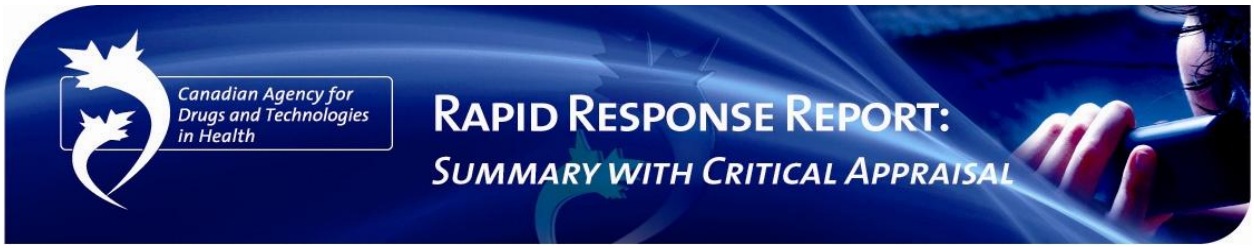

TITLE: Screening, Isolation and Decolonization Strategies for Methicillin-Resistant *Staphylococcus Aureus*: A Review of the Clinical Evidence

DATE: 29 October 2012

CONTEXT AND POLICY ISSUES

Bacterial resistance to antibiotics is an increasing problem in Canada and worldwide.[1-4] Methicillin-resistant *Staphylococcus aureus* (MRSA) are strains of *Staphylococcus aureus* that are resistant to beta-lactam antibiotics, including methicillin, cloxacillin, and penicillin. MRSA bacteria are associated with infections of skin, soft tissue, surgical sites, bones, joints, lungs, and the urinary tract. MRSA is commonly transmitted in hospitals from infected or colonized (presence of bacteria without clinical signs or symptoms) patients to others, often by the transiently-colonized hands of health care workers.[5] MRSA is a major cause of morbidity and mortality for hospitalized patients, with greatest susceptibility for patients in intensive care units (ICUs), where exposure to broad-spectrum antimicrobials is more common.[6]

The Canadian Nosocomial Infection Surveillance Program (CNISP) performs surveillance of hospitalized patients in sentinel hospitals across Canada. The program reported that the incidence of MRSA colonization and infection increased significantly (17-fold) from 0.65 cases per 10,000 patient days in 1995, to 11.04 cases per 10,000 patient days in 2007.[7]

The Ontario Provincial Infectious Disease Advisory Committee (PIDAC)[5] has issued the following recommendations regarding MRSA:

- Each health care setting should have a prevention and control program for MRSA. (p.19)
- Screening for risk factors for MRSA should include a screening tool that is applied to all clients/patients/residents admitted to the health care facility. (p.20)
- Every effort should be made to try to determine the source of new cases of MRSA. Every new case should warrant an investigation. (p.21)
- During an outbreak, all client/patient/resident contacts with common risk factors should be actively screened. (p.22)

- Hand hygiene must be performed by all staff before and after each contact with a client/patient/resident or contact with environmental surfaces near the client/patient/resident. (p.24)
- Additional precautions such as contact precautions are required for MRSA.[5]

Infection control programs for MRSA can include screening, isolation, and decolonization. Screening programs may be universal or may specifically target patients considered to be at increased risk for MRSA. Patients considered to be at increased risk are those previously colonized or infected with MRSA, those who have been in a health care facility outside of Canada within 12 months, those who have spent more than 12 continuous hours as a patient or resident in any health care facility within 12 months, and those transferred between health care facilities.[8] Isolation of patients entails placement of patients in single rooms, with or without dedicated nursing staff, and the use of disposable gloves and gowns. Decolonization typically involves treating patients with topical antibiotics such as chlorhexidine or with intranasal mupirocin in order to eliminate or reduce bacterial load, and thus reduce the chance of transmission or infection.[9]

Antibiotic-resistant pathogens such as MRSA lead to an increased use of hospital resources due to extended hospital stays, laboratory tests, physician consultations, and the need to take infection control measures to prevent the further spread of these pathogens.[6] The health care impact of resistance cannot be limited to the hospital perspective, as significant portions of clinical care are provided in other facilities.[10]

The objective of this study is to conduct a review of the clinical evidence of screening, isolation, and decolonization strategies for MRSA organisms.

RESEARCH QUESTIONS

1. What is the clinical evidence on the effectiveness of selective versus universal versus no screening of patients (adult and pediatric) for methicillin-resistant staphylococcus aureus (MRSA)?

2. What is the clinical evidence on the effectiveness of patient isolation for MRSA?

3. What is the clinical evidence on the impact of isolation on the patient?

4. What is the clinical evidence for the effectiveness of decolonizing patients known to be carrying MRSA organisms?

5. What is the clinical evidence on the effectiveness of additional precautions in the operating room or post-anesthesia recovery room in patients colonized with MRSA?

KEY MESSAGE

Evidence from mostly observational studies showed that findings on the comparative clinical impact of different MRSA screening strategies is inconsistent and inconclusive on the incidence of MRSA acquisition and infection. Isolation precautions significantly reduced the MRSA acquisition rate, but can be associated with depression in hospitalized patients. Decolonization therapy with topical mupirocin together with surveillance cultures helped to reduce the MRSA

colonization and infection rates. The addition of systemic antibiotics into the strategy increased the success rate of decolonization MRSA carriers, but did not have added value in the incidence of 30-day mortality. There was no evidence found on the effectiveness of additional precautions in the operating room or post-anesthesia recovery room.

METHODS

A limited literature search was conducted on key resources including MEDLINE, EMBASE, The Cochrane Library (2012, Issue 6), University of York Centre for Reviews and Dissemination (CRD) databases, Canadian and major international health technology agencies, as well as a focused Internet search. Methodological filters were applied to limit retrieval to health technology assessments, systematic reviews, meta-analyses, randomized controlled trials and non-randomized studies. Where possible, retrieval was limited to the human population. The search was also limited to English language documents published between January 1, 2009 and June 15, 2012. Regular alerts were established to update the search until September 28, 2012.

Literature search

One reviewer screened the titles and abstracts of the retrieved publications and examined the full-text publications for the final article selection. Selection criteria are outlined in Table 1.

Table 1: Selection Criteria

Population	Adult and pediatric patients with MRSA, in acute and long-term care facilities
Intervention	• Screening (targeted or universal) for MRSA • Isolation for MRSA • Decolonization for MRSA • Contact isolation (gloves, gowns), additional cleaning, or treating colonized individuals as the last case of the day to prevent transmission to subsequent patients in the OR or PAR
Comparator	• No screening • No isolation • No decolonization • No additional precautions (contact isolation, additional cleaning, or “last case” treatment)
Outcomes	• Transmission rate, infection rate, infection rate in community versus hospital • Clinical outcomes: morbidity (including complications of MRSA infection), case-fatality, and mortality • Adverse events: adverse effects of screening and treatment, including allergic reactions, non-allergic toxicities, medical errors, and resistance to antimicrobials. Adverse events due to isolation (such as depression) • Patient reported outcomes: quality of care for noninfectious conditions • Duration of hospitalization
Study design	Health technology assessments, systematic reviews, meta-analyses, randomized controlled trials (RCTs), non-RCTs

Exclusion Criteria

Articles were excluded if they did not meet the selection criteria in Table 1, if they did not have a comparator group, if they were published prior to January 2009, if they were duplicate publications of the same study, or if they were referenced in the selected systematic review.

