271	0.04336513
Good	1.52	0.4162179	0.048819675
Bad	6.46	1.865867441	0.090732601
Bad	7.40	2.00148	0.117027027
Bad	8.00	2.079441542	0.406666667
Bad	4.08	1.404986494	0.018127184
Bad	1.74	0.555946059	0.04505279
Bad	10.57	2.358154944	0.074942085
Bad	15.20	2.721295428	0.216315789
Bad	9.00	2.197224577	0.601111111
Bad	1.70	0.530628251	0.098823529
Bad	3.71	1.312186389	0.20978022
Bad	2.74	1.006804739	0.081093117
Bad	1.27	0.240302677	0.038267813
Bad	0.30	-1.205924024	1.026503107
Bad	2.84	1.045367774	0.473871528
Bad	0.70	-0.357455889	0.048734916
Bad	1.66	0.506371273	0.158395337
Good	0.49	-0.723408557	0.062049995
Bad	1.29	0.252702354	0.202087379
Bad	0.80	-0.223143551	4.48
Bad	18.00	2.890371758	10.53555556
Bad	0.33	-1.098612289	13.31333333
Bad	2.50	0.916290732	6.98
Bad	1.31	0.271933715	1.081190476
Bad	1.50	0.405465108	2.757777778
Bad	1.67	0.510825624	2.646666667
Bad	3.00	1.098612289	13.31333333
Bad	2.00	0.693147181	7.48
Bad	2.60	0.955511445	1.364615385
Bad	1.30	0.259511195	0.013688412
Bad	0.90	-0.102654154	0.037903757
Good	0.94	-0.06285297	0.287849231
Good	0.88	-0.123284032	0.233440685
Good	1.04	0.035506688	0.366068927
Good	0.95	-0.052185753	0.002663438
Good	0.93	-0.071458964	0.004278416
Good	0.88	-0.131028262	0.00754386

All RR data

Good	0.92	-0.088553397	0.00398619
Good	0.89	-0.111570701	0.004241055
Good	0.83	-0.187078253	0.007093105
Bad	1.13	0.122461169	0.038914572
Good	1.03	0.027305451	0.012378689
Good	0.93	-0.075507553	0.006959622
Good	0.91	-0.093487231	0.009592601
Good	0.90	-0.103656938	0.009180356
Good	0.88	-0.131336002	0.021997301
Good	0.98	-0.021661497	0.006716902
Good	0.93	-0.070380797	0.008483248
Good	1.02	0.017376376	0.008095858
Good	0.96	-0.044370248	0.013424748
Good	1.02	0.018343838	0.00822694
Good	0.88	-0.129070995	0.025000527
Good	0.86	-0.156088039	0.018069057
Good	0.87	-0.139887958	0.007814204
Good	0.93	-0.07271475	0.017290406
Good	0.85	-0.166223261	0.047950646
Good	0.98	-0.021479807	0.00403207
Good	0.95	-0.051838018	0.004202366
Good	0.87	-0.138110854	0.011015725
Good	0.97	-0.029413885	0.001640349
Good	0.99	-0.014184635	0.000592444
Good	0.99	-0.013889112	0.000381857
Good	0.94	-0.060624622	0.002553105
Good	1.06	0.062520357	0.00350277
Good	0.94	-0.062520357	0.00350277
Good	0.93	-0.073025135	0.001458244
Good	0.93	-0.074107972	0.001892552
Good	0.97	-0.028573372	0.000799483
Good	0.93	-0.077558234	0.003276628
Good	0.94	-0.0588405	0.001659452
Bad	1.00	0	0.089869281
Good	0.98	-0.015504187	0.003231838
Good	0.93	-0.075223421	0.002339976
Good	0.88	-0.124052649	0.007756813
Good	1.01	0.01091989	0.001918507
Bad	0.97	-0.032789823	0.014777681
Good	0.95	-0.051767565	0.007845417
Good	0.96	-0.039095014	0.009954277
Good	0.98	-0.015564517	0.010507987
Good	0.95	-0.04681706	0.016043193
Good	1.08	0.079745663	0.007477684
Good	1.02	0.017225306	0.009432718
Good	0.91	-0.095986084	0.010575161
Good	1.01	0.005826673	0.017429194
Good	0.98	-0.015564517	0.021936558
Good	0.90	-0.109875196	0.016826668
Good	0.94	-0.058581902	0.018142458
Good	0.98	-0.015564517	0.021936558
Good	1.01	0.008533035	0.011088707
Good	0.95	-0.051767565	0.007845417
Good	0.93	-0.074405017	0.004076323
Good	0.92	-0.084557388	0.008920685

All RR data

Good	1.01	0.005826673	0.017429194
Good	1.03	0.033225648	0.026281797
Good	0.84	-0.173788522	0.017755374
Good	0.84	-0.171568765	0.026597453
Good	0.96	-0.037054222	0.007582513
Bad	0.92	-0.087011377	0.851212121
Bad	1.00	0	6.646666667
Bad	1.16	0.147452731	0.154103105
Bad	0.85	-0.167054085	1.658321678
Bad	0.82	-0.194156014	0.414173669
Bad	0.86	-0.15415068	3.075238095
Bad	1.02	0.022223137	0.20224966
Bad	1.13	0.126293725	0.033466218
Bad	0.98	-0.023530497	0.020818965
Bad	1.18	0.162166755	0.010316573
Bad	0.81	-0.207639365	0.016096327
Bad	0.87	-0.135955636	0.007760099
Bad	0.98	-0.024097552	0.010718384
Bad	0.94	-0.063100706	0.006096982

	Reference	Year	Outcome	Isolated	IsolatedSD	Isolated.N	Control	ControlSD
2	Kennedy (1	1997	Anxiety	37.8	19.9	16	12.3	10.7
9	Gammon (1	1998	Anxiety	12.75	2.43	20	8.15	3.17
15	Tarzi (2001	2001	Anxiety	15	3	22	8.6	3
16	Day (2011a	2011	Anxiety/De	14.35	1.61	20	13	0.8
13	Findink (20	2012	Anxiety	7.23	4.1	61	6.42	3.9
	Soon (2013	2013	Anxiety					
17	Lupion-Mer	2015	Anxiety	8.2	0.48	72	6.9	0.41
8	Lau (2016)	2016	Anxiety	1.48	1.72	75	1.7	1.8

Control.N	yi	vi
16	1.5558	0.1628
20	1.5963	0.1319
20	2.093	0.1476
83	1.3351	0.0707
57	0.201	0.0341
	2.5649	0.986
72	2.8969	0.0569
421	-0.1228	0.0157

	Reference	Year	Outcome	Isolated	IsolatedSD	Isolated.N	Control	ControlSD
1	Kennedy (1	1997	Depression	16.5	9.9	16	12.3	10.7
10	Gammon (1	1998	Depression	12.45	2.21	20	7.3	2.05
	Tarzi (200	2001	Depression					
16	Day (2011a	2011	Anxiety/De	14.3	1.61	20	13	0.8
14	Findink (20	2012	Depression	8.83	4.7	61	7.89	4.9
	Soon (2013	2013	Depression					
18	Lupion-Mer	2015	Depression	7.8	0.51	72	6.6	0.43
7	Lau (2016)	2016	Depression	6.89	4.92	75	7.35	5.92

Control.N	yi	vi
16	0.397	0.127
20	2.368	0.17
	2.101	0.125
83	1.335	0.071
57	0.195	0.034
	1.562	0.2
72	2.531	0.05
420	-0.079	0.016

Case-control studies

	Colorado (2014)	Kennedy (1997)	Livorsi (2015)	Lupion (2015)	Masse (2013)	Soon (2013)	Tarzi (2001)
1) Is the case definition adequate? a) yes, with independent validation * b) yes, eg record linkage or based on self reports c) no description	*	*	*	*	*	*	*
2) Representativeness of the cases a) consecutive or obviously representative series of cases * b) potential for selection biases or not stated	b	b	*	b	b	*	*
3) Selection of Controls a) community controls (studies of hospital patients) * b) hospital controls c) no description	*	*	*	*	*	*	*
4) Definition of Controls a) no history of disease (endpoint) * b) no description of source	*			*			
Comparability							
1) Comparability of cases and controls on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *	* * (l)	* * (l, g)		* * (g)	* *(g)	* * (l, g)	* *(l, g)
Outcome							
1) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview where blind to case/control status * c) interview not blinded to case/control status d) written self report or medical record only e) no description	*	*	*	*	*	*	*
2) Same method of ascertainment for cases and controls a) yes * b) no	Functional Independence Measure ## *	Functional Independence Measure; Beck Inventory Depression; State Anxiety Inventory; Profile Mood States ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Charlston Comorbidity Index ## *	Hospital Anxiety and Depression Scale ## *	Geriatric Depression Scale; Profile of Mood States; Abbreviated Mental Test Score; Barthel Index ## *
3) Non-Response rate a) same rate for both groups * b) non respondents described c) rate different and no designation	*	*	*	*			*

Cohort studies (1)

Selection	Croft (2015)	Day (2011) a	Day (2011) b	Day (2012)	Day (2013)	Evans (2003)	Findink (2012)	Guilley (2017)
1) Representativeness of the exposed cohort a) truly representative of the average patient in the community * b) somewhat representative of the average patient in the community * c) selected group of users eg nurses, volunteers d) no description of the derivation of the cohort	*	*	*	*	* b	c	*b	*b
2) Selection of the non exposed cohort a) drawn from the same community as the exposed cohort * b) drawn from a different source c) no description of the derivation of the non exposed cohort	*	*	*	*	*	*	*	*
3) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview * c) written self report d) no description	*	*	*	*	*	*	*	*
4) Demonstration that outcome of interest was not present at start of study a) yes * b) no	*	b	b	*	*	*		*
Comparability								
1) Comparability of cohorts on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *	* * (l,g)		* * (l,g)	* * (l,g)	* * (l,g)			* (g)
Outcome								
1) Assessment of outcome a) independent blind assessment * b) record linkage * c) self report d) no description	Global Trigger Tool ## *	Hospital Anxiety and Depression Scale ## *	*	Clinical diagnosis of delirium *	Hospital Anxiety and Depression Scale ## *	Clinical encounters per hour *	Hospital Anxiety and Depression Scale ## *	State-Trait Anxiety Inventory ## *
2) Was follow-up long enough for outcomes to occur a) yes (during hospitalisation or immediately afterwards) * b) no	*	*	*	*	* 3 days	*	*	
3) Adequacy of follow up of cohorts a) complete follow up - all subjects accounted for * b) subjects lost to follow up unlikely to introduce bias - small number lost - > 90 % follow up, or description provided of those lost) * c) follow up rate < 90% and no description of those lost d) no statement	*	*	*	*	*	*	*	*

Community – was hospital population
Time to outcome of interest – question is regarding outcome during isolation

