CONTACT PRECAUTIONS FOR PATIENTS COLONIZED OR INFECTED WITH METHICLIIIN-RESISTANT \textit{STAPHYLOCOCCUS AUREUS} (MRSA) OR VANCOMYCIN-RESISTANT ENTEROCOCCUS (VRE)

Evidence-Based Practice Summary

\textbf{ASK THE QUESTION}

\textbf{Question 1:} How effective are contact precautions (e.g., gowning and gloving) in preventing infections in hospitalized patients colonized with MRSA or VRE?

\textbf{Question 2:} What adverse effects/outcomes are associated with contact precautions in hospitalized patients colonized or infected with MRSA or VRE?

\textbf{Question 3:} When should contact precautions be discontinued in hospitalized patients colonized or infected with MRSA or VRE?

\textbf{SEARCH STRATEGY}

Search strategies included research-based articles on contact precautions (e.g., gloving and gowning) for hospitalized adults and children colonized or infected with MRSA or VRE. Articles were restricted to publications in English.

Databases included PubMed, CINAHL, Ovid, Cochrane Collaboration, National Guideline Clearinghouse, University of Michigan Evidence-Based Medicine, and Google Scholar.

\textbf{CRITICALLY ANALYZE THE EVIDENCE}

\begin{tabular}{|l|l|l|}
\hline
\textbf{External Guideline/Pathway/Order Set} & \textbf{Organization and Author} & \textbf{Last Update} \\
\hline
Guideline for Preventing Nosocomial Transmission of Multidrug-Resistant Strains of \textit{Staphylococcus aureus} and \textit{Enterococcus} & Society for Healthcare Epidemiology of America & 2003 \\
Guidelines for the Control and Prevention of Methicillin-Resistant \textit{Staphylococcus aureus} (MRSA) in Healthcare Facilities & British Society of Antimicrobial Chemotherapy, the Hospital Infection Society, and the Infection Control Nurses Association & 2006 \\
The Best Hospital Practices for Controlling Methicillin-Resistant \textit{Staphylococcus Aureus}: On the Cutting Edge & The Society for Healthcare Epidemiology of America & 2002 \\
Management of Multidrug-Resistant Organisms in Healthcare Settings & Healthcare Infection Control Practices Advisory Committee, Centers for Disease Control and Prevention & 2006 \\
\hline
\end{tabular}
The four published clinical guidelines have been evaluated for this review using the AGREE II criteria. AGREE II includes evaluation of: Guideline Scope and Purpose, Stakeholder Involvement, Rigor of Development, Clarity and Presentation, Applicability, and Editorial Independence.

**Question 1: How effective are contact precautions (e.g., gowning and gloving) in preventing infections in patients colonized with MRSA or VRE?**

**Recommendation:** Patients colonized or infected with MRSA or VRE should be placed on contact precautions.

**Grade Criteria:** Strong Recommendation; Low Quality Evidence

The Society for Healthcare Epidemiology of America’s (SHEA) 2003 guideline for Preventing Nosocomial Transmission of Multidrug-Resistant Strains of Staphylococcus aureus and Enterococcus recommends that gloves always be worn on entering the room of a patient on contact precautions for colonization or infection with antibiotic-resistant pathogens such as MRSA or VRE, and that gowns always be worn as part of contact precautions for all patient and environmental contact with patients colonized with MRSA or VRE, except when there is no direct contact with the patient or environmental surfaces. SHEA’s 2002 guideline, The Best Hospital Practices for Controlling Methicillin-Resistant Staphylococcus Aureus: On the Cutting Edge, recommends placing all patients infected or colonized with MRSA on contact precautions, and that healthcare workers be required to wear gloves and gowns when entering the patient’s room. The British Society of Antimicrobial Chemotherapy, the Hospital Infection Society, and the Infection Control Nurses Association’s 2006 Guidelines for the Control and Prevention of Methicillin-Resistant Staphylococcus aureus (MRSA) in Healthcare Facilities, recommends that disposable aprons or gowns be worn by all staff handling the patient colonized or infected with MRSA, or having contact with their immediate environment; and that gloves be worn when there is contact with body fluids and handling of contaminated dressings or linens. The 2006 Centers for Disease Control and Prevention guideline on the Management of Multidrug-Resistant Organisms in Healthcare Settings, recommends that acute-care hospitals implement contact precautions routinely for all patients infected with multidrug-resistant organisms (MDRO), and for patients that have been previously identified as being colonized with target MDROs.