Critical Appraisal of Individual Studies

The quality of the included studies was assessed using the Downs and Black checklist.[11] Numerical scores were not calculated. Instead, the strengths and limitations of individual studies are summarized and presented.

SUMMARY OF EVIDENCE

Quantity of Available Evidence

The literature search yielded 399 citations. Six additional studies were identified by searching the grey literature. After screening of abstracts, 55 potentially relevant studies were selected for full-text review.

Twenty-one studies[12-32] were included in the review.

The PRISMA flowchart in Appendix 1 details the process of the study selection.

Summary of Study Characteristics

A detailed summary of the included studies is provided in Appendix 2.

Study design

One randomized controlled trial (RCT),[12] three prospective observational studies,[13,20,21] nine pre-post implementation studies,[15,23,24,27-32] and eight retrospective observational studies[14,16-19,22,25,26] were included for review. Eleven of the non-RCTs[15,18,21-25,27-29,31] were from the US, the RCT and one non-RCT[12,32] were conducted in France, two non-RCT studies were from the UK,[14,19] two were from Taiwan,[16,20] one from Ireland,[13] one from Spain,[17] one from Singapore,[30] and one was conducted in Canada.[26]

Population

The population of all studies was hospitalized patients. Study size ranged from 24[25] to 420,452.[14] Three studies examined infants admitted to neonatal intensive care units (NICU) or pediatric patients admitted to pediatric ICU.[16,25,28] The remaining studies[13-15,17-24,26] appeared to include only adults, although not all of them specified the age range of the patients. Five studies limited the population to adult patients in intensive care units (ICU).[12,15,20,21,30]

Interventions and comparators

Fourteen studies[12-19,27-31] reported the comparative clinical effectiveness of different MRSA screening strategies. Four studies[12,20,21,32] examined the comparative clinical impact of isolation

precautions on MRSA acquisition and infection. One study examined the effect of contact precautions on depression or anxiety.[22] Six studies reported the clinical effectiveness of decolonization patients carrying MRSA.[16,23-26,32]

Outcomes

The main outcomes in the included studies were rates or incidence of acquired MRSA colonization or infection, and risk factors for acquiring nosocomial MRSA. One study[22] focused mainly on depression and anxiety in patients requiring contact isolation, and two study[18,31] focused specifically on post-operative MRSA infection rates.

Summary of Critical Appraisal

A summary of the critical appraisal conducted for selected studies can be found in Appendix 3. Only one study was a randomized controlled trial (RCT).[12] It was unclear, in the RCT, if the randomization assignments were concealed. Unconcealed assignments could result in allocation bias. The study patients were not blinded to their assignments, and this could result in a treatment outcome bias. The remainder of the included studies were observational studies. Among them, sixteen were pre-post design with no contemporary control group.[15-21,23-25,27-32] Observational studies have the potential for selection bias, as there is no randomization of patients. As with the included RCT, unconcealed assignment to treatment could result in treatment outcome bias. Most studies failed to report whether power calculation was performed to determine adequate sample size.

Summary of Findings

Main findings of included studies are summarized in detail in Appendix 4.

1. <u>What is the clinical evidence on the effectiveness of selective versus universal versus no screening of patients (adult and pediatric) for methicillin-resistant staphylococcus aureus (MRSA)?</u>

One RCT,[12] and 13 observational studies[13-19,27-32] reported the comparative clinical effectiveness of different MRSA screening strategies. The comparative clinical impact of different MRSA screening strategies is inconsistent and inconclusive on the incidence of MRSA acquisition and infection.

Data from these studies showed inconclusive findings on the comparative clinical effectiveness of MRSA screening. The RCT in an ICU setting found that the intervention which, in addition to standard precaution measures (comprised of screening, contact precautions, isolation precautions, and decontamination), did not reduce MRSA acquisition rate, infection rate, duration of antimicrobial therapy, length of stay in the ICU, or mortality rate in the ICU, as compared to standard precautions (i.e., general prevention of nosocomial infections, hand-rubbing with alcoholic solutions, isolation only if MRSA was detected and no mupirocin nasal decolonization use).[12] The results for clinical effectiveness of universal screening compared to screening that targeted high risk patients, were not found to be consistent, with results not supporting universal screening in two studies,[13,15] and supporting the strategy in another study.[14] Pre- and post-implementation studies showed benefits of MRSA targeted screening and decolonization in significantly reducing the colonization and infection incidence in endemic

hospital situations,[17,19,27,29,32] pediatric ICUs,[16,28] or in surgical wards.[18,31] One pre- and post-implementation study did not show any significant reduction in MRSA infection incidence rate following active surveillance testing and decontamination strategies in an ICU setting.[30]

2. What is the clinical evidence on the effectiveness of patient isolation for MRSA?

One RCT[12] and two prospective cohort studies[20,21] examined the comparative clinical impact of isolation precautions on MRSA acquisition and infection. Isolation precautions significantly reduced MRSA acquisition rate.

The RCT showed that MRSA acquisition rate was higher in an ICU setting without isolation precautions than with isolation precautions. The difference was statistically significant.[12] One observational study showed that the addition of early initiation of isolation to active surveillance in an ICU setting failed to reduce MRSA transmission as compared to active surveillance without early isolation,[20] while another study found early initiation of isolation to be effective in reducing the incidence of ventilator-associated pneumonia and nosocomial MRSA infection.[21]

3. What is the clinical evidence on the impact of isolation on the patient?

A retrospective cohort study examined the effect of contact precautions on depression or anxiety in over 36,000 patients admitted to a tertiary care hospital.[22] There was an association between contact precautions and depression in patients hospitalized for multi-drug resistant infections, except for ICU patients.

Patients were placed on contact precautions (no detail was provided on specific contact precautions, but patients were given a private room when available) when their medical record indicated the presence of multi-drug resistant bacteria or when they were positive upon screening for MRSA, VRE, or ESBL-producing organisms. The incidence of depression, using the International Classification of Diseases, ninth revision, Clinical Modification (ICD-9-CM), was compared between the contact precaution group and the non-contact precaution group. In the non-ICU population, patients on contact precautions were 40% more likely than those not on contact precautions to be diagnosed with depression (OR 1.4, 95% CI 1.2 to 1.6). In the ICU population, there was no relationship found between contact precautions and depression or anxiety.

4. What is the clinical evidence for the effectiveness of decolonizing patients known to be carrying MRSA organisms?

Five observational studies reported the clinical effectiveness of decolonization patients carrying MRSA.[16,23-26] Findings showed that topical mupirocin helped to significantly reduce the MRSA colonization and infection rates. The addition of systemic antibiotics increased the decolonization success rate and reduced the infection rate.