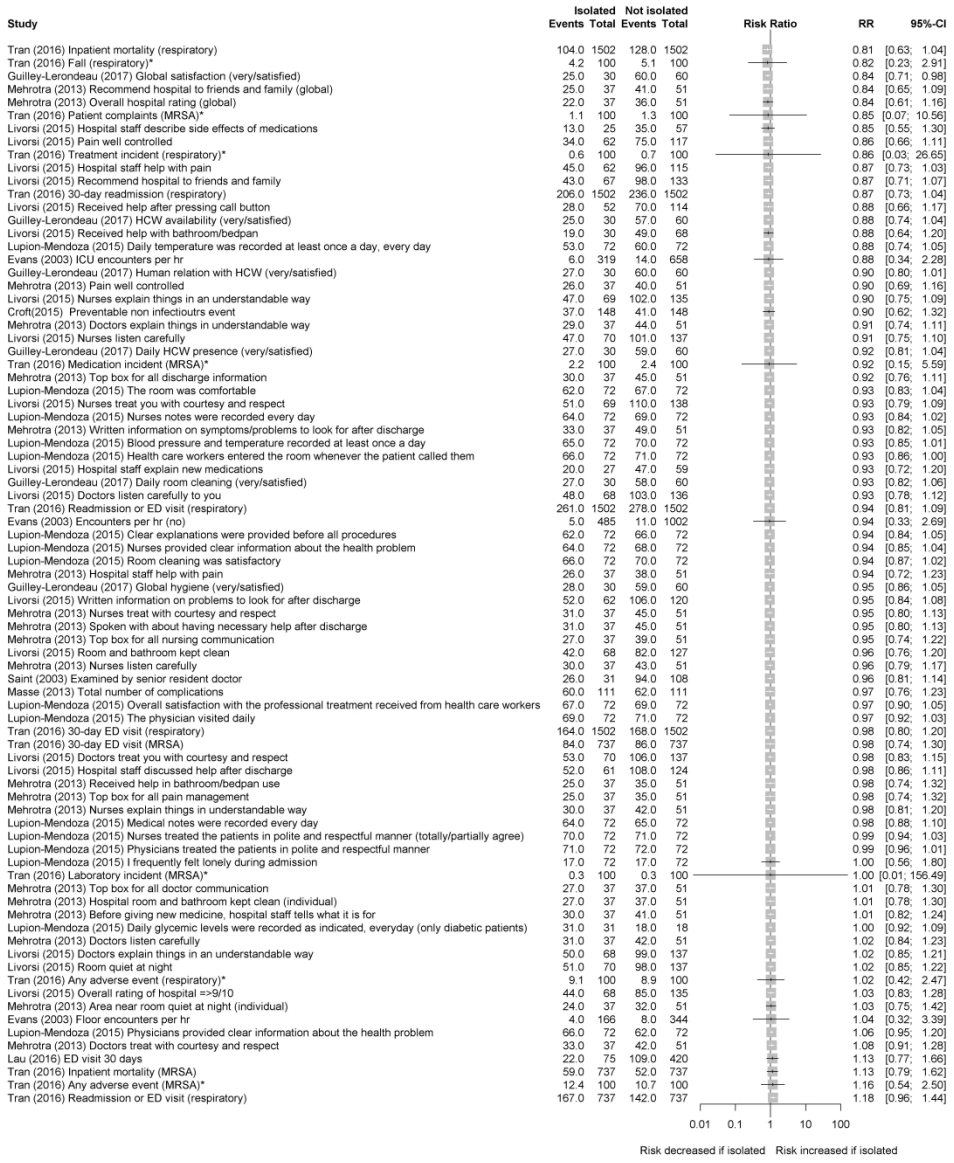
a – age
g- gender
l – LOS

own scale
validated scale/s used appropriately

Cohort studies (2)

Selection	Kirkland (1999)	Lau (2016)	Mehotra (2013)	Stelfox (2003)	Spense (2011)	Saint (2003)	Tran (2016)	Wassenberg (2010)
1) Representativeness of the exposed cohort a) truly representative of the average patient in the community * b) somewhat representative of the average patient in the community * c) selected group of users eg nurses, volunteers d) no description of the derivation of the cohort	*b	*	*	*	b	*	*	*
2) Selection of the non exposed cohort a) drawn from the same community as the exposed cohort * b) drawn from a different source c) no description of the derivation of the non exposed cohort	*	*	*	*	*	*	*	*
3) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview * c) written self report d) no description	*	*b	*b	*	*	*	*	*
4) Demonstration that outcome of interest was not present at start of study a) yes * b) no	*	*	*	*	*	*	*	*
Comparability								
1) Comparability of cohorts on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *		* (g)	* * (l,g)	* * (l,g)		*	* * (l,g)	(l,g)
Outcome								
1) Assessment of outcome a) independent blind assessment * b) record linkage * c) self report d) no description	* #	Patient Health Quetionnaire-9; CQ-5D c telephone /health records ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Clinical satisfaction # *	Clinical outcomes *	Observation of doctors *	Clinical outcomes *	EQ5-D; Hospital Anxiety and Depression Scale ## *
2) Was follow-up long enough for outcomes to occur a) yes (during hospitalisation or immediately afterwards) * b) no	*		*	*	*	*	*	*
3) Adequacy of follow up of cohorts a) complete follow up - all subjects accounted for * b) subjects lost to follow up unlikely to introduce bias - small number lost - > 90 % follow up, or description provided of those lost) * c) follow up rate < 90% and no description of those lost d) no statement	*		37/278 contact; 51/290 non	*	*		*	*

General notes
Community – the population of interest was a hospital population
Time to outcome of interest – question is regarding outcome during isolation or shortly afterwards



381x465mm (300 x 300 DPI)

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4-5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Suppl information
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6-7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6-7

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7-8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	None
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Suppl information
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Suppl information
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Figures
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	None
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	None
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	8-11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	14
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	None

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

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Impact of isolation on hospitalised patients who are infectious: systematic review with meta-analysis

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Impact of isolation on hospitalised patients who are infectious: systematic review with meta-analysis

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Word count - excluding title page, references, figures and tables – 3 301

Impact of isolation on hospitalised patients who are infectious: systematic review with quantitative and meta-analysis

Abstract

Objective

To systematically review the literature exploring impact of isolation on hospitalised patients who are infectious: psychological and non-psychological outcomes

Design

Systematic review with meta-analysis

Data Sources

Embase, Medline and Psychinfo were searched from inception until December 2018. Reference lists and Google Scholar were also handsearched.

Results

Twenty six papers published from database inception until December 2018 were reviewed. A wide range of psychological and non-psychological outcomes were reported. There was a marked trend for isolated patients to exhibit higher levels of depression, the pooled standardised mean difference being 1.28 (95% CI: 0.47 to 2.09) and anxiety 1.45 (95% CI: 0.56 to 2.34), although both had high levels of heterogeneity; and worse outcomes for a range of care-related factors but with significant variation.

Conclusion

The review indicates that isolation to contain risk of infection has negative consequences for segregated patients. Although strength of the evidence is weak, comprising primarily single centre convenience samples, consistency of the effects may strengthen this conclusion. More research needs to be undertaken to examine this relationship and develop and test interventions to reduce the negative effects of isolation.

Strengths and limitations of this study

- This review covers a wide variety of literature from a range of different clinical areas.
- Data collected and the methods of collecting data on the impact of isolation is varied across studies.
- These data do not show if these effects are temporary, or in most cases if they are clinically significant.

Funding statement

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Competing interests statement

No authors have any competing interests to declare

Introduction

Isolation is an established part of any infection prevention programme. Its purpose is to prevent the transmission of antibiotic-resistant pathogens, those that are highly contagious or cause serious infection.[1] The effectiveness of isolation has been questioned however [2–5] and it can be challenging to undertake, especially if patients' lack of understanding of the need for segregation, boredom or distress result in uncooperative behaviour. [6] A recent survey exploring the care of patients isolated for infectious conditions suggests that in clinical practice the main issues are identifying which patients need to be isolated as quickly as possible and prioritising which patients should be segregated when isolation accommodation is in short supply. Infection preventionists were aware that isolation could have negative effects on patients such as increased risk of anxiety, depression and falls and felt that more should be done to prevent these risks.[6]

Although single rooms are assumed to reduce infection risk, evidence of ability to contain spread is equivocal [7,8] and a recent study conducted in an all-single-room hospital was unable to demonstrate lower infection rates than in hospitals where most care takes place in open wards. [9] This study identified advantages and disadvantages of single room accommodation, whereas isolating infectious patients is generally assumed to result in adverse outcomes.[10]

A systematic review reported eight years ago indicated higher levels of anxiety, depression, perceptions of stigmatisation and a higher incidence of falls, medication errors and other incidents that detract from patient safety among patients who were isolated compared to those who were not.[11] This review reported studies undertaken

before 2010 and included patients whose experiences are unlikely to be comparable: children and adults and those isolated to reduce their own risk of infection as well as infectious patients. The review was not reported according to standards currently expected for systematic reviews [12] and presents a qualitative description of patient outcomes only. A more rigorously reported and up-to-date systematic review is indicated in view of increasing concern about satisfaction with health care and patient safety and increasing emphasis on infection prevention as part of the global strategy to reduce risks of antimicrobial resistance.[13]

We undertook a systematic review of the literature to establish the effects of infection related isolation on psychological and non-psychological care-related outcomes in adults. This review is therefore more focussed than that previously undertaken which also included those in protective isolation, and contains a significant body of literature published since 2010.

Method

The eligibility criteria for inclusion was that studies should compare quantitative data on psychological or non-psychological outcomes in adult patients who are in infective isolation with those not isolated. Purely symptomatic/disease progression outcomes were not included, neither were those looking at patients isolated due to immunosuppression. Studies not containing comparative data between those isolated and not isolated were also excluded. Search terms were: Patient isolation; cross infection; contact isolation; respiratory, source or contact isolation; droplet, airborne or contact precautions; cubicle; MRSA or methicillin resistant *Staphylococcus aureus*; patient safety or harm; depression; anxiety; adaptation; stress; patient satisfaction;

quality of life. These were searched as free-text and index terms where these existed. The information sources used were Embase, Medline and Psychinfo, which were searched from inception until December 2018. The full Medline search is shown in Supplementary File 1. Reference lists and Google Scholar were also handsearched. Characteristics of included and excluded papers are shown in Supplementary File 2. The PRISMA flow-chart is given in Supplementary File 3. No protocol was published in advance.

Studies were initially screened for relevance by one author (EP), with the final stage being undertaken by two (EP, DG). Data were extracted and checked by two authors (DG, EP); where there were disagreements data were rechecked for relevance and accuracy. Where available, raw data were extracted and entered into a spreadsheet, and depending upon the nature of the data either the risk ratio (where numbers of patients were given) or standardised mean difference (where other statistics were given) calculated. Results were then presented as forest plots.

Due to the variety of different settings and methods it was deemed that the methodological and clinical heterogeneity was too broad to pool results; apart from those related to anxiety and depression, for which results were pooled using the random-effects model. This model assumes that the observed effect from each study is estimating a related but different true effect, allowing for between-study variation to be calculated in the form of heterogeneity statistics. All calculations and plots were produced using the meta and metafor packages in R.[14–16] Where raw data were not provided the summary results are given in the text but not the forest plots. All data relevant to the study are included in the article or uploaded as Supplementary File 3.

Patient and Public Involvement

No patient involved.

Results

A total of 3 879 papers were retrieved from the three databases; of which 38 were assessed for eligibility by reading the full text. Of these 13 studies provided data suitable for the calculation of risk ratio, 5 giving psychological outcomes,[17–21] and 12 non-psychological;[19,22–32] and 8 provided data for the calculation of standardised mean differences, 6 giving psychological outcomes,[21,30,33–36] and 2 non-psychological.[29,37] A further 6 studies did not provide raw data but are included in the results; 3 each giving psychological outcomes[38–40] and non-psychological outcomes.[17,41,42] Meta-analyses were possible on two outcomes: anxiety and depression from 8 studies using standardised mean difference. [19–21,30,33–36] Where only risk ratio data were given[20,21] conversion to standardised mean difference was undertaken using the Campbell Collaboration calculator (https://campbellcollaboration.org/research-resources/effect-size-calculator.html).[43]

Where it was not possible to pool outcome data because of methodological and clinical heterogeneity, the data from studies are shown as forest plots but without meta-analysis. The forest plots contain results from the studies where sufficient data were given to calculate either the risk ratio or standardised mean difference. A number of studies provided data on those under contact precautions, but no comparative data and so were not included.[44–47]

Because of the large number of non-psychological outcomes for which RR could be calculated, it was decided that a change of 20% (i.e. a RR of 0.8 or less, or 1.2 or more) would be clinically significant, regardless of the statistical significance. This was a pragmatic decision, and all results are shown in Supplementary File 4. Results are shown in Figures 1 to 6. Supplementary Figure 1 contains results that did not meet our criteria for being clinically significant. Outcomes were classified into one of three categories: those to do with quality of care; satisfaction of care; and adverse events from which median values and interquartile ranges were calculated.

The studies included were primarily single-centre and consisted of case-control, cross-sectional and cohort studies. Risk of bias was assessed using the Newcastle-Ottowa scale, full details of each study and its risk of bias are in the Supplementary File 5.[48] Overall, although these studies have limited generalisability, there did not appear to be significant cause for concern regarding bias within the limitations inherent in these study designs. Most studies used established or validated tools[17–21,23–25,27,29,30,33–37] or clinical outcomes.[22,26,28,31,32]

The data from the comparative studies suggest that although in many cases infective isolation precautions make little difference to psychological outcomes, where it does make a difference this is primarily negative. There were significant declines in mean scores related to control and self-esteem, and in many studies increases in the mean scores for risk of anxiety and depression. However, these findings were not consistent, and some larger studies showed little or no difference between the groups for these outcomes. These are shown in Figures 1 and 2 respectively.