Eighteen observational studies and 2 systematic reviews addressing the question were found in the literature. Results from the systematic reviews were not pooled for analysis, and both concluded that major methodological weaknesses and inadequate reporting in researching the effectiveness of isolation measures makes it difficult to draw conclusions about the effectiveness of such measures (Cooper 2004, Halcomb 2008). Of the 18 observational studies found in the literature, 8 of them evaluated the effectiveness of an infection control bundle. Contact precautions were just one component of a larger program. Seven of these studies demonstrated a significant reduction in MRSA- or VRE-associated infections as a result of the infection control program, but it is difficult to draw conclusions about the role contact precautions had in this success (Ambrose 2011, Evans 2012, Eveillard 2000, Muder 2008, Monteavalvo 1999, Ostrowksy 2001, Trautmann 2007). One of the studies evaluating the effect of an infection control program on MRSA and VRE colonization, found no significant difference in MRSA or VRE colonization or infection between the intervention group and the control (Huskins 2011). Nine observational studies found, evaluated the impact of contact precautions on MRSA or VRE incidence. The comparison groups, however, were not consistent. Six of these studies found that using contact precautions reduced the incidence of MRSA- or VRE-associated infections (Beamann 2007, Donowitz 1986, Huang 2008, Mangini 2007, Puzniak 2002, Srinivasan 2002). Four of the studies evaluating the impact of contact precautions alone, found no significant difference in incidence of MRSA- or VRE-associated infections between the intervention group using contact precautions and the control (Pogorzelska 2012, Rodriguez-Bano 2010, Slaughter 1996, Spence 2012).

Despite the volume of literature, there is a lack of robust studies on the effectiveness of contact precautions for containing the spread of MRSA and VRE. An appropriate set of evidence-based control measures that can be universally applied has not been definitively established. This is due in part to differences in study methodology, and outcome measures, including an absence of randomized, controlled trials comparing one control measure to another.


A 3-month period of standard practice in which patients were placed in contact precautions per CDC guidelines, in the second 3 months (phase 2) gloves were required for all patients. (Betts 2014, Cooper 2004, Donowitz 1986, Evans 2012, Pogorzelska 2012, Puzniak 2002, Rodriguez 2010, Slaughter 1996, Spence 2012, Srinivasan 2002, Trautmann 2007)

Compliance with contact precautions in phase 1

- Rates of MRSA infections in ICUs declined with implementation of the bundle from 1.64 infections per 1000 patient days to 0.62 per 1000 patient days, a decrease of 62% (p<0.001)
- Rates of MRSA infections in non-ICUs fell from 0.47 per 1000 patient days to 0.26 per 1000 patient days, a decrease of 45% (p<0.001)

Compliance with contact precautions in phase 2

- Compliance with contact precautions in phase 1 vs. universal gloving in phase 2 was 75.7% vs. 87%, respectively (p<0.01)
- Hand hygiene compliance before patient care was higher in phase 1 compared with phase 2 (57.7% vs. 52.5% in phase 2) (p<0.011)
- Infection rates per 1000 device days in phase 1 vs. phase 2 were as follows: bloodstream infection, 6.2 vs. 14.1 (p<0.01); ventilator associated pneumonia, 0 vs. 2.3, (p<0.01)

Rates of MRSA infections in ICUs declined with implementation of the bundle from 1.64 infections per 1000 patient days to 0.62 per 1000 patient days, a decrease of 62% (p<0.001)
culture changes on healthcare associated MRSA infections.