Nasal mupirocin, hexachlorophene body wash, and systemic antibiotics were shown to significantly reduce the incidence of infections in patients with recurrent community-associated MRSA infections.[23] A hospital decolonization protocol comprising topical mupirocin, oral trimethoprim/sulfamethoxazole, and oral rifampin significantly increased the decolonization success rate and reduced infection rate, compared to no decolonization therapy, or to other

decolonization regimens which comprised topical mupirocin alone, or topical mupirocin plus oral cotrimazole. The difference in the incidence of 30-day mortality was statistically significant between the hospital protocol and no decolonization, but not statistically significant between the hospital protocol and other decolonization regimens.[26] Surveillance cultures and decolonization therapy (topical mupirocin, systemic minocycline and rifampin, and 5% tea tree oil body wash) significantly reduced the prevalence of MRSA carriage in a nursing home and the nosocomial MRSA infection rates after 12 months of intervention.[24] Surveillance cultures with decolonization therapy (intranasal mupirocin) significantly reduced the MRSA colonization and infection rates in a neonatal ICU as compared to surveillance cultures without decolonization therapy.[16] The value of intranasal mupirocin as decolonization therapy for neonate carriers of MRSA was reconfirmed in another study, in which decolonization with mupirocin reduced (not statistically significantly) MRSA infection rates.[25]

5. What is the clinical evidence on the effectiveness of additional precautions in the operating room or post-anesthesia recovery room in patients colonized with MRSA?

There was no comparative clinical evidence found regarding the effectiveness of additional precautions in the operating room or post-anesthesia recovery room, for disease transmission by patients colonized with MRSA.

Limitations

The robustness of the evidence on the comparative clinical efficacy of MRSA screening strategies, contact precautions, decolonization therapies, and the impact of patients' isolation is limited, due to the nature of the available evidence. Without contemporary controls, the pre- and post-implementation studies did not prove causality, but rather an association between precaution measures and rates of MRSA infections. As well, due to the pre and post design, it is uncertain whether the decrease in colonization rates was due to the intervention program or to a change in MRSA epidemiology outside the hospitals. The lack of a control group in studies in which patients received topical and systemic antibiotics for decolonization creates uncertainty as to whether patients would have a reduction in infections even without treatment. The non-randomized design did not account for factors that might have impacted an investigator's decision to attempt treatment. Stronger evidence, supported by large RCTs, is needed to confirm the findings, despite ethical concerns on performing trials with randomized design on patients infected with MRSA. There was no comparative clinical evidence found regarding the effectiveness of additional precautions in the operating room or post-anesthesia recovery room, for disease transmission by patients colonized with MRSA.

CONCLUSIONS AND IMPLICATIONS FOR DECISION OR POLICY MAKING

Evidence from primarily observational studies showed that the comparative clinical impact of different MRSA screening strategies on the incidence of MRSA acquisition and infection is inconclusive. Implementation of precautionary measures needs to take into consideration the negative psychological effects that isolation may have on hospitalized patients. Decolonization therapy with topical mupirocin together with surveillance cultures helped to reduce the MRSA colonization and infection rates. The addition of systemic antibiotics such as oral trimethoprim/sulfamethoxazole into the strategy increased the success rate of decolonizing patients carrying MRSA organisms, and reduced the infection rate, but did not have added value in the incidence of 30-day mortality as compared to other decolonization regimen. There

was no evidence found on the effectiveness of additional precautions in the operating room or post-anesthesia recovery room.

In order to maximize the efficacy of infection control, in addition to screening, isolation procedures, and antimicrobial stewardship programs, specific control measures may need to be considered in hospital settings. Surveillance data in an acute tertiary care hospital found that the rates of healthcare-associated MRSA infections were highest in the ICUs, and lowest in the wards.[33] A Canadian tertiary care hospital found that the number of roommates a patient was exposed to was directly associated with the risk of acquiring nosocomial MRSA.[34] The role of overcrowding was also shown to be associated with an increase in MRSA transmission rates.[35] These findings can have implications for the staff deployment and design of acute care hospitals. Increased awareness of potential sources of bacteria in hospital settings may also help to reduce the risk of bacterial transmission. Bath basins are found to be a reservoir for MRSA and many other bacteria.[36] Mobile phones of patients, companions, and visitors represent a risk for hospital-acquired infections.[37] Despite the belief that white lab coats could be contaminated with antibiotic-resistant organisms,[38] a review of the literature did not support the hypothesis that uniforms or clothing could be a vehicle for the transmission of healthcare-associated infections.[39] Despite the increased risk of nosocomial infections, compliance of health care workers to hand hygiene was low when working with patients infected with MRSA (47% and 43% in the ICU and intermediate care units, respectively).[40] Use of electronic alerts in the form of beeps to prompt health care workers to perform antisepsis was shown to improve hand hygiene compliance.[41] Implementation of a computerized reminder increased the rate of patients appropriately isolated.[42] Direct and efficient communication between different teams is also a factor, as shown in another survey of Canadian acute care hospitals.[43] Hospitals that reported MRSA infection rates by specific risk group and that kept attendance records of infection prevention and control teaching activities had lower incidence of MRSA acquisition.[43] Revelations from these findings are important for decision makers in infection prevention and control policy making. Finally, access to staff and communication with isolated patients may help to decrease the rates of contact precautions-associated adverse outcomes such as preventable medical errors, depression, and may increase patients' satisfaction.[44]

In Canada, there are variable practices among hospitals in implementing infection prevention and control measures, which may be costly to implement. As part of the Canadian Nosocomial Infection Surveillance program, a 2003 survey of Canadian tertiary care hospitals[45] found that greater than 96% and greater than 89% of Canadian teaching hospitals conducted admission screening for MRSA and VRE, respectively, but only one site screened for ESBL/AmpC (organisms that produce AmpC-type beta-lactamase). A cost-effectiveness analysis of three alternative screening strategies for MRSA (universal surveillance screening for all hospital admissions, targeted surveillance screening for ICU admissions, and no surveillance screening) in an academic hospital setting[46] showed that targeted surveillance screening is the most cost-effective strategy, with universal surveillance screening associated with an incremental cost-effectiveness ratio of US $14,955 per MRSA health-care associated infection. An economic evaluation on the cost-effectiveness of different screening, isolation, and decolonization strategies in the control of MRSA in ICUs[9] showed that all strategies using isolation but not decolonization improved health outcomes, but control strategies that included decolonization are likely to be cost saving. A survey in 2006 sent to infection prevention and control programs in all Canadian acute care hospitals with 80 or more beds[47] found that hospital size was not associated with infection prevention and control professionals (ICP) full-time equivalents, nor with years of infection control experience of ICPs, and larger hospitals were associated with

higher MRSA rates. However, a significant increase in the number of full-time ICPs has not translated into improvement of MRSA control [from 1999 to 2005, the number ICP full time employees per 100 beds increased from a mean of 0.5 to 0.8 ($p < 0.0001$), but mean MRSA rate per 1,000 admissions raised from 2.0 to 5.2].