[INSERT FIGURES 1 and 2 HERE]

Figure 1. Risk ratio of psychological events in those isolated versus not isolated

Figure 2. Standardised mean difference of psychological scores in those isolated versus those not isolated

For the 8 studies reporting data on anxiety the pooled SMD was 1.45 (95% CI: 0.56 to 2.34); although within this there was significant heterogeneity ($Q = 168.11$, $df = 7$, $p < 0.0001$; $I^2 = 95.84\%$). This was primarily caused by two studies [30,34] which showed lower levels of anxiety than the remaining studies. For depression the SMD was 1.28 (95% CI: 0.47 to 2.09); again with significant heterogeneity ($Q = 154.5$, $df = 7$, $p < 0.0001$; $I^2 = 95.47\%$), in this case the studies falling into two categories, those with lower [30,34,35] and higher depression scores among those isolated.[19,20,33,36] The forest plots for these outcomes are shown in Figures 3 and 4 respectively.

[INSERT FIGURES 3 and 4 HERE]

Figure 3. Meta-analysis of the standardised mean difference of anxiety in those isolated versus those not isolated

Figure 4. Meta-analysis of the standardised mean difference of depression in those isolated versus those not isolated

Studies not reporting the raw data showed that contact precautions were associated with depression OR 1.4 (95% CI 1.2 to 1.5) but not anxiety OR 0.8 (95% CI 0.7 to 1.1) in a non-ICU population.[41] There was also an association with delirium OR 1.40 (95% CI 1.24 to 1.51); although this was primarily among those who were newly diagnosed as needing isolation OR 1.75 (95% CI 1.60 to 1.92, $p<0.01$) rather than those who had been under contact precautions for their entire stay OR 0.97 (95% CI 0.86 to 1.09, $p=0.60$).[17] Another study showed no difference in the median values for the Hospital Anxiety and Depression Scale anxiety or depression scores (HADS-A and -D), or the EuroQol Visual Analogue Scale EQ VAS scores.[42]

For non-psychological outcomes, using a difference in the risk of +/- 20% of an event as being a measure of clinical significance it appears there was a trend for less attention to be given to, and for more errors to occur in those who were isolated. However, again there was wide variation between studies. Data on these outcomes are given in Figures 5 and 6, and the non-clinically significant risks in the Supplementary Figure 1. For those outcomes associated with quality, the median risk ratio (with positive outcomes reversed so a higher risk ratio is associated with a worse outcome) was 0.94 (IQR 0.92 to 0.98), satisfaction 0.95 (IQR 0.89 to 1.01) and adverse events was 1.27 (0.91 to 2.5). The minimum and maximum risk ratio for each category was 0.49 and 1.72; 0.3 and 8; and 0.3 and 18 respectively.

[INSERT FIGURES 5 and 6 HERE]

Figure 5. Risk ratio of non-psychological events in those isolated versus not isolated with a RR of < =0.8 or > =1.2

* outcome was measured in rate per 100 admissions

Figure 6. Standardised mean difference of non-psychological scores in those isolated versus those not isolated

FIM – functional independence measure

A study not giving raw data which looked at the rates of falls and pressure ulcers before and after a policy change that resulted in the discontinuation of contact precautions for patients with methicillin resistant *Staphylcoccus aureus* (MRSA) or vancomycin resistant enterococci (VRE) found that falls and pressure ulcers were more common among those with MRSA or VRE both before the change (when they were in isolation) and afterwards (when they were not). Before the change the number of falls was 4.57 vs 2.04 per 1000 patient-days respectively ($p< 0.0001$) and pressure ulcers 4.87 vs 1.22 per 1000 patient-days ($p< 0.0001$). After the policy change the same numbers were falls 4.82 vs 2.10 ($p<0.0001$) and pressure ulcers 4.17 vs 1.19 per 1000 patient-days ($p<0.0001$).[39] Other studies found that staff spent less time with those on contact precautions: internal medicine interns spent less time with their isolated patients compared to non-isolated patients, the median times being 5.2 and 6.9 minutes respectively ($p<0.001$)[38]; while the mean number of contacts per hour with healthcare workers was 2.1 compared to 4.2 in those not isolated ($p=0.03$), although the duration was longer at 4.5 minutes compared to 2.8 ($p=0.6$).[40]

Discussion

Current recommendations say that contact precautions should include a single room, with personal protective equipment consisting of a gown and gloves for all patient contacts or contacts with potentially contaminated environmental areas.[1] This review has shown that there are a number of apparently negative aspects to contact precautions, in particular with regards to psychological effects and a reduction in the quality of some aspects of care. These data come from studies carried out in a variety of countries and different types of facilities; although there are few data from particularly vulnerable populations such as the elderly.

Although at times there are discussions as to the necessity of contact precautions for drug resistant organisms, with some arguing that that there is mixed evidence for or against their use[49] another recent review has concluded that they are of great importance in the control of epidemic and endemic multidrug-resistant microorganisms.[50] The ethics of using contact precautions and other forms of isolation rely on a positive assessment of the balance between the risks and benefits of this to the individual concerned and that of the broader population of patients and staff.[51] However, even when this assessment is positive, it is important to ensure that any harm to the individual is minimised.

One way of balancing the various priorities is to use the GRADE Evidence to Decision Framework, which provides criteria for making recommendations at the individual, group and policy-levels, and provides a number of highly patient focussed criteria for doing this. In addition to the certainty of evidence and resource requirements, it also requires consideration of: the balance of desirable and undesirable effects; the impact upon equity; and the feasibility and acceptability of the

intervention.[52] The last two of these might have very different outcomes when considered at the population and individual levels; and there is certainly evidence here that for the individual patient the balance of desirable and undesirable effects might be very different to that of the broader population.

However, within the broad population of infected or potentially infected patients, some groups might have different needs. For example a study of people isolated for MERS found that while access to telephones reduced anxiety and anger; access to email, text and internet increased these.[53] This was not an area investigated in any depth in these studies. Another area where information may be lacking is that of age, as older people in particular might feel sadness and loneliness more; and gender, as qualitative data suggest that women in isolation were more concerned about precautions and transmission while men were more resigned, rational and tended to cope better.[54]

In some countries, such as the United States single-rooms have become the standard for new hospitals and so one might expect fewer adverse effects if everyone is in a single room, this being the norm. However it may be that a single room is necessary but not sufficient for these findings, and that it is the combination of a single room with an infection that leads to these results. Certainly it is far from clear that the long list of advantages claimed for single rooms which include reduced stress, the ability to deliver better care, and a lower probability of dietary or medication errors apply to this group of patients.[55]

Caring for patients in single-rooms does have many challenges, but there is evidence that these can be mitigated in a general population;[9] however the expanding literature on how this can be done in a general population does not necessarily apply here due to the necessity of isolation procedures which are, by design, 'a barrier'. Therefore patients' needs for greater social interaction will need a solution quite different from that which might be used for a different patient population, and the benefit of choice about this which single rooms offer does not apply here.[56]

Although this review has quantified the extent of the problem, we have not been able to find solutions in the literature. Care might be improved through increased staff attention with more resources being allocated to these patients, although the extra cost of contact precautions is already considerable, one estimate being that it was an extra $158.90 (95% CI $124.90 to $192.80) per patient day.[57] Alternatively new ways of working might be developed, perhaps using technology to mitigate some of these problems. Technology might be particularly useful in reducing adverse events such as medication or clinical errors; although increasing satisfaction and some areas of quality are more likely to be achieved by increasing the availability of staff and other people. The extent to which scarce resources are allocated to this may be driven in part by the longevity of any negative effects; which current literature is not really able to clarify. To understand this longituduinal studies are needed.

Study strengths and limitations

This review suggests that infectious isolation has a number of negative effects on patients. Because this evidence is comprised of cohort and case-control studies, a claim for a causal relationship can not be made on this evidence, although the strong

and consistent effects across the studies may increase the confidence in this relationship. There are some qualitative data, although more in-depth mixed-methods data where those reporting negative effects are questioned about them would strengthen the evidence on this. In some cases large effect sizes were accompanied by very wide confidence intervals, suggesting that studies were underpowered, thus studies with larger sample sizes would be useful. It would also be useful if there were more consistent methods of examining and reporting these data, particularly outside of the realms of depression and anxiety where the variety of methods makes analysis of the body of evidence difficult. We were also unable to assess whether these effects varied according to reason for isolation; or to understand if they are likely to be long-term or simply temporary phenomena.

Although these data suggest that there is a problem, there is a clear gap both in what we know about improving the experience of isolation and what can be done in practical terms to make it more tolerable for patients and their families. In particular older people who may be most vulnerable to these negative effects were under-represented in these studies; and this group are likely to represent an increasingly large proportion of those isolated.

Contributors

EP, DG and JC conceived the review, EP conducted the search, EP and DG examined the studies and extracted data, EP undertook the quantitative analysis, EP, DG and JC wrote the discussion.

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Competing interests statement

No authors have any competing interests to declare.

Data Availability

All data relevant to the study are included in the article or uploaded as supplementary information.

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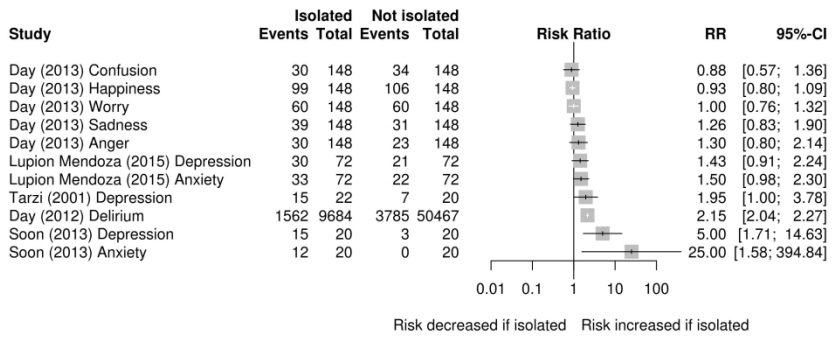

Figure 1. Risk ratio of psychological events in those isolated versus not isolated

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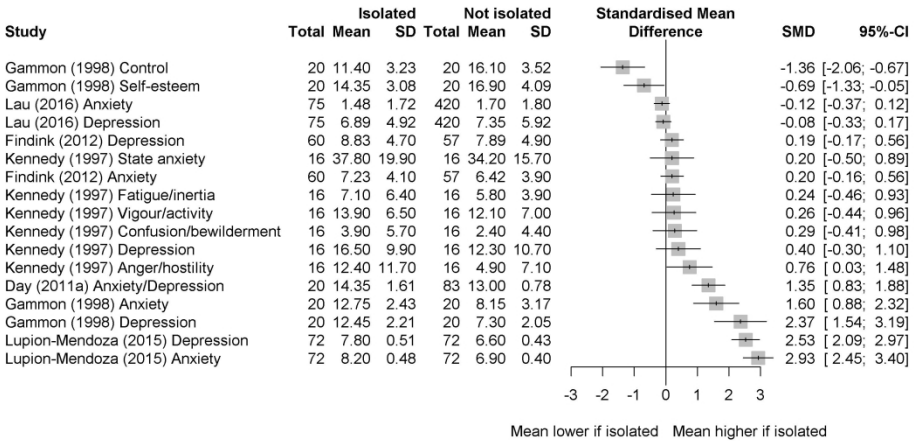

Figure 2. Standardised mean difference of psychological scores in those isolated versus those not isolated