Eveillard (2000): Before and after observational study in a 1837-bed teaching hospital in France to evaluate an infection control program that included hand washing, contact precautions and surveillance on the incidence of MRSA infections.

Halcomb (2008): Systematic review of 7 studies evaluating the efficacy of isolation practices in minimizing MRSA transmission in the acute hospital setting.

Huang (2006): Retrospective study of 4 infection control interventions using time series design to evaluate their impact on MRSA in an 800-bed hospital with 8 ICUs. One intervention included the use of routine nares surveillance cultures for MRSA in all ICU patients, followed by placing the patient on contact precautions for positive cultures.

Huskins (2011): Cluster randomized trial of 5434 admissions to 18 ICUs to evaluate the effect of surveillance for MRSA and VRE colonization and the expanded use of barrier precautions (including contact precautions) compared with existing practices (control) on the incidence of MRSA or VRE colonization or infection in adult ICUs.

Mangini (2007): Before and after observational study of 439-bed hospital to evaluate the efficacy of contact and droplet precautions on the incidence of MRSA. Measurements were taken at baseline, after the implementation of contact and droplet precautions, and after droplet precautions were discontinued.

Montecalvo (1999): Prospective cohort study of 443 patients in an adult oncology unit to determine whether advanced infection control strategies reduce transmission of VRE.

Muder (2008): Before and after observational study of 158-bed VA hospital to evaluate the efficacy of intervention that included use of standard precautions with emphasis on hand hygiene, use of contact precautions for interactions with patients known to be colonized or infected with MRSA, use of active surveillance cultures, and use of industrial-engineering systems approach on incidence of MRSA.

Ostrowsky (2001): Epidemiological study of an infection control intervention after VRE was detected in the Siouxland region of Iowa, Nebraska and South Dakota. Intervention included screening, use of contact precautions, isolation, hand washing and education.

Pogorzelska (2012): Survey of 180 hospitals in California to assess relationship between infection control policies and rates of MRSA or VRE infections.

Puzniak (2002): Observational study of all patients admitted to a 19-bed MICU from July 1997 – December 1999 to determine whether the use of a gown and gloves gives greater protection than glove use alone against VRE in a medical intensive care unit.

Rodriguez-Bano (2010): Quasi-experimental study in a 950-bed teaching hospital in Spain to evaluate an infection control intervention after VRE was detected in the acute hospital setting.

Donowitz 1986:

- Overall infection rate was 26 (13%) of 198 admissions during the gown-wearing periods vs. 23 (9%) of 256 admissions for the periods when the gowns were not worn (P<0.05).
- Of 78 patient contacts 54 (69%) were followed by no hand washing during gown-wearing periods and 59 (70%) of 84 contacts were followed by no hand washing during periods when gowns were worn.

Evans 2012:

- Monthly HAI rates declined 81% from 1.217 per 1000 patient-days to 0.237 per 1000 patient-days (p<0.001).
- Blood stream infections declined by 100% (p<0.002), skin and soft tissue infections by 60% (p<0.007) and urinary tract infections by 35% (p=0.07).

Eveillard 2000:

- During implementation of the program, incidence of MRSA infections decreased by 17.9%.

Halcomb 2008:

- Results not pooled for analysis.
- Some evidence to suggest that standard precautions alone is as effective as isolating MRSA patients in private rooms, wearing gowns/gloves/masks and enforcing hand washing.

Huang 2006:

- Routine surveillance and contact precautions resulted in reduction in MRSA infections.
- In 16 months, incidence density of MRSA decreased by 75% (ICU (p=0.007) and by 40% in non-ICU (p=0.008), leading to 67% hospital-wide reduction in incidence density of MRSA bacteremia (p=0.02).