Some Canadian programs have specifically addressed selected aspects of antimicrobial resistance; these include "Do Bugs need Drugs" (http://www.dobugsneeddrugs.org), Northern Antibiotic Resistance Partnership (http://www.Germsaway.ca), Canadian Nosocomial Infection Surveillance Program (CNISP) (http://www.phac-aspc.gc.ca/nois-sinp/survprog-eng.php), and Canadian Integrated Program of Antimicrobial Resistance Surveillance (CIPARS) (http://www.phac-aspc.gc.ca/cipars-picra/index-eng.php). However, it has been suggested that the importance of the issue and the complexity of potential solutions may require the integration of a comprehensive national program.[48]

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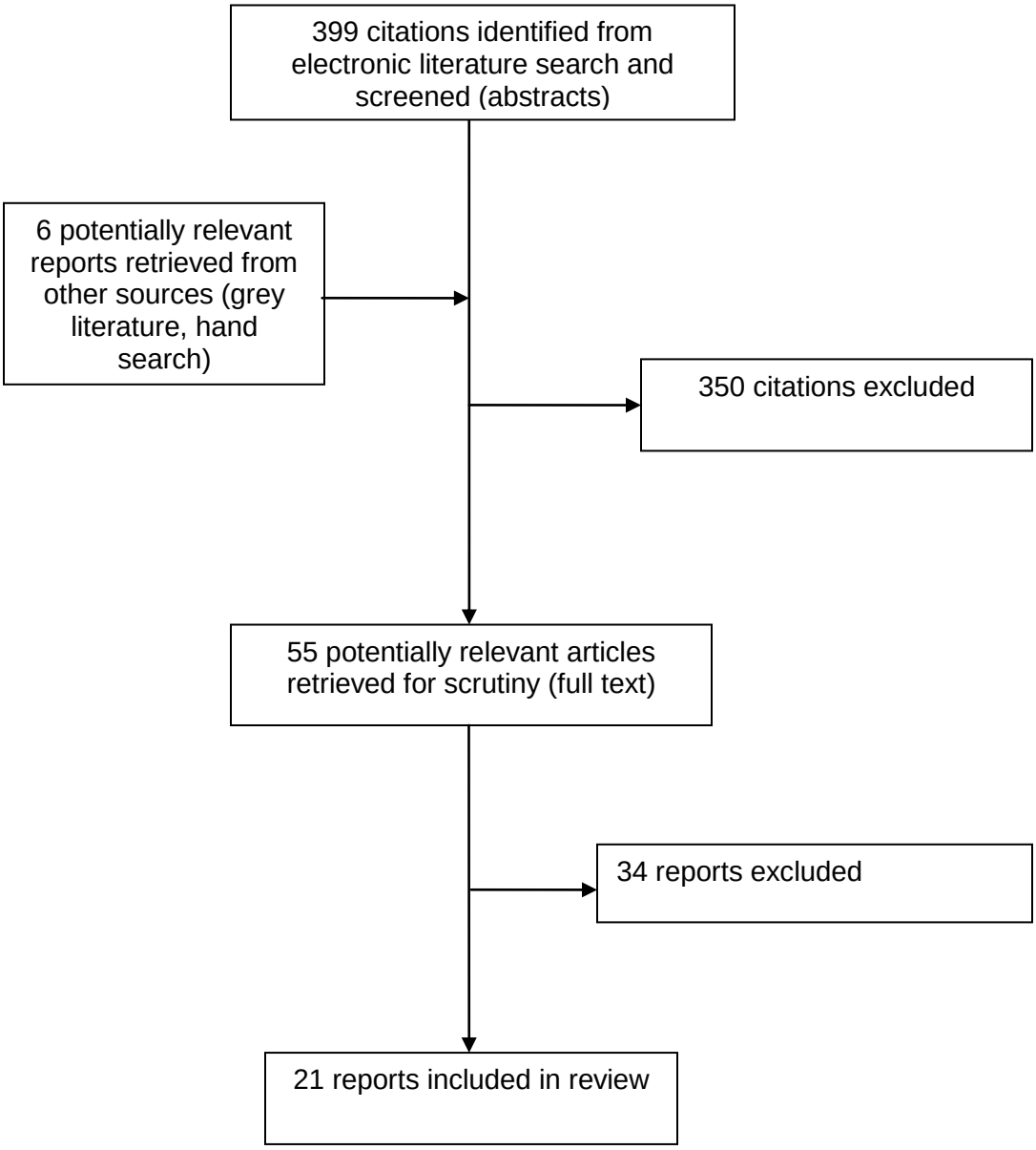
Appendix 1: Selection of Publications



Appendix 2: Characteristics of Included Studies

Table A1: Characteristics of Included Clinical Trials

First Author, Year, Country, Study Design, Length of Study	Population, Number of patients (n)	Intervention	Comparator	Clinical Outcomes
Creamer, 2012[13] Ireland Prospective observational study (series of prevalence surveys conducted over 4-6 weeks) 3 years	All patients admitted to 4 specific wards of an acute care hospital n=892	Screening of nasal, groin, and non-intact skin sites for all patients within 72 hours of admission to hospital	Screening of only high-risk patients on admission to hospital	Number of MRSA-positive patients; Patient risk factors associated with positive MRSA
Chalfine, 2012[32] France Pre-post implementation study 10 years	Patients admitted to hospital for ≥ 24 hours n=171,366	Screening in wards (no details provided) and active screening of all patients admitted to ICU, with weekly follow-up; Colonized patients placed in contact isolation; ICU patients decolonized using daily bathing with povidone iodine antiseptic soap and 3x daily nasal mupirocin for 5 days; Antibiotic stewardship (formal consults with patients regarding antibiotics in use)	Alert system for patients with multi-resistant bacteria (no details provided)	Rates of hospital-acquired MRSA colonization and bacteremia
Kjonegaard, 2012[15] US Pre-post implementation study 7 months each of intervention and comparator	Patients admitted to ICU of an acute care hospital n=3,341 during intervention period; number not reported for pre-intervention period	Comprehensive period: screening of nares and perineal in all patients admitted to ICU State-mandated period: screening of nares in all patients admitted to ICU	Screening of patients admitted to ICU only if symptoms were present and there was a physician order. MRSA-positive patients undergoing CABG were placed in contact precautions and decolonized; other MRSA-positive patients were placed in contact precautions	Rates of hospital-acquired MRSA in ICU patients; Patient risk factors associated with positive MRSA