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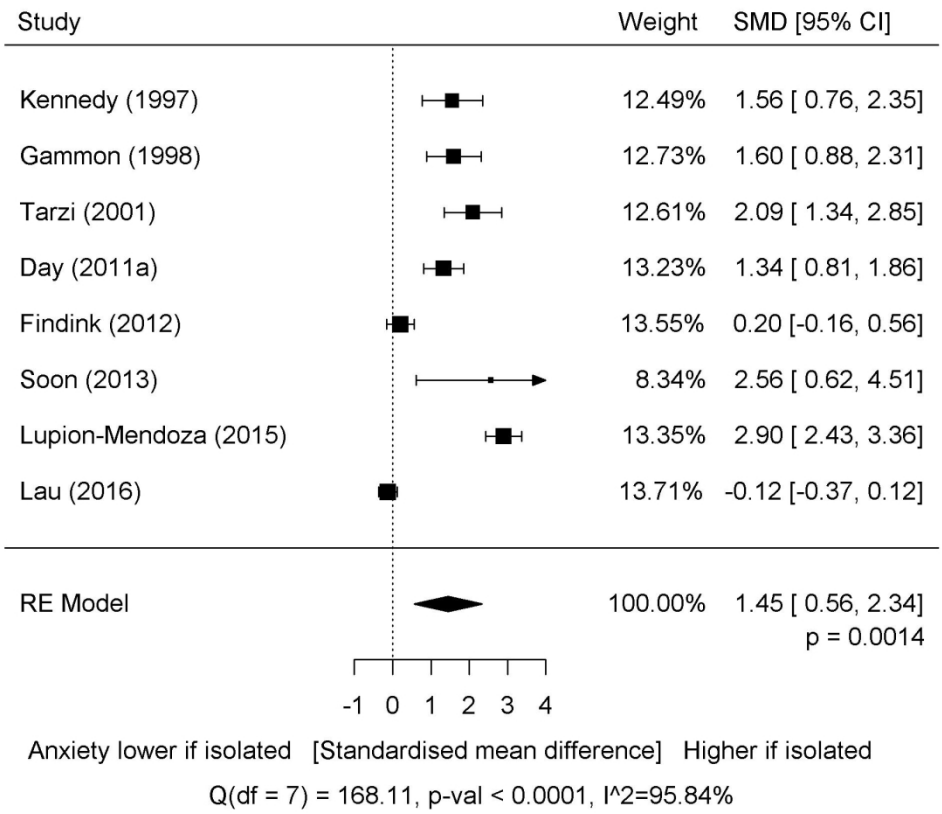

Figure 3. Meta-analysis of the standardised mean difference of anxiety in those isolated versus those not isolated

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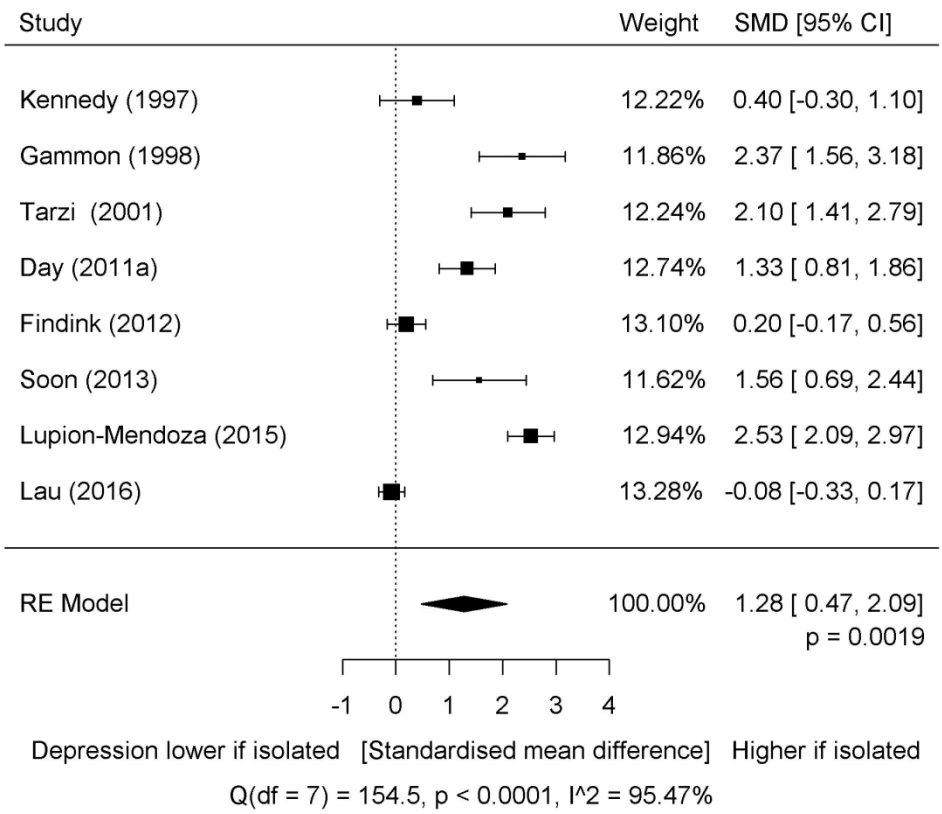

Figure 4. Meta-analysis of the standardised mean difference of depression in those isolated versus those not isolated

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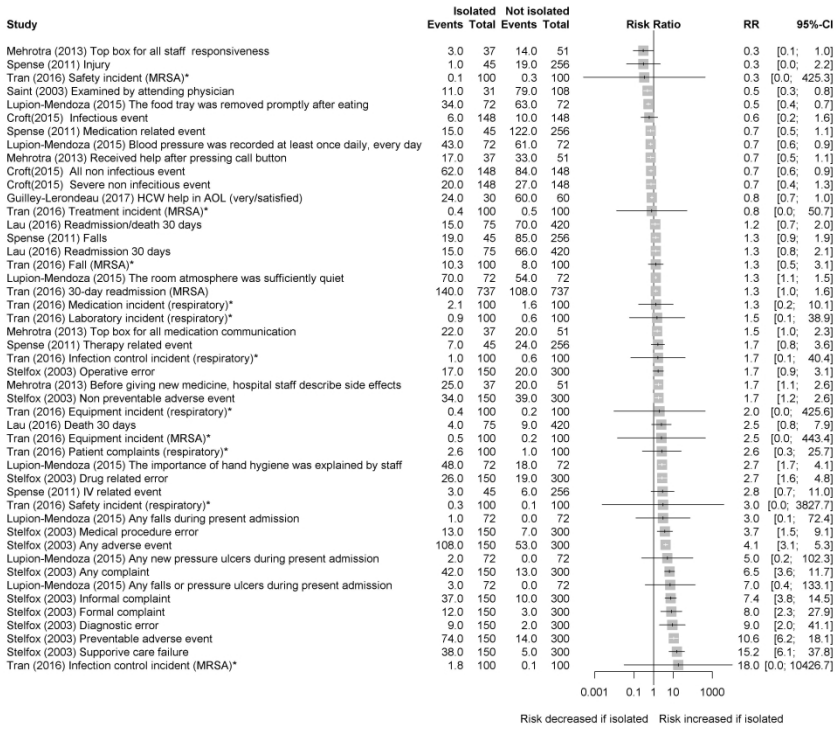

Figure 5. Risk ratio of non-psychological events in those isolated versus not isolated with a RR of < =0.8 or > =1.2

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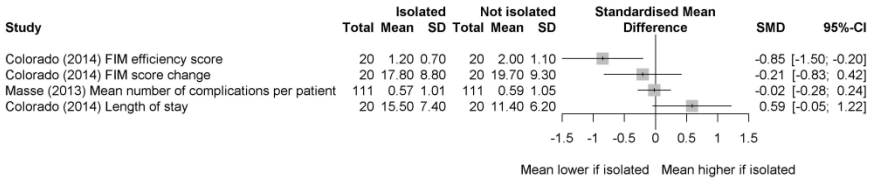
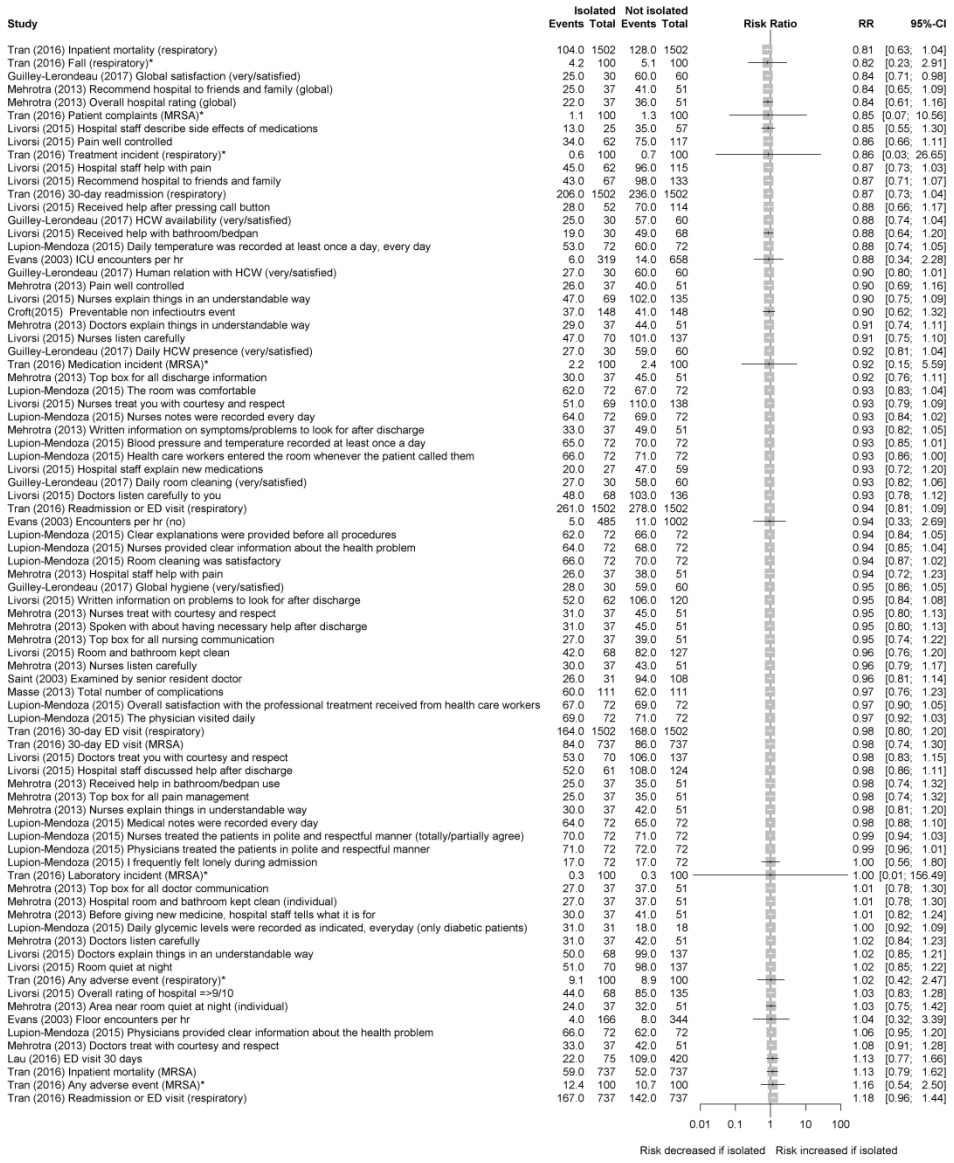


Figure 6. Standardised mean difference of non-psychological scores in those isolated versus those not isolated

321x127mm (300 x 300 DPI)



381x465mm (300 x 300 DPI)

Supplementary File 1. Search strategy - Medline

1. patient isolation.mp. or exp Patient Isolation/
2. exp Cross Infection/ or contact isolation.mp.
3. respiratory isolation.mp.
4. source isolation.mp.
5. contact isolation.mp.
6. droplet precautions.mp.
7. airborne precautions.mp.
8. contact precautions.mp.
9. cubicle.mp.
10. mrsa.mp. or exp Methicillin-Resistant Staphylococcus aureus/
11. 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8 or 9 or 10
12. patient safety.mp. or exp Patient Safety/
13. patient harm.mp. or exp Patient Harm/
14. depression.mp. or exp DEPRESSION/
15. exp ANXIETY/ or anxiety.mp.
16. adaptation.mp. or exp ADAPTATION, PSYCHOLOGICAL/
17. exp STRESS, PSYCHOLOGICAL/ or stress.mp.
18. patient satisfaction.mp. or exp Patient Satisfaction/
19. quality of life.mp. or exp "Quality of Life"/
20. 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20
21. 11 and 20