Table A1: Characteristics of Included Clinical Trials

First Author, Year, Country, Study Design, Length of Study	Population, Number of patients (n)	Intervention	Comparator	Clinical Outcomes
Lawes, 2012[14] Scotland Retrospective cohort study and multivariate time-series analysis 5 years	All patients admitted to medical, surgical, pediatric, and maternity services in a single acute care and tertiary referral hospital n=420,452	Universal admission screening by nasal swabs, plus wound or device swabs if needed; MRSA-positive patients were isolated or cohorted and those admitted to any specialty were decolonized	Screening of selected high-risk patients, with same isolation and decolonization procedures as intervention	Rates of MRSA bacteremia; Length of stay and readmission rates; Mortality
Miller, 2012[23] US Pre-post implementation study 3 years (patients followed-up individually for 6 months)	Adult outpatients referred for management of recurrent MRSA infections n=31	Decolonization for 10 days nasal with mupirocin, topical hexachlorophene body wash, and an oral anti-MRSA antibiotic	6 months pre-study (not reported if patients received treatment)	Number of MRSA infections
Camus, 2011[12] France Prospective, parallel-group, non-blinded RCT 6 months at one centre and 8 months at a 2nd centre	Adults with an expected stay of > 48 hours, admitted to ICUs of 2 tertiary care university hospitals n=488	Screening of patients at ICU admission; Pre-emptive contact isolation precautions for high-risk patients; Precautions maintained for patients with MRSA-positive results until negative results; Decolonization with nasal mupirocin and chlorhexidine gluconate body wash	Standard precautions for surveillance and prevention of nosocomial infections; Isolation precautions as in intervention for patients positive for MRSA; No decolonization	Rates of acquired MRSA; Rates of acquired MRSA infection and total number of acquired infections; Duration of and reasons for isolation; Proportion of patients received antimicrobial drugs; Length of stay; ICU mortality rate

Table A1: Characteristics of Included Clinical Trials

First Author, Year, Country, Study Design, Length of Study	Population, Number of patients (n)	Intervention	Comparator	Clinical Outcomes
Day, 2011[22] US Retrospective cohort study 2 years	All adult patients admitted to a tertiary care teaching hospital n=36,112	Patients on contact precautions for MRSA and other MDR bacteria (private room if possible or cohorted with other MDR-positive patients)	Patients not on contact precautions	Depression and anxiety, stratified by admission to ICU
Ellingson, 2011[27] US Interrupted time-series analyses (pre-post) 9 years	Patients admitted to acute care units in a Veterans Affairs hospital n=not reported	Use of behavioural change strategies promoting adherence to infection control protocol, emphasizing hand hygiene and environmental disinfection; Active surveillance, within 48 hours of admission, by testing anterior nares and open wounds	Not reported what screening or infection control methods were used before intervention	Incidence of MRSA colonization or infection
Holzmann-Pazgal, 2011[28] US Pre-post implementation study 3 years	Patients admitted to the pediatric intensive care unit in a tertiary care pediatric hospital n=3,097	Active surveillance by obtaining cultures of samples from anterior nares, within 48 hours of admission, of all patients admitted to the pediatric intensive care unit, with weekly follow-up; Patients with positive cultures treated with contact isolation precautions (gowning and gloving)	Not reported what screening or infection control methods were used before intervention	Incidence of nosocomial MRSA infection
Huang, 2011[16] Taiwan Retrospective cohort study 2 years	Infants admitted to NICU n=1,233	Universal screening of infants admitted to NICU; Infants colonized with MRSA were separated and placed in a segregated area of the units, with cohorted care provided by designated nurses; Infants were decolonized with topical mupirocin in nares and umbilical area, administered twice daily for 5 consecutive days	Universal screening of infants admitted to NICU; Infants colonized with MRSA were separated and placed in a segregated area of the units, with cohorted care provided by designated nurses	Rates of acquired MRSA infection including bloodstream infection

Table A1: Characteristics of Included Clinical Trials

First Author, Year, Country, Study Design, Length of Study	Population, Number of patients (n)	Intervention	Comparator	Clinical Outcomes
Simmons, 2011[29] US Pre-post implementation study 3 years	Patients admitted to acute-care hospital including subpopulation of ICU patients n=not reported	Active surveillance plus clinical cultures; Patients with positive MRSA cultures were placed in contact isolation; Isolation discontinuation of patients testing positive with clinical cultures as described in Comparator; Isolation discontinuation of patients testing positive with active surveillance, following decolonization with mupirocin intranasal ointment; most patients were not decolonized, so remained in isolation for duration of hospitalization	No active surveillance, but clinical cultures taken; Patients with positive MRSA cultures placed in contact isolation; Isolation discontinued following antimicrobial therapy and 2 negative cultures, taken at least 5 days apart	Rate of MRSA acquisition
Bowler, 2010[24] US Pre-post implementation study 24 months	Nursing home residents in 5 nursing homes and residents from the nursing homes who were admitted to hospital; patients with a history of MRSA admitted to the MRSA clinic n=147nursing home residents; n=125 MRSA clinic	Universal screening of all nursing home residents and patients in MRSA clinic, with decolonization of those nursing home residents positive for MRSA, using minocycline and rifampin for 5 days, mupirocin ointment for 7 days, and bathing with tea tree oil body wash for 7 days	Follow-up screening of MRSA-positive residents at 6, 12, and 24 months	Prevalence of MRSA; Rates of nosocomial transmission of MRSA
Dow, 2010[26] Canada Retrospective cohort study 6 years (individual patient follow-up of at least 3 months)	At-risk (for positive MRSA) patients admitted to hospital n=241	Screening of at-risk patients, with decolonization of MRSA-positive patients; topical mupirocin to nares and open or colonized wounds, 3 times daily, trimethoprim/ sulfamethoxazole and oral rifampin twice daily, all for 7 days.	Any alternative decolonization regimen or no decolonization regimen	Incidence of MRSA infection; Mortality

Table A1: Characteristics of Included Clinical Trials

First Author, Year, Country, Study Design, Length of Study	Population, Number of patients (n)	Intervention	Comparator	Clinical Outcomes
Kurup, 2010[30] Singapore Pre-post implementation study 1 year	Patients admitted to2 ICUs of a tertiary care hospital n=653	Active surveillanceof patients admitted to ICU, by swabbing anterior nares within 24 hours of admission, and every 7 days thereafter; Patients positive for MRSA treated with strict contact isolation precautions in a private room, and daily decolonization with polyhexanide solution; Additional staff education on hand hygiene provided	Not reported what screening or infection control methods were used before intervention	Incidence of MRSA infection rate
Martinez-Capolino, 2010[21] US Prospective cohort study 11 months control (pre-intervention) followed by 8 months intervention	Patients admitted to the ICUs in 2 hospitals n=not reported	Universal screening of all patients admitted to ICUs, with continued weekly screening for MRSA-negative patients; MRSA colonized patients placed in contact isolation (single or cohorted rooms, and use of gloves and gowns); Hospital 1 discontinued contact precautions upon discharge from ICU; Hospital 2 continued precautions throughout hospital stay	Infection control initiatives included surgical infection reduction initiatives, Keystone ventilator and central line bundles, and a hand-washing campaign	Incidence of MRSA infection acquired in the hospitals; Incidence of new MRSA colonization and infection in ICU patients
Milstone, 2010[25] US Retrospective cohort study 2 years	Infants admitted to NICU n=24	16 patients received intranasal mupirocin and 5 of these patients received at least 1 topical chlorhexidine bath	8 patients not treated with mupirocin	Incidence of MRSA infection
Rodríguez-Baño, 2010[17] Spain Retrospective interrupted time-series analysis 13 years	Patients admitted to hospital n=1,230	Period B: contact precautions for MRSA-positive patients; no active surveillance; patients placed in individual rooms or cohorts; strict cleaning policy with sodium hypochlorite and ethyl alcohol Period C: intervention as in Period B plus active surveillance of units with transmission of MRSA, and decolonization (mupirocin nasal ointment 3 times daily and daily body washing with chlorhexidine gluconate, for 5	Period A: pre-intervention period with an active global infection control program (included review and implementation of infection control protocols, educational sessions, and surveillance)	Rates of MRSA colonization or infection; Rates of MRSA bacteremia