Characteristics of studies

Reference	Study type	Isolated	Non isolated
Colorado (2014)	Retrospective matched case control study. Rehabilitation facility- tertiary centre United States July 2009 to December 2010	N20 Patients in contact isolation	N=20 Matched to patients not in contact isolation based on age, rehabilitation diagnosis, and type of insurance
Croft (2015)	Prospective cohort Medical or surgical inpatients admitted to non–intensive care unit hospital wards, United States. January to November 2010.	N=148 Patients on contact precautions Age: 52 (13.8) % male: 53.4	N=148 Individually matched by after an initial 3-day length of stay to patients not on contact precautions. Age 52.3 (14.6) % male: 46.6
Dashiell-Earp (2014)	Collected real-time data on the location of 15 internal medicine interns, United States. October 1, 2012 to December 31, 2012	1156 encounters	2467 encounters
Day (2011)	Patients admitted to the general acute care units, United States. June 1, 2009 to October 30, 2009	N=20 Age: 68.5 (14.7) % male: 85.0	N=83 Age: 63.9 (12.6) % male: 95.2
Day (2011)	A two-year retrospective cohort Tertiary care, United States.. All general inpatients over 18 years hospitalized for >24 h February 1, 2007 to January 31, 2009.	Contact precautions private room when possible, can be cohorted General N = 3138 Age: 51.2 (17.5) % male 58.9 ITU N=1694 Age: 54.9 (17.5) % male 61.0	General N = 25 426 Age: 49.6 (19.0) % male 46.3% ICU N = 5 854 Age: 56.0 (17.7) % male 59.7
Day (2012)	2-year retrospective cohort study of all non-psychiatric hospital admissions >18 years, United States. February 1, 2007 to January 31, 2009	N = 9 684 Contact precautions as above Mean age: 50.1 (18.8) % male 51.4	N = 50 458 Mean age: 52.3 (16.9) % males 59.1
Day (2013)	Longitudinal frequency-matched cohort study of patients admitted to general medical and surgical units, United States. Day 0, day 3 then weekly. January to November 2010	N = 148 Mean age: 52.0 (13.9) % male 58.1	N = 148 Mean age: 52.3 (14.6) % male 50.7

Evans (2003)	Prospective observation; survey; retrospective review, United States. Tertiary care. June and July 2001	N 48 Mean age: 47.8 (2) % male 85%	N = 48 Mean age: 58.3 (2.4) % male 75%
Findink (2012)	Non-random quasi-experiment, Turkey Age 18 to 65 Administered day 5 January 1, 2009 to December 31, 2009	N = 60 Mean age: 53.95 (18.4) % male 75%	N = 57 Mean age: 56.14 (17.1) % male 76.3%
Gammon (1998)	Quasi experiment Selected if last two numbers on their case notes even. Two large District General Hospitals and one elderly care hospital, United Kingdom	N = 20 Placed in isolation for a minimum of 7days Mean age: 61 years % male: 65	N = 20 Mean age: 52 years % male: 55
Gandra (2014)	Retrospective hospital-wide cohort study, United States. All patients admitted to medical-surgical inpatient units November 1, 2009 to October 31, 2011	Falls N=77 Mean age: 66.1 (14.3) % male: 61% Pressure ulcers N=82 Mean age: 64.5 (15.5) % male: 63	Falls N=82 Mean age: 63.7 (15.8) % male: 51 (62%) Pressure ulcers N=71 Mean age: 65.7 (15) % male: 57
Guilley-Lerondeau (2017)	Matched cohort study with prospective inclusions Interview 3 days after commencing General sample. France March to July 2012	N=30 First prescription of isolation precaution Median age (range) 69 (32 to 91) % male 47	N=60 Median age (range) 64 (24 to 91) % male 53
Kennedy (1997)	Cross-sectional matched-control study, United Kingdom. May 1994 to November 1996	N = 16 Isolated as a result of being MRSA Mean age: 31.1 All male	N = 16 Matched for age, sex, level of injury, and time since admission or injury
Kirkland (1999)	Observational study - 7 months Medical intensive-care, United States	N=14	N=21
Lau (2016)	Prospective cohort study. Adult patients discharged from internal medicine wards, Canada October 2013 to November 2014,	N=75 Mean age 60.35 (17.83) % male 59	N=420 Mean age 63.31 (18.69) % male 48%
Livorsi (2015)	Case-control study Retrospective January 1, 2012 to	N = 70 On contact precautions for MRSA throughout	N = 139 No significant differences between isolated and

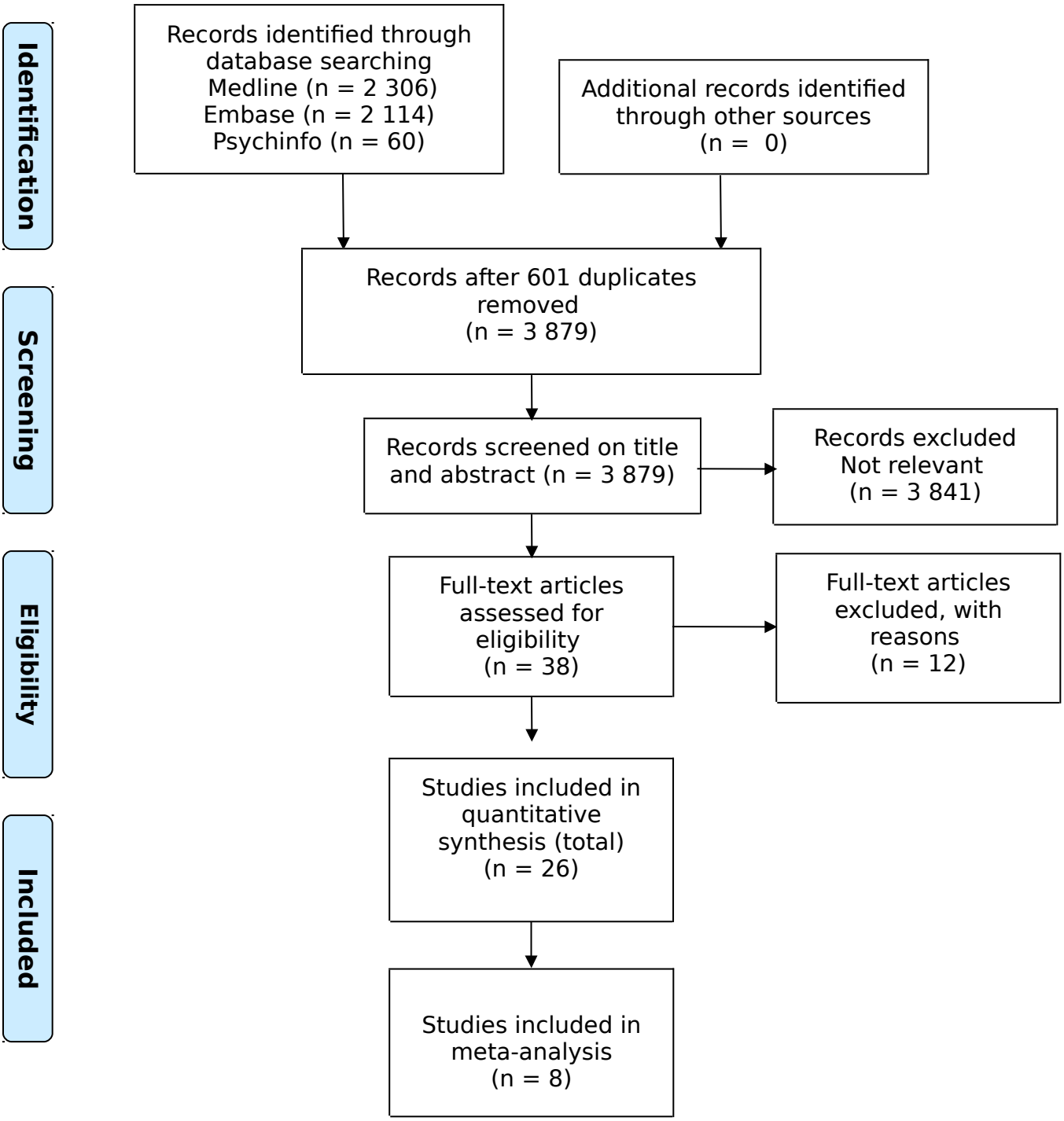
	May 31, 2012/prospective June 1, 2012 to March 31, 2013 'safety-net facility', United States	their hospital stay. Found to be MRSA positive during a previous hospitalization or as an outpatient, not current case	non-isolated patients
Lupión-Mendoza (2015)	Matched case-control study Tertiary hospital, Spain 2011 and 2012	N = 72 Adult patients admitted in isolation for =>5 days. Median age (range) 62 (21-93) % male 73%	N = 72 Median age (range) 69 (23-89), % male 68.1%
Massee (2013)	Retrospective case-control Tertiary care, Canada	N = 111 Matched MRSA patients with an admission diagnosis of heart failure or COPD to similar non-isolated controls Median age (IQR) 80.0 (69.0-86.0) % male 60.4%	N = 111 Median age (IQR) 80.0 (68.0–86.0) % male 60.4%
Mehrotra (2013)	Prospective cohort Admission and on days 3, 7, 14 Tertiary centre, United States	N = 238 Segregation into a private or cohorted room Mean age (SD) 52.4 (13.4) % male 55.7	N = 290 Mean age (SD) 52.9 (14.8) % male 48
Saint (2003)	Prospective cohort study 2 university-affiliated medical centers, United States. October 1999 to March 2000	N=31	N=108
Soon (2013)	Cross-sectional survey of cases and matched controls Teaching hospital Singapore June and August 2011	N=20 Contact isolation in a cohort cubicle for the first time because of colonization or infection with a MDRO for at least 3 days No statistically significant differences in age or gender	N=20
Spense (2011)	Retrospective evaluation of incident reports All patients admitted to acute care facility, United States January 1, 2008 to December 31, 2008.	N=45	N=256
Stelfox (2003)	Case control study Consecutive adults isolated for at least 2 days with MRSA. Canada and United States Controls patients admitted before	General N = 78 Age: 69.6 (17.1) % male: 45% CHF N = 72 Age: 66.9 (14.7)	General N = 156 Age: 65.4 (18.2) % male: 51% CHF N = 144 Age: 66.0 (14.5)

	and after. January 1, 1999,to January 1, 2000	% male: 58	% male: 54
Tarzi (2001)	Cross-sectional matched case-control study Care of the elderly rehabilitation wards, UK	N = 22 Had been in isolation for at least two weeks with MRSA Mean age (SD) 80 (8.4) % male 27.3	N = 20 Mean age (SD) 81 (9.1) % male 33.3
Tran (2017)	Propensity matched cohort study. General internal medicine services, 3 hospitals, Canada January 2010 to December 2012	MRSA Age: 69 % male 57% Respiratory Age: 71.7 % male: 53 Isolated for MRSA or respiratory illness	MRSA Age: 69 % male 58% Respiratory Age: 70.6 % male: 55
Wassenburg (2010)	Cross-sectional matched cohort study Single university hospital, Netherlands November 2006 to February 2007	N = 42 Age: 52 (19) % male: 52	N = 84 Age: 55 (16) % male: 55

Excluded papers

Reference	Reason for exclusion
Chittick et al (2016)	No comparative data
Godsell (2013)	Focussed on HCP
Jeong (2016)	MERS
MacKellaig (1986)	Qualitative
Madsden (2015)	Qualitative
Maunder (2003)	SARS
Moran (2009)	Focus on family centred care
Morgan (2011)	Focus on process measures
Rees (2000a)	No comparative data
Rees (2000a)	No comparative data
Simon (2016)	Before and after
Wilkins (1988)	No comparative data

PRISMA 2009 Flow Diagram



From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). *P*referred *R*eporting *I*tems for *S*ystematic Reviews and *M*eta-*A*nalyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097

For more information, visit www.prisma-statement.org.

All RR data

	Reference	Year
1	Croft(2015)	2015
2	Croft(2015)	2015
4	Croft(2015)	2015
9	Guilley-Lerondeau (2017)	2017
15	Lau (2016)	2016
16	Lau (2016)	2016
18	Lau (2016)	2016
43	Lupion-Mendoza (2015)	2015
48	Lupion-Mendoza (2015)	2015
50	Lupion-Mendoza (2015)	2015
54	Lupion-Mendoza (2015)	2015
57	Lupion-Mendoza (2015)	2015
58	Lupion-Mendoza (2015)	2015
59	Lupion-Mendoza (2015)	2015
69	Mehrotra (2013)	2013
71	Mehrotra (2013)	2013
76	Mehrotra (2013)	2013
77	Mehrotra (2013)	2013
85	Stelfox (2003)	2003
86	Stelfox (2003)	2003
87	Stelfox (2003)	2003
88	Stelfox (2003)	2003
89	Stelfox (2003)	2003
90	Stelfox (2003)	2003
91	Stelfox (2003)	2003
92	Stelfox (2003)	2003
93	Stelfox (2003)	2003
94	Stelfox (2003)	2003
95	Stelfox (2003)	2003
96	Spense (2011)	2011
97	Spense (2011)	2011
98	Spense (2011)	2011
99	Spense (2011)	2011
100	Spense (2011)	2011
102	Saint (2003)	2003
103	Tran (2016)	2016
106	Tran (2016)	2016
107	Tran (2016)	2016
108	Tran (2016)	2016
109	Tran (2016)	2016
113	Tran (2016)	2016
114	Tran (2016)	2016
116	Tran (2016)	2016
117	Tran (2016)	2016
118	Tran (2016)	2016
120	Tran (2016)	2016
122	Tran (2016)	2016
3	Croft(2015)	2015
5	Evans (2003)	2003
6	Evans (2003)	2003
7	Evans (2003)	2003
8	Guilley-Lerondeau (2017)	2017
10	Guilley-Lerondeau (2017)	2017
11	Guilley-Lerondeau (2017)	2017

All RR data

12	Guilley-Lerondeau (2017)	2017
13	Guilley-Lerondeau (2017)	2017
14	Guilley-Lerondeau (2017)	2017
17	Lau (2016)	2016
19	Livorsi (2015)	2015
20	Livorsi (2015)	2015
21	Livorsi (2015)	2015
22	Livorsi (2015)	2015
23	Livorsi (2015)	2015
24	Livorsi (2015)	2015
25	Livorsi (2015)	2015
26	Livorsi (2015)	2015
27	Livorsi (2015)	2015
28	Livorsi (2015)	2015
29	Livorsi (2015)	2015
30	Livorsi (2015)	2015
31	Livorsi (2015)	2015
32	Livorsi (2015)	2015
33	Livorsi (2015)	2015
34	Livorsi (2015)	2015
35	Livorsi (2015)	2015
36	Livorsi (2015)	2015
37	Lupion-Mendoza (2015)	2015
38	Lupion-Mendoza (2015)	2015
39	Lupion-Mendoza (2015)	2015
40	Lupion-Mendoza (2015)	2015
41	Lupion-Mendoza (2015)	2015
42	Lupion-Mendoza (2015)	2015
44	Lupion-Mendoza (2015)	2015
45	Lupion-Mendoza (2015)	2015
46	Lupion-Mendoza (2015)	2015
47	Lupion-Mendoza (2015)	2015
49	Lupion-Mendoza (2015)	2015
51	Lupion-Mendoza (2015)	2015
52	Lupion-Mendoza (2015)	2015
53	Lupion-Mendoza (2015)	2015
55	Lupion-Mendoza (2015)	2015
56	Lupion-Mendoza (2015)	2015
60	Masse (2013)	2013
61	Mehrotra (2013)	2013
62	Mehrotra (2013)	2013
63	Mehrotra (2013)	2013
64	Mehrotra (2013)	2013
65	Mehrotra (2013)	2013
66	Mehrotra (2013)	2013
67	Mehrotra (2013)	2013
68	Mehrotra (2013)	2013
70	Mehrotra (2013)	2013
72	Mehrotra (2013)	2013
73	Mehrotra (2013)	2013
74	Mehrotra (2013)	2013
75	Mehrotra (2013)	2013
78	Mehrotra (2013)	2013
79	Mehrotra (2013)	2013
80	Mehrotra (2013)	2013

All RR data

81	Mehrotra (2013)	2013
82	Mehrotra (2013)	2013
83	Mehrotra (2013)	2013
84	Mehrotra (2013)	2013
101	Saint (2003)	2003
104	Tran (2016)	2016
105	Tran (2016)	2016
110	Tran (2016)	2016
111	Tran (2016)	2016
112	Tran (2016)	2016
115	Tran (2016)	2016
119	Tran (2016)	2016
121	Tran (2016)	2016
123	Tran (2016)	2016
124	Tran (2016)	2016
125	Tran (2016)	2016
126	Tran (2016)	2016
127	Tran (2016)	2016
128	Tran (2016)	2016

All RR data

Outcome	Isolated
All non infectious event	62
Severe non infecitious event	20
Infectious event	6
HCW help in AOL (very/satisfied)	24
Readmission/death 30 days	15
Readmission 30 days	15
Death 30 days	4
The importance of hand hygiene was explained by staff	48
The food tray was removed promptly after eating	34
The room atmosphere was sufficiently quiet	70
Blood pressure was recorded at least once daily, every day	43
Any falls during present admission	1
Any new pressure ulcers during present admission	2
Any falls or pressure ulcers during present admission	3
Received help after pressing call button	17
Top box for all staff responsiveness	3
Before giving new medicine, hospital staff describe side effects	25
Top box for all medication communication	22
Any complaint	42
Informal complaint	37
Formal complaint	12
Any adverse event	108
Non preventable adverse event	34
Preventable adverse event	74
Supporive care failure	38
Diagnostic error	9
Operative error	17
Medical procedure error	13
Drug related error	26
Falls	19
Injury	1
IV related event	3
Medication related event	15
Therapy related event	7
Examined by attending physician	11
Fall (MRSA)*	10.3
Treatment incident (MRSA)*	0.4
Infection control incident (MRSA)*	1.8
Safety incident (MRSA)*	0.1
Equipment incident (MRSA)*	0.5
Medication incident (respiratory)*	2.1
Laboratory incident (respiratory)*	0.9
Infection control incident (respiratory)*	1
Safety incident (respiratory)*	0.3
Equipment incident (respiratory)*	0.4
Patient complaints (respiratory)*	2.6
30-day readmission (MRSA)	140
Preventable non infectioutrs event	37
Encounters per hr (no)	5
ICU encounters per hr	6
Floor encounters per hr	4
Global hygiene (very/satisfied)	28
Daily room cleaning (very/satisfied)	27
HCW availability (very/satisfied)	25

All RR data

Daily HCW presence (very/satisfied)	27
Human relation with HCW (very/satisfied)	27
Global satisfaction (very/satisfied)	25
ED visit 30 days	22
Overall rating of hospital =>9/10	44
Nurses treat you with courtesy and respect	51
Nurses listen carefully	47
Nurses explain things in an understandable way	47
Received help after pressing call button	28
Doctors treat you with courtesy and respect	53
Doctors listen carefully to you	48
Doctors explain things in an understandable way	50
Room and bathroom kept clean	42
Room quiet at night	51
Received help with bathroom/bedpan	19
Pain well controlled	34
Hospital staff help with pain	45
Hospital staff explain new medications	20
Hospital staff describe side effects of medications	13
Hospital staff discussed help after discharge	52
Written information on problems to look for after discharge	52
Recommend hospital to friends and family	43
Overall satisfaction with the professional treatment received from health care workers	67
Nurses treated the patients in polite and respectful manner (totally/partially agree)	70
Physicians treated the patients in polite and respectful manner	71
Nurses provided clear information about the health problem	64
Physicians provided clear information about the health problem	66
Clear explanations were provided before all procedures	62
Health care workers entered the room whenever the patient called them	66
Blood pressure and temperature recorded at least once a day	65
The physician visited daily	69
The room was comfortable	62
Room cleaning was satisfactory	66
I frequently felt lonely during admission	17
Medical notes were recorded every day	64
Nurses notes were recorded every day	64
Daily temperature was recorded at least once a day, every day	53
Daily glycemic levels were recorded as indicated, everyday (only diabetic patients)	31
Total number of complications	60
Nurses treat with courtesy and respect	31
Nurses listen carefully	30
Nurses explain things in understandable way	30
Top box for all nursing communication	27
Doctors treat with courtesy and respect	33
Doctors listen carefully	31
Doctors explain things in understandable way	29
Top box for all doctor communication	27
Received help in bathroom/bedpan use	25
Pain well controlled	26
Hospital staff help with pain	26
Top box for all pain management	25
Before giving new medicine, hospital staff tells what it is for	30
Spoken with about having necessary help after discharge	31
Written information on symptoms/problems to look for after discharge	33
Top box for all discharge information	30

All RR data

Hospital room and bathroom kept clean (individual)	27
Area near room quiet at night (individual)	24
Recommend hospital to friends and family (global)	25
Overall hospital rating (global)	22
Examined by senior resident doctor	26
Medication incident (MRSA)*	2.2
Laboratory incident (MRSA)*	0.3
Any adverse event (MRSA)*	12.4
Patient complaints (MRSA)*	1.1
Fall (respiratory)*	4.2
Treatment incident (respiratory)*	0.6
Any adverse event (respiratory)*	9.1
Inpatient mortality (MRSA)	59
30-day ED visit (MRSA)	84
Readmission or ED visit (respiratory)	167
Inpatient mortality (respiratory)	104
30-day readmission (respiratory)	206
30-day ED visit (respiratory)	164
Readmission or ED visit (respiratory)	261

All RR data

Isolated.N	Control	Control.N	RI	RC	RR	inout	Type
148	84	148	0.418918919	0.567567568	0.738095238	a	AE
148	27	148	0.135135135	0.182432432	0.740740741	a	AE
148	10	148	0.040540541	0.067567568	0.6	a	AE
30	60	60	0.8	1	1.25	a	Satisfaction
75	70	420	0.2	0.166666667	1.2	a	AE
75	66	420	0.2	0.157142857	1.272727273	a	AE
75	9	420	0.053333333	0.021428571	2.488888889	a	AE
72	18	72	0.666666667	0.25	0.375	a	Satisfaction
72	63	72	0.472222222	0.875	1.852941177	a	Satisfaction
72	54	72	0.972222222	0.75	0.771428572	a	Satisfaction
72	61	72	0.597222222	0.847222222	0.704918033	a	Quality
72	0	72	0.013888889	0	#DIV/0!	a	AE
72	0	72	0.027777778	0	#DIV/0!	a	AE
72	0	72	0.041666667	0	#DIV/0!	a	AE
37	33	51	0.459459459	0.647058824	1.408304501	a	Quality
37	14	51	0.081081081	0.274509804	3.385620919	a	Satisfaction
37	20	51	0.675675676	0.392156863	0.580392157	a	Quality
37	20	51	0.594594595	0.392156863	0.659536542	a	Quality
150	13	300	0.28	0.043333333	6.461538462	a	Satisfaction
150	10	300	0.246666667	0.033333333	7.4	a	Satisfaction
150	3	300	0.08	0.01	8	a	Satisfaction
150	53	300	0.72	0.176666667	4.075471698	a	Satisfaction
150	39	300	0.226666667	0.13	1.743589744	a	AE
150	14	300	0.493333333	0.046666667	10.57142857	a	AE
150	5	300	0.253333333	0.016666667	15.2	a	AE
150	2	300	0.06	0.006666667	9	a	AE
150	20	300	0.113333333	0.066666667	1.7	a	AE
150	7	300	0.086666667	0.023333333	3.714285714	a	AE
150	19	300	0.173333333	0.063333333	2.736842105	a	AE
45	85	256	0.422222222	0.33203125	1.271633987	a	AE
45	19	256	0.022222222	0.07421875	0.299415205	a	AE
45	6	256	0.066666667	0.0234375	2.844444444	a	AE
45	122	256	0.333333333	0.4765625	0.699453552	a	AE
45	24	256	0.155555556	0.09375	1.659259259	a	AE
31	79	108	0.35483871	0.731481481	2.061447808	a	Quality
100	8	100	0.103	0.08	1.2875	a	AE
100	0.5	100	0.004	0.005	0.8	a	AE
100	0.1	100	0.018	0.0011	16.36363636	a	AE
100	0.3	100	0.001	0.003	0.333333333	a	AE
100	0.2	100	0.005	0.002	2.5	a	AE
100	1.6	100	0.021	0.016	1.3125	a	AE
100	0.6	100	0.009	0.006	1.5	a	AE
100	0.6	100	0.01	0.006	1.666666667	a	AE
100	0.1	100	0.003	0.001	3	a	AE
100	0.2	100	0.004	0.002	2	a	AE
100	1	100	0.026	0.01	2.6	a	Satisfaction
737	108	737	0.19	0.147	1.292517007	a	AE
148	41	148	0.25	0.277027027	0.902439024	b	AE
485	11	1002	0.010309278	0.010978044	1.064870304	b	Quality
319	14	658	0.018808777	0.021276596	1.131205713	b	Quality
166	8	344	0.024096386	0.023255814	0.965116263	b	Quality
30	59	60	0.933333333	0.983333333	1.053571429	b	Satisfaction
30	58	60	0.9	0.966666667	1.074074074	b	Satisfaction
30	57	60	0.833333333	0.95	1.14	b	Satisfaction