Table A1: Characteristics of Included Clinical Trials				
First Author, Year, Country, Study Design, Length of Study	**Population, Number of patients (n)**	**Intervention**	**Comparator**	**Clinical Outcomes**
		days) Period D: Active surveillance in previously MRSA-positive patients re-admitted and patients admitted from other healthcare centres and long-term care facilities; pre-emptive isolation for previously MRSA-positive patients; alcohol hand rubs used		
Wang, 2010[20] Taiwan Prospective cohort study (pre-post) 14 months	Patients admitted to the ICUs of 2 hospitals n=1,625	Washout phase after phase 1: education of HCWs of upcoming isolation procedures Phase II: Positive-MRSA patients were put on contact isolation until discharge: private rooms or cohorts; non-critical devices used exclusively with isolated patients; HCWs instructed to hand wash with chlorhexidine or alcohol-based hand rubs before and after entering isolation rooms; gowns and gloves for isolation rooms; environmental cleaning and disinfection (sodium hypochlorite) of beds and surroundings following patient discharge; study assistants monitored HCW adherence to procedures	Phase I: Active surveillance of all patients in and admitted to ICU, every 3 days; HCWs screened monthly; HCWs not informed of results; MRSA-positive patients placed in isolation	Incidence of MRSA transmission and infection; Risk factors for acquiring MRSA during ICU stay
Karas, 2009[19] UK Retrospective cohort 66 months	Hospitalized patients n=1,140	Phase 1: Screening of patients undergoing elective major surgery; screening of 50-60 random beds quarterly; decolonization of MRSA-positive patients using mupirocin nasal or wound cream, triclosan body washes, and chlorhexidine mouthwash Phase II: As for phase 1 plus quarterly increased screening and education in ward with highest MRSA; screening the whole identified ward; decolonization as per phase 1.	Pre-study: screening of patients undergoing elective major surgery; not reported what actions were taken with MRSA-positive patients	Rates of MRSA colonization and bacteremia

Table A1: Characteristics of Included Clinical Trials

First Author, Year, Country, Study Design, Length of Study	Population, Number of patients (n)	Intervention	Comparator	Clinical Outcomes
		Phase III: As for phases I and II; screening of all emergency admissions >65 years and pre-treatment with naseptin until negative MRSA screening results obtained		
Pofahl, 2009[31] US Pre-post implementation design 3 years pre-implementation; 1 year post-implementation	All patients admitted to a tertiary care hospital n=56,835 for pre-implementation period; n=35,778 for post-implementation period	Active anterior nares surveillance of all patients admitted to hospital; Patients positive for MRSA placed on contact precautions; Patients undergoing elective surgery pre-screened for MRSA; positives were decolonized with nasal mupirocin ointment for 5 days	Patients considered at high risk for MRSA carriage screened on admission and placed in contact isolation prior to results; patients testing positive remained on contact precautions throughout hospitalization	Rate of MRSA surgical site infections
Richer, 2009[18] US Retrospective cohort study 1 year screening compared with 1 year pre-study	Adult general otolaryngology patients and head and neck oncology patients of a single surgeon n=420	Nasal swab screening; MRSA-positive patients treated with topical mupirocin twice daily for 5 days, and chlorhexidine wash on days 1, 3, and 5; postsurgical surveillance for infected wounds within 30 days of surgery	No pre-operative screening or decolonization	MRSA post-operative infection rates

CABG=coronary artery bypass graft; HCW=healthcare worker; ICU=intensive care unit; MDR=multi-drug resistant; MRSA=methicillin-resistant *Staphylococcus aureus*; NICU=neonatal intensive care unit; UK=United Kingdom; US=United States

Appendix 3: Summary of Critical Appraisal of Included Studies

Table A2: Summary of Critical Appraisal of Included Studies

First Author, Publication Year	Strengths	Limitations
Randomized controlled trial		
Camus, 2011[12]	• hypothesis clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided • losses to follow-up described • patients randomized • study had sufficient power to detect a clinically important effect	• patients not blinded • unable to determine if randomization assignment was concealed
Non randomized controlled trials		
Creamer, 2012[13]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided • losses to follow-up described	• unclear whether power calculation was performed to determine adequate sample size
Kjonegaard, 2012[15]	• hypothesis clearly described • interventions of interest clearly described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • method of selection from source population and representation not clearly described • unclear whether power calculation was performed to determine adequate sample size
Lawes, 2012[14]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• retrospective study • unclear whether power calculation was performed to determine adequate sample size
Miller, 2012[23]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size • main outcomes, interventions, patient characteristics, and main findings not clearly described

Chalfine, 2012[32]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size
Day, 2011[22]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• retrospective study • unable to determine if cases and controls were studied over the same period of time • unable to determine if compliance with intervention was reliable • unclear whether power calculation was performed to determine adequate sample size
Huang, 2011[16]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size
Ellingson, 2011[27]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size
Holzmann-Pazgal, 2011[28]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size

Simmons, 2011[29]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • estimates of random variability and actual probability values provided	• pre-post design • main outcomes, interventions, patient characteristics, and main findings not clearly described • unclear whether power calculation was performed to determine adequate sample size
Kurup, 2110[30]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size
Bowler, 2010[24]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size
Dow, 2010[26]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• retrospective study • unclear whether power calculation was performed to determine adequate sample size
Martinez-Capolino, 2010[21]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described	• unclear whether power calculation was performed to determine adequate sample size • main outcomes, interventions, patient characteristics, and main findings not clearly described • estimates of random variability and actual probability values not provided

Milstone, 2010[25]	• hypothesis clearly described • estimates of random variability and actual probability values provided	• retrospective study • unclear whether power calculation was performed to determine adequate sample size • interventions of interest not clearly described • method of selection from source population and representation not clearly described • main outcomes, interventions, patient characteristics, and main findings not clearly described
Rodríguez-Baño, 2010[17]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size
Wang, 2010[20]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• unclear whether power calculation was performed to determine adequate sample size
Pofahl, 2009[31]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • main outcomes, interventions, patient characteristics, and main findings clearly described • estimates of random variability and actual probability values provided	• pre-post design • unclear whether power calculation was performed to determine adequate sample size
Karas, 2009[19]	• hypothesis clearly described • interventions of interest clearly described • method of selection from source population and representation described • power calculation was performed to determine adequate sample size • estimates of random variability and actual probability values provided	• pre-post design • main outcomes, interventions, patient characteristics, and main findings not clearly described

Richer, 2009[18]	• hypothesis clearly described	• retrospective study • interventions of interest not clearly described • method of selection from source population and representation not clearly described • main outcomes, interventions, patient characteristics, and main findings not clearly described • unclear whether power calculation was performed to determine adequate sample size • estimates of random variability and actual probability values not provided

Appendix 4: Main Study Findings and Authors' Conclusions

Table A3: Main Study Findings and Authors' Conclusions

First Author, Publication Year	Main Study Findings	Authors' Conclusions
Research question 1 (effectiveness of screening)		
Randomized controlled trial		
Camus, 2011[12]	**Intervention group** (screening, contact precautions, isolation precautions, decontamination) MRSA acquisition rate: 13/243 patients (5.3%) MRSA infection rate: 1.6% ICU-acquired infection: 16.5% Duration of antimicrobial therapy, median days, range: 6 (3 – 9) Length of stay in ICU, median days, range: 7 (4 – 12) Mortality in ICU: 49 (19.8%) **Control group** (standard precautions) MRSA acquisition rate: 16/245 patients (6.5%) (p = 0.58) MRSA infection rate : 1.6% (p > 0.99) ICU-acquired infection rate : 16.5% (p = 0.98) Duration of antimicrobial therapy, median days, range: 5 (3 – 10) (p = 0.65) Length of stay in ICU, median days, range: 6 (4 – 12) (p = 0.42) Mortality in ICU: 52 (20.9%) (p = 0.76)	"*Individual allocation to MRSA screening, isolation precautions, and decontamination do not provide individual benefit in reducing MRSA acquisition, compared with standard precautions…*" (p. 1064)
Observational studies		
Creamer, 2012[13]	**Universal screening** (patients without risk factors): MRSA in 4/340 patients (1%) **Targeted screening** (patients with risk factors):MRSA in 44/552 patients (8%) Universal screening increased by 62% the number of screening samples with a proportionate increase in costs of screening.	""*screening patients without risk factors increased the number of screenings and costs but resulted in few additional cases being detected*" (p. 411)
Lawes, 2012[14]	**Targeted screening**: 2006 - 2008 **Universal screening**: 2008 – March 2011 MRSA bacteremia prevalence declined by 19% (p < 0.001) 30-day mortality declined by 46% (p < 0.001)	*"Compared with a strategy of targeted screening in high-risk environments, universal admission screening may significantly reduce rates of MRSA bacteraemia and associated early mortality alongside improvements in antibiotic stewardship and infection control"* (p. 1)
Kjonegaard, 2012[15]	**Before implementation** of active surveillance (**targeted screening** of patients with symptoms): rate of hospital-acquired MRSA infections: 0.8/1000 admissions **After implementation** of active surveillance (**universal screening** of all patients admitted to ICU): rate of hospital-acquired MRSA infections: 1.6/1000 admissions (p = 0.037) Comprehensive active surveillance (screened in the nares and the perineum) added 1.7% additional MRSA-positive screens, compared to state-mandated active surveillance	"*Results do not support mandates to conduct screening on all patients admitted to critical care units*" (p. 1) No added value in screening with perineal in addition to nares specimens

Table A3: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
	(screened in the nares only)	
Chalfine, 2012[32]	**After implementation** of active screening and decontamination of ICUs patients, hospital wide alcohol based hand rubs, control of specific classes of antibiotics, compliance audits, and feed backs to care providers MRSA colonization decreased by 84% from 1.09 to 0.17/1000 patient-days ($p < 10^{-7}$) MRSA bacteremia decreased by 93%, from 0.15 to 0.01/1000 patient-days ($p < 10^{-7}$)	*"In an area highly endemic for MRSA, a multifaceted prevention program allows for sustainable reduction in HA* (hospital-acquired) *– MRSA bacteremia rates"* (p. 1)
Huang, 2011[16]	**Before implementation** of infection control measures (reinforcement of hand hygiene, increase aseptic care at central venous catheters insertion sites, alcohol-based hand rubs, surveillance cultures, and decolonization) : 5.47 episodes per 1,000 patients **After implementation** of infection control measures: 0.45 episodes per 1,000 patients (92% reduction)	"*Through infection control measures, MRSA health care-associated infection can be successfully controlled, even in areas with high levels of endemic MRSA infections such as our NICU*" (p. 1)
Ellingson, 2011[27]	**After implementation** of infection control measures (strategies to promote adherence to infection control protocol, hand hygiene and environmental disinfection, and active surveillance testing): incidence of MRSA colonization or infection decreased by 61% ($p < 0.001$) in the 70year post intervention period Proportion of S. aureus isolates that were methicillin resistant decreased by 30% ($p < 0.001$)	"*Sustained decreases in hospital-wide clinical incidence of MRSA colonization or infection…followed implementation of a multifaceted prevention program…*" (p. 1)
Holzmann-Pazgal, 2011[28]	**After implementation** of active surveillance culture for MRSA: yearly incidence of MRSA acquisition decreased from 6.88/1,000 patient days to 2.40/1,000 patients days (p 0.001)	"*Active surveillance culturing resulted in significantly decreased nosocomial acquisition of MRSA in a pediatric intensive care setting*" (p. 171)
Simmons, 2011[29]	**After implementation** of ICU-only active surveillance program: ICU rate of MRSA acquisition reduced from 3.19/1,000 patient days to 1.66/1,000 patient days (p 0.005). Facility rate of MRSA acquisition reduced from 0.80/1,000 patient days to 0.38/1,000 patient days (p 0.0003)	"*Implementing an ICU-only active surveillance program is an effective method of controlling MRSA transmission on a hospital wide level*" (p. 18)
Kurup, 2110[30]	**After implementation** of active surveillance testing and decontamination strategies: no significant reduction in mean MRSA infection incidence rate in medical (1.4 to 1.7/1,000 patient days; p value not reported) or surgical ICU (3.8 to 3.0 per 1000 patient days; p 0.057)	"*The lack of reduction in MRSA infection rates in the ICUs does not negate the roles of AST (*active surveillance testing*) and DS (*decontamination strategies*), but does argue for better study design and outcome measures* (p. 361)
Rodriguez-Bano, 2010[17]	**Before intervention** MRSA colonization or infection rate: 0.56 cases per 1000 patient-days **Contact precautions, with no active surveillance** No change compared to pre intervention period **Targeted active surveillance for patients and health care workers in specific wards** MRSA colonization or infection rate: 0.28 cases per 1000 patient-days	"*The use of targeted active surveillance for MRSA in patients and health care workers in specific wards and the use of decolonization were key to success…*" (p. 786)