All RR data

30	59	60	0.9	0.983333333	1.092592592	b	Satisfaction
30	60	60	0.9	1	1.111111111	b	Satisfaction
30	60	60	0.833333333	1	1.2	b	Satisfaction
75	109	420	0.293333333	0.25952381	1.130275229	b	AE
68	85	135	0.647058824	0.62962963	0.973063973	b	Satisfaction
69	110	138	0.739130435	0.797101449	1.078431372	b	Satisfaction
70	101	137	0.671428571	0.737226277	1.097996583	b	Satisfaction
69	102	135	0.68115942	0.755555556	1.109219859	b	Satisfaction
52	70	114	0.538461538	0.614035088	1.140350879	b	Satisfaction
70	106	137	0.757142857	0.773722628	1.021897811	b	Satisfaction
68	103	136	0.705882353	0.757352941	1.072916666	b	Satisfaction
68	99	137	0.735294118	0.722627737	0.982773722	b	Satisfaction
68	82	127	0.617647059	0.645669291	1.045369328	b	Satisfaction
70	98	137	0.728571429	0.715328467	0.981823386	b	Satisfaction
30	49	68	0.633333333	0.720588235	1.137770898	b	Satisfaction
62	75	117	0.548387097	0.641025641	1.16892911	b	Satisfaction
62	96	115	0.725806452	0.834782609	1.150144927	b	Satisfaction
27	47	59	0.740740741	0.796610169	1.075423728	b	Satisfaction
25	35	57	0.52	0.614035088	1.180836708	b	Satisfaction
61	108	124	0.852459016	0.870967742	1.021712159	b	Satisfaction
62	106	120	0.838709677	0.883333333	1.053205128	b	Satisfaction
67	98	133	0.641791045	0.736842105	1.148102814	b	Satisfaction
72	69	72	0.930555556	0.958333333	1.029850745	b	Satisfaction
72	71	72	0.972222222	0.986111111	1.014285714	b	Satisfaction
72	72	72	0.986111111	1	1.014084507	b	Satisfaction
72	68	72	0.888888889	0.944444444	1.062499999	b	Satisfaction
72	62	72	0.916666667	0.861111111	0.939393939	b	Satisfaction
72	66	72	0.861111111	0.916666667	1.06451613	b	Satisfaction
72	71	72	0.916666667	0.986111111	1.075757575	b	Satisfaction
72	70	72	0.902777778	0.972222222	1.076923076	b	Quality
72	71	72	0.958333333	0.986111111	1.028985507	b	Quality
72	67	72	0.861111111	0.930555556	1.080645162	b	Satisfaction
72	70	72	0.916666667	0.972222222	1.06060606	b	Quality
72	17	72	0.236111111	0.236111111	1	b	Satisfaction
72	65	72	0.888888889	0.902777778	1.015625	b	Quality
72	69	72	0.888888889	0.958333333	1.078124999	b	Quality
72	60	72	0.736111111	0.833333333	1.132075471	b	Quality
31	18	18	1	1	1	b	Quality
111	62	111	0.540540541	0.558558559	0.967741935	b	Satisfaction
37	45	51	0.837837838	0.882352941	1.053130929	b	Satisfaction
37	43	51	0.810810811	0.843137255	1.039869281	b	Satisfaction
37	42	51	0.810810811	0.823529412	1.015686275	b	Satisfaction
37	39	51	0.72972973	0.764705882	1.047930282	b	Satisfaction
37	42	51	0.891891892	0.823529412	0.923351159	b	Satisfaction
37	42	51	0.837837838	0.823529412	0.982922201	b	Satisfaction
37	44	51	0.783783784	0.862745098	1.100743745	b	Satisfaction
37	37	51	0.72972973	0.725490196	0.994190268	b	Satisfaction
37	35	51	0.675675676	0.68627451	1.015686274	b	Quality
37	40	51	0.702702703	0.784313725	1.116138762	b	Quality
37	38	51	0.702702703	0.745098039	1.060331824	b	Quality
37	35	51	0.675675676	0.68627451	1.015686274	b	Quality
37	41	51	0.810810811	0.803921569	0.991503268	b	Quality
37	45	51	0.837837838	0.882352941	1.053130929	b	Quality
37	49	51	0.891891892	0.960784314	1.077243019	b	Quality
37	45	51	0.810810811	0.882352941	1.088235294	b	Quality

All RR data

37	37	51	0.72972973	0.725490196	0.994190268	b	Quality
37	32	51	0.648648649	0.62745098	0.96732026	b	Satisfaction
37	41	51	0.675675676	0.803921569	1.189803922	b	Satisfaction
37	36	51	0.594594595	0.705882353	1.187165775	b	Satisfaction
31	94	108	0.838709677	0.87037037	1.037749288	b	Quality
100	2.4	100	0.022	0.024	0.916666667	b	AE
100	0.3	100	0.0027	0.0033	0.818181818	b	AE
100	10.7	100	0.124	0.107	1.158878505	b	AE
100	1.3	100	0.0109	0.0125	0.872	b	Satisfaction
100	5.1	100	0.042	0.051	0.823529412	b	AE
100	0.7	100	0.006	0.007	0.857142857	b	AE
100	8.9	100	0.091	0.089	1.02247191	b	AE
737	52	737	0.08	0.07	1.142857143	b	AE
737	86	737	0.114	0.117	0.974358974	b	AE
737	142	737	0.227	0.193	1.176165803	b	AE
1502	128	1502	0.069	0.085	0.811764706	b	AE
1502	236	1502	0.137	0.157	0.872611465	b	AE
1502	168	1502	0.109	0.112	0.973214286	b	AE
1502	278	1502	0.174	0.185	0.940540541	b	AE

All RR data

Good/bad	exp yi	yi	vi
Bad	0.74	-0.303682414	0.014520281
Bad	0.74	-0.300104592	0.073523524
Bad	0.60	-0.510825624	0.253153153
Good	0.80	-0.227083588	0.008693745
Bad	1.20	0.182321557	0.065238095
Bad	1.27	0.241162057	0.066103896
Bad	2.49	0.911836382	0.345396825
Good	2.67	0.980829253	0.048611111
Good	0.54	-0.616774202	0.017507003
Good	1.30	0.259511195	0.005026455
Good	0.70	-0.349673748	0.011871479
Bad	3.00	1.098612289	2.639269406
Bad	5.00	1.609437912	2.37260274
Bad	7.00	1.945910149	2.258317025
Good	0.71	-0.342386497	0.04249169
Good	0.30	-1.219537321	0.358127035
Good	1.72	0.544051271	0.04336513
Good	1.52	0.4162179	0.048819675
Bad	6.46	1.865867441	0.090732601
Bad	7.40	2.00148	0.117027027
Bad	8.00	2.079441542	0.406666667
Bad	4.08	1.404986494	0.018127184
Bad	1.74	0.555946059	0.04505279
Bad	10.57	2.358154944	0.074942085
Bad	15.20	2.721295428	0.216315789
Bad	9.00	2.197224577	0.601111111
Bad	1.70	0.530628251	0.098823529
Bad	3.71	1.312186389	0.20978022
Bad	2.74	1.006804739	0.081093117
Bad	1.27	0.240302677	0.038267813
Bad	0.30	-1.205924024	1.026503107
Bad	2.84	1.045367774	0.473871528
Bad	0.70	-0.357455889	0.048734916
Bad	1.66	0.506371273	0.158395337
Good	0.49	-0.723408557	0.062049995
Bad	1.29	0.252702354	0.202087379
Bad	0.80	-0.223143551	4.48
Bad	18.00	2.890371758	10.53555556
Bad	0.33	-1.098612289	13.31333333
Bad	2.50	0.916290732	6.98
Bad	1.31	0.271933715	1.081190476
Bad	1.50	0.405465108	2.757777778
Bad	1.67	0.510825624	2.646666667
Bad	3.00	1.098612289	13.31333333
Bad	2.00	0.693147181	7.48
Bad	2.60	0.955511445	1.364615385
Bad	1.30	0.259511195	0.013688412
Bad	0.90	-0.102654154	0.037903757
Good	0.94	-0.06285297	0.287849231
Good	0.88	-0.123284032	0.233440685
Good	1.04	0.035506688	0.366068927
Good	0.95	-0.052185753	0.002663438
Good	0.93	-0.071458964	0.004278416
Good	0.88	-0.131028262	0.00754386

All RR data

Good	0.92	-0.088553397	0.00398619
Good	0.89	-0.111570701	0.004241055
Good	0.83	-0.187078253	0.007093105
Bad	1.13	0.122461169	0.038914572
Good	1.03	0.027305451	0.012378689
Good	0.93	-0.075507553	0.006959622
Good	0.91	-0.093487231	0.009592601
Good	0.90	-0.103656938	0.009180356
Good	0.88	-0.131336002	0.021997301
Good	0.98	-0.021661497	0.006716902
Good	0.93	-0.070380797	0.008483248
Good	1.02	0.017376376	0.008095858
Good	0.96	-0.044370248	0.013424748
Good	1.02	0.018343838	0.00822694
Good	0.88	-0.129070995	0.025000527
Good	0.86	-0.156088039	0.018069057
Good	0.87	-0.139887958	0.007814204
Good	0.93	-0.07271475	0.017290406
Good	0.85	-0.166223261	0.047950646
Good	0.98	-0.021479807	0.00403207
Good	0.95	-0.051838018	0.004202366
Good	0.87	-0.138110854	0.011015725
Good	0.97	-0.029413885	0.001640349
Good	0.99	-0.014184635	0.000592444
Good	0.99	-0.013889112	0.000381857
Good	0.94	-0.060624622	0.002553105
Good	1.06	0.062520357	0.00350277
Good	0.94	-0.062520357	0.00350277
Good	0.93	-0.073025135	0.001458244
Good	0.93	-0.074107972	0.001892552
Good	0.97	-0.028573372	0.000799483
Good	0.93	-0.077558234	0.003276628
Good	0.94	-0.0588405	0.001659452
Bad	1.00	0	0.089869281
Good	0.98	-0.015504187	0.003231838
Good	0.93	-0.075223421	0.002339976
Good	0.88	-0.124052649	0.007756813
Good	1.01	0.01091989	0.001918507
Bad	0.97	-0.032789823	0.014777681
Good	0.95	-0.051767565	0.007845417
Good	0.96	-0.039095014	0.009954277
Good	0.98	-0.015564517	0.010507987
Good	0.95	-0.04681706	0.016043193
Good	1.08	0.079745663	0.007477684
Good	1.02	0.017225306	0.009432718
Good	0.91	-0.095986084	0.010575161
Good	1.01	0.005826673	0.017429194
Good	0.98	-0.015564517	0.021936558
Good	0.90	-0.109875196	0.016826668
Good	0.94	-0.058581902	0.018142458
Good	0.98	-0.015564517	0.021936558
Good	1.01	0.008533035	0.011088707
Good	0.95	-0.051767565	0.007845417
Good	0.93	-0.074405017	0.004076323
Good	0.92	-0.084557388	0.008920685