Table A3: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
	Targeted active surveillance for patients admitted from other medical centers MRSA colonization or infection rate: 0.07 cases per 1000 patient-days MRSA colonization incidence: decreased 83% from baseline MRSA infection decreased 80% from baseline	
Pofahl, 2009[31]	**After implementation** of active surveillance for MRSA and eradication of the carrier state: MRSA surgical-site infection decreased from 0.23% to 0.09% (p 0.04)	"*Surveillance for MRSA and eradication of the carrier state reduces the rate of MRSA SSI (*surgical-site infection) (p .981)
Richer, 2009[18]	**Before implementation** of pre-operative screening patients 0.8% (2/241) post-operative MRSA surgical-site infection **After implementation** of pre-operative screening patients 0% (0/179) post-operative MRSA surgical-site infection	"*Early results show the potential benefit of pre-operative S aureus screening in MRSA infection rate reduction*" (p. 29)
Karas, 2009[19]	**Regular random colonization surveillance and systemic decolonization (from year 2003 to 2008)** Colonization incidence: reduced from 14.6% to 7.0% (p < 0.001) Bacteremia incidence cases: reduced from 42 to 22 (p = 0.012)	"*Regular surveillance of MRSA carriage is useful*" (p. 327)
Research question 2 (effectiveness of isolation)		
Randomized controlled trial		
Camus, 2011[12]	**Without isolation** MRSA acquisition rate: 7.57‰ **With isolation** MRSA acquisition rate: 2.36‰ (p = 0.01)	"*Individual allocation to MRSA screening, isolation precautions, and decontamination do not provide individual benefit in reducing MRSA acquisition, compared with standard precautions, although the collective risk was lower during the periods of isolation*" (p. 1064)
Observational studies		
Wang, 2010[20]	**Active surveillance only (phase 1)** Incidence of MRSA infection: - Hospital A: 1.00 - Hospital B: 2.87 Incidence of MRSA transmission: - Hospital A: 9.60 - Hospital B: 13.92 **Active surveillance and early initiation of isolation (phase 2)** Incidence of MRSA infection: - Hospital A: 0.38 (p = 0.719) - Hospital B: 2.76 (p = 0.932) Incidence of MRSA transmission:	" *ASI alone could not reduce MRSA transmission in two ICUs in Taiwan, where the MRSA prevalence was high*" (p. 258)

Table A3: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
	- Hospital A: 9.98 (p = 0.940) - Hospital B: 13.52 (p = 0.810)	
Martnez-Capolino, 2010[21]	**Contact isolation while in ICU (tertiary care hospital 1)** New colonization incidence: 1.85 per 1000 patient-days Hospital-wide nosocomial MRSA infection: no change before and after intervention BSI from ICU: - before intervention: 0.21889 - after intervention: 0.12845 (p value not reported) - VAP from ICU: - before intervention: 0.95372 - after intervention: 0.17127 (p value not reported) MRSA from ICU: - before intervention: 0.06254 - after intervention: 0.04282 (p value not reported) **Contact isolation throughout hospital stay (community-based hospital 2)** New colonization incidence: 3.47 per 1000 patient-days Hospital-wide nosocomial MRSA infection: - before intervention: 0.62629 - after intervention: 0.31383 (p value not reported) BSI from ICU: - before intervention: 0.93342 - after intervention: 0.31247 (p value not reported) VAP from ICU: - before intervention: 0.46671 - after intervention: 0 (p value not reported) MRSA from ICU: - before intervention: 0.62629 - after intervention: 0.31383 (p value not reported)	"*in addition to standard infection prevention initiatives, ACS with contact precautions can be effective in reducing the incidence of VAP and nosocomial MRSA infection in healthcare communities with endemic MRSA*" (p. 233)
Research question 3 (impact of isolation)		
Observational studies		
Day, 2011[22]	**General hospital (contact precautions versus no contact precautions)** Depression OR 1.4 (95% CI: 1.2 – 1.6); p <0.01 Anxiety: OR 0.9 (95% CI: 0.7 – 1.1); p 0.35 **Intensive care Unit (contact precautions versus no contact precautions)** Depression: OR 0.9 (95% CI: 0.7 – 1.2); p 0.44 Anxiety: OR 0.7 (95% CI 0.4 – 1.1); p 0.10	"…contact precautions were associated with depression but not with anxiety in the non-ICU population" (p. 103) "No relationship was found between contact precautions and depression or anxiety in the ICU population" (p. 104)

Table A3: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
Research question 4 (effectiveness of decolonization)		
Observational studies		
Miller, 2012[23]	**Before decolonization therapy** 0.84 infections/month **After decolonization therapy** 0.03 infections/month (p = 0.0001)	"*The regimen appears promising at preventing recurrent community-associated MRSA infections*" (p. 1084)
Huang, 2011[16]	Surveillance culture **without decolonization** MRSA colonization rate: 41% Infection rate: 12% Surveillance culture **with decolonization** MRSA colonization rate: 8.6% (p < 0.001) Infection rate: 1.1% (p < 0.001)	"*compared to those obtained during the period of surveillance culture without decolonization, both rates of MRSA colonization and infection decreased significantly during the period of surveillance and decolonization*" (p. 1)
Bowler, 2010[24]	**Active surveillance cultures and decolonization therapy** - Nursing homes: MRSA carriage prevalence: decreased by 67% (p < 0.001) after more than 12 months. - Hospital: nosocomial MRSA infection (per 1000 patient-days): decreased from 0.64 infections before the interventions to 0.40 infections 1 year after interventions and to 0.32 infections 2 years after the interventions (p < 0.1)	"*Use of active surveillance cultures and decolonization therapy was effective in decreasing the prevalence of asymptomatic carriage, the incidence of nosocomial infections, and the overall prevalence of MRSA in our rural healthcare setting*" (p. 269)
Milstone, 2010[25]	**Decolonization with mupirocin** MRSA infection: 1/16 patients (6%) **Decolonization without mupirocin** MRSA infection: 3/38 patients (38%) (p = 0.09)	"*suggests that MRSA infection rates may be lowered by use of MRSA decolonization with intranasal mupirocin, with or without chlorhexidine baths*" (p. 1)
Dow, 2010[26]	**Interventions:** - **Hospital protocol** (topical mupirocin cream, oral trimethoprim/sulfamethoxazole and oral rifampin , all for 7 days) - **Other decolonization regimen** (for example topical mupirocin alone, or topical mupirocin plus oral cotrimazole) - **No decolonization therapy** Overall decolonization: (OR; 95% CI) - Hospital vs other treatment 3.3 (1.6 -7.1); p = 0.0004 - Hospital vs no treatment: 36.9 (11.2 – 161.7); P < 000001 MRSA infection rate (OR; 95% CI) - Hospital vs other treatment 0.38 (0.18 – 0.78); p = 0.003 - Hospital vs no treatment: 1.66 (0.53 – 6.24); P = 0.452 30-day mortality (OR; 95% CI)	"*MRSA decolonization can be successful using a multifactorial approach (chlorhexidine soap, enhanced hygiene/housekeeping and combination oral/topical antimicrobial therapy*" (p. 38)

Table A3: Main Study Findings and Authors' Conclusions		
First Author, Publication Year	**Main Study Findings**	**Authors' Conclusions**
	- Hospital vs other treatment 0.35 (0.06 – 1.45); p = 0.139 - Hospital vs no treatment: 0.24 (0.04 – 1.10); P = 0.042	
Research question 5 (effectiveness of additional precautions in the operating room or post-anesthesia recovery room)		
No studies identified for this research question		

ACS=active surveillance cultures; ASI=active surveillance and early initiation of contact isolation; BSI=blood stream infection; ICU=intensive care unit; MRSA=methicillin-resistant *Staphylococcus aureus*; NICU=neonatal intensive care unit; RR=relative risk; SAB=*Staphylococcus aureus* bacteremia; VAP=ventilator-associated pneumonia