All RR data

Good	1.01	0.005826673	0.017429194
Good	1.03	0.033225648	0.026281797
Good	0.84	-0.173788522	0.017755374
Good	0.84	-0.171568765	0.026597453
Good	0.96	-0.037054222	0.007582513
Bad	0.92	-0.087011377	0.851212121
Bad	1.00	0	6.646666667
Bad	1.16	0.147452731	0.154103105
Bad	0.85	-0.167054085	1.658321678
Bad	0.82	-0.194156014	0.414173669
Bad	0.86	-0.15415068	3.075238095
Bad	1.02	0.022223137	0.20224966
Bad	1.13	0.126293725	0.033466218
Bad	0.98	-0.023530497	0.020818965
Bad	1.18	0.162166755	0.010316573
Bad	0.81	-0.207639365	0.016096327
Bad	0.87	-0.135955636	0.007760099
Bad	0.98	-0.024097552	0.010718384
Bad	0.94	-0.063100706	0.006096982

	Reference	Year	Outcome	Isolated	IsolatedSD	Isolated.N	Control	ControlSD
2	Kennedy (1	1997	Anxiety	37.8	19.9	16	12.3	10.7
9	Gammon (1	1998	Anxiety	12.75	2.43	20	8.15	3.17
15	Tarzi (2001	2001	Anxiety	15	3	22	8.6	3
16	Day (2011a	2011	Anxiety/De	14.35	1.61	20	13	0.8
13	Findink (20	2012	Anxiety	7.23	4.1	61	6.42	3.9
	Soon (2013	2013	Anxiety					
17	Lupion-Mer	2015	Anxiety	8.2	0.48	72	6.9	0.41
8	Lau (2016)	2016	Anxiety	1.48	1.72	75	1.7	1.8

Control.N	yi	vi
16	1.5558	0.1628
20	1.5963	0.1319
20	2.093	0.1476
83	1.3351	0.0707
57	0.201	0.0341
	2.5649	0.986
72	2.8969	0.0569
421	-0.1228	0.0157

	Reference	Year	Outcome	Isolated	IsolatedSD	Isolated.N	Control	ControlSD
1	Kennedy (1	1997	Depression	16.5	9.9	16	12.3	10.7
10	Gammon (1	1998	Depression	12.45	2.21	20	7.3	2.05
	Tarzi (200	2001	Depression					
16	Day (2011a	2011	Anxiety/De	14.3	1.61	20	13	0.8
14	Findink (20	2012	Depression	8.83	4.7	61	7.89	4.9
	Soon (2013	2013	Depression					
18	Lupion-Mer	2015	Depression	7.8	0.51	72	6.6	0.43
7	Lau (2016)	2016	Depression	6.89	4.92	75	7.35	5.92

Control.N	yi	vi
16	0.397	0.127
20	2.368	0.17
	2.101	0.125
83	1.335	0.071
57	0.195	0.034
	1.562	0.2
72	2.531	0.05
420	-0.079	0.016

Case-control studies

	Colorado (2014)	Kennedy (1997)	Livorsi (2015)	Lupion (2015)	Masse (2013)	Soon (2013)	Tarzi (2001)
1) Is the case definition adequate? a) yes, with independent validation * b) yes, eg record linkage or based on self reports c) no description	*	*	*	*	*	*	*
2) Representativeness of the cases a) consecutive or obviously representative series of cases * b) potential for selection biases or not stated	b	b	*	b	b	*	*
3) Selection of Controls a) community controls (studies of hospital patients) * b) hospital controls c) no description	*	*	*	*	*	*	*
4) Definition of Controls a) no history of disease (endpoint) * b) no description of source	*			*			
Comparability							
1) Comparability of cases and controls on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *	* * (l)	* * (l, g)		* * (g)	* *(g)	* * (l, g)	* *(l, g)
Outcome							
1) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview where blind to case/control status * c) interview not blinded to case/control status d) written self report or medical record only e) no description	*	*	*	*	*	*	*
2) Same method of ascertainment for cases and controls a) yes * b) no	Functional Independence Measure ## *	Functional Independence Measure; Beck Inventory Depression; State Anxiety Inventory; Profile Mood States ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Charlston Comorbidity Index ## *	Hospital Anxiety and Depression Scale ## *	Geriatric Depression Scale; Profile of Mood States; Abbreviated Mental Test Score; Barthel Index ## *
3) Non-Response rate a) same rate for both groups * b) non respondents described c) rate different and no designation	*	*	*	*			*

Cohort studies (1)

Selection	Croft (2015)	Day (2011) a	Day (2011) b	Day (2012)	Day (2013)	Evans (2003)	Findink (2012)	Guilley (2017)
1) Representativeness of the exposed cohort a) truly representative of the average patient in the community * b) somewhat representative of the average patient in the community * c) selected group of users eg nurses, volunteers d) no description of the derivation of the cohort	*	*	*	*	* b	c	*b	*b
2) Selection of the non exposed cohort a) drawn from the same community as the exposed cohort * b) drawn from a different source c) no description of the derivation of the non exposed cohort	*	*	*	*	*	*	*	*
3) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview * c) written self report d) no description	*	*	*	*	*	*	*	*
4) Demonstration that outcome of interest was not present at start of study a) yes * b) no	*	b	b	*	*	*		*
Comparability								
1) Comparability of cohorts on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *	* * (l,g)		* * (l,g)	* * (l,g)	* * (l,g)			* (g)
Outcome								
1) Assessment of outcome a) independent blind assessment * b) record linkage * c) self report d) no description	Global Trigger Tool ## *	Hospital Anxiety and Depression Scale ## *	*	Clinical diagnosis of delirium *	Hospital Anxiety and Depression Scale ## *	Clinical encounters per hour *	Hospital Anxiety and Depression Scale ## *	State-Trait Anxiety Inventory ## *
2) Was follow-up long enough for outcomes to occur a) yes (during hospitalisation or immediately afterwards) * b) no	*	*	*	*	* 3 days	*	*	
3) Adequacy of follow up of cohorts a) complete follow up - all subjects accounted for * b) subjects lost to follow up unlikely to introduce bias - small number lost - > 90 % follow up, or description provided of those lost) * c) follow up rate < 90% and no description of those lost d) no statement	*	*	*	*	*	*	*	*

Community – was hospital population
Time to outcome of interest – question is regarding outcome during isolation

a – age
g- gender
l – LOS

own scale
validated scale/s used appropriately

Cohort studies (2)

Selection	Kirkland (1999)	Lau (2016)	Mehotra (2013)	Stelfox (2003)	Spense (2011)	Saint (2003)	Tran (2016)	Wassenberg (2010)
1) Representativeness of the exposed cohort a) truly representative of the average patient in the community * b) somewhat representative of the average patient in the community * c) selected group of users eg nurses, volunteers d) no description of the derivation of the cohort	*b	*	*	*	b	*	*	*
2) Selection of the non exposed cohort a) drawn from the same community as the exposed cohort * b) drawn from a different source c) no description of the derivation of the non exposed cohort	*	*	*	*	*	*	*	*
3) Ascertainment of exposure a) secure record (eg surgical records) * b) structured interview * c) written self report d) no description	*	*b	*b	*	*	*	*	*
4) Demonstration that outcome of interest was not present at start of study a) yes * b) no	*	*	*	*	*	*	*	*
Comparability								
1) Comparability of cohorts on the basis of the design or analysis a) study controls for diagnosis * b) study controls for any additional factor *		* (g)	* * (l,g)	* * (l,g)		*	* * (l,g)	(l,g)
Outcome								
1) Assessment of outcome a) independent blind assessment * b) record linkage * c) self report d) no description	* #	Patient Health Quetionnaire-9; CQ-5D c telephone /health records ## *	Hospital Consumer Assessment of Healthcare Providers and Systems ## *	Clinical satisfaction # *	Clinical outcomes *	Observation of doctors *	Clinical outcomes *	EQ5-D; Hospital Anxiety and Depression Scale ## *
2) Was follow-up long enough for outcomes to occur a) yes (during hospitalisation or immediately afterwards) * b) no	*		*	*	*	*	*	*
3) Adequacy of follow up of cohorts a) complete follow up - all subjects accounted for * b) subjects lost to follow up unlikely to introduce bias - small number lost - > 90 % follow up, or description provided of those lost) * c) follow up rate < 90% and no description of those lost d) no statement	*		37/278 contact; 51/290 non	*	*		*	*

General notes
Community – the population of interest was a hospital population
Time to outcome of interest – question is regarding outcome during isolation or shortly afterwards

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
TITLE			
Title	1	Identify the report as a systematic review, meta-analysis, or both.	1
ABSTRACT			
Structured summary	2	Provide a structured summary including, as applicable: background; objectives; data sources; study eligibility criteria, participants, and interventions; study appraisal and synthesis methods; results; limitations; conclusions and implications of key findings; systematic review registration number.	1-2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known.	3
Objectives	4	Provide an explicit statement of questions being addressed with reference to participants, interventions, comparisons, outcomes, and study design (PICOS).	4-5
METHODS			
Protocol and registration	5	Indicate if a review protocol exists, if and where it can be accessed (e.g., Web address), and, if available, provide registration information including registration number.	5
Eligibility criteria	6	Specify study characteristics (e.g., PICOS, length of follow-up) and report characteristics (e.g., years considered, language, publication status) used as criteria for eligibility, giving rationale.	5
Information sources	7	Describe all information sources (e.g., databases with dates of coverage, contact with study authors to identify additional studies) in the search and date last searched.	5
Search	8	Present full electronic search strategy for at least one database, including any limits used, such that it could be repeated.	Suppl information
Study selection	9	State the process for selecting studies (i.e., screening, eligibility, included in systematic review, and, if applicable, included in the meta-analysis).	5
Data collection process	10	Describe method of data extraction from reports (e.g., piloted forms, independently, in duplicate) and any processes for obtaining and confirming data from investigators.	5
Data items	11	List and define all variables for which data were sought (e.g., PICOS, funding sources) and any assumptions and simplifications made.	5
Risk of bias in individual studies	12	Describe methods used for assessing risk of bias of individual studies (including specification of whether this was done at the study or outcome level), and how this information is to be used in any data synthesis.	7
Summary measures	13	State the principal summary measures (e.g., risk ratio, difference in means).	6-7
Synthesis of results	14	Describe the methods of handling data and combining results of studies, if done, including measures of consistency (e.g., I^2) for each meta-analysis.	6-7

PRISMA 2009 Checklist

Section/topic	#	Checklist item	Reported on page #
Risk of bias across studies	15	Specify any assessment of risk of bias that may affect the cumulative evidence (e.g., publication bias, selective reporting within studies).	7-8
Additional analyses	16	Describe methods of additional analyses (e.g., sensitivity or subgroup analyses, meta-regression), if done, indicating which were pre-specified.	None
RESULTS			
Study selection	17	Give numbers of studies screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally with a flow diagram.	6
Study characteristics	18	For each study, present characteristics for which data were extracted (e.g., study size, PICOS, follow-up period) and provide the citations.	Suppl information
Risk of bias within studies	19	Present data on risk of bias of each study and, if available, any outcome level assessment (see item 12).	Suppl information
Results of individual studies	20	For all outcomes considered (benefits or harms), present, for each study: (a) simple summary data for each intervention group (b) effect estimates and confidence intervals, ideally with a forest plot.	Figures
Synthesis of results	21	Present results of each meta-analysis done, including confidence intervals and measures of consistency.	None
Risk of bias across studies	22	Present results of any assessment of risk of bias across studies (see Item 15).	8-9
Additional analysis	23	Give results of additional analyses, if done (e.g., sensitivity or subgroup analyses, meta-regression [see Item 16]).	None
DISCUSSION			
Summary of evidence	24	Summarize the main findings including the strength of evidence for each main outcome; consider their relevance to key groups (e.g., healthcare providers, users, and policy makers).	8-11
Limitations	25	Discuss limitations at study and outcome level (e.g., risk of bias), and at review-level (e.g., incomplete retrieval of identified research, reporting bias).	14
Conclusions	26	Provide a general interpretation of the results in the context of other evidence, and implications for future research.	14
FUNDING			
Funding	27	Describe sources of funding for the systematic review and other support (e.g., supply of data); role of funders for the systematic review.	None

From: Moher D, Liberati A, Tetzlaff J, Altman DG, The PRISMA Group (2009). Preferred Reporting Items for Systematic Reviews and Meta-Analyses: The PRISMA Statement. PLoS Med 6(7): e1000097. doi:10.1371/journal.pmed1000097