Huskins 2011:

- In intervention ICUs when contact precautions were specified, gloves were used for a median of 82% of contacts, gowns for 77% of contacts and hand hygiene after 69% of contacts.
- The mean ICU-level incidence of events of colonization or infection per 1000 patient days, adjusted for baseline incidence, did not differ significantly between the intervention and control ICUs (40.4 +/- 3.3 and 35.6 +/- 3.7 in the 2 groups, respectively (p=0.35)).

Mangini 2007:

- After implementing contact and droplet precautions, MRSA in MICU and SICU decreased to 4.3 infections per 1000 patient days from 10 infections per 1000 patient days (95% CI: 0.17-0.97, p=0.03).
evaluate the long-term effects of successive interventions on rates of MRSA.

Slaughter (1996): Epidemiologic study and controlled, non-randomized trial of 181 consecutive patients admitted to the medical intensive care unit for 48 hr or more. All hospital employees used gloves alone when attending 8 beds on the unit, and gloves and gowns when attending the other 8.

Spence (2012): Prospective observational study in hospital; for 3 year period screened a select group of patients for MRSA and compared HAI rate for first 2 years (when contact precautions were employed) to last year (when use of contact precautions was discontinued)

Srinivasan (2002): Prospective observational in 16-bed intensive care unit (314 patients) to assess the effect of disposable cover gowns on preventing nosocomial transmission of VRE. VRE isolation precautions were changed from gowns and gloves to gloves alone.

Trautmann (2007): Observational study of an infection control program at a 900-bed tertiary care community hospital in Germany. Program to reduce MRSA transmission was implemented in 2003 and included: detailed written MRSA standard, signal-colored isolation gowns and storage carts facilitating the use of separate supplies for MRSA patients, intensified surveillance, and flagging of formerly positive MRSA pts.

<table>
<thead>
<tr>
<th>Study Source</th>
<th>Findings</th>
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<tbody>
<tr>
<td>Montecalvo 1999:</td>
<td>After discontinuation of droplet precautions, the combined rate in the MICU and SICU decreased further to 2.5 infections per 1000 patient days (p=0.43)</td>
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<td>Muder 2008:</td>
<td>During use of enhanced infection control strategies (which included use of gloves and gowns), incidence of VRE bloodstream infections decreased from 0.45 patients per 1000 patient days compared with 2.1 patients per 1000 days before infection control strategies were used (p=0.04), RR: 0.22, 95% CI: 0.05 – 0.92</td>
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<td>Ostrowsky 2001:</td>
<td>Overall prevalence of VRE at 30 facilities participating all three years of the study decreased from 2.2% in 1997 to 1.4% in 1998 to 0.5% in 1999 (p&lt;0.001)</td>
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<td>Pogorzelska 2012:</td>
<td>Vast majority of hospitals reported policies to implement contact precautions in patients positive with MRSA (93.3%) and VRE (65%)</td>
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<td>Puzniak 2002:</td>
<td>During the gown and glove period, 59 patients acquired VRE (9.1 cases per 1000 MICU-days), and 73 patients acquired VRE during the no-gown period (19.6 cases per 1000 MICU-days), (p&lt; 0.01)</td>
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<td>Rodriguez 2010:</td>
<td>Neither the preintervention rate of MRSA (0.56 cases per 1,000 patient days (95% CI: 0.49-0.62 cases per 1000 patient days)) nor the slope for the rate of MRSA colonization or infection changed significantly after implementing contact precautions with no active surveillance for MRSA</td>
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**Spence 2012:**
- There was 1 MRSA HAI identified in 2007 and 2 MRSA HAI noted in each of the following 2 years (2008 and 2009) while contact precautions were employed; there were 2 MRSA HAI in 2010, the year contact precautions were discontinued
- The rates of MRSA HAI in the first 3 years (2007-2009) were not significantly different from the MRSA HAI rate of 0.086 for 2010 (p<0.99)

**Srinivasan 2002:**
- VRE acquisition rate was 1.8 cases per 1000 days at risk in the gown and gloves period compared with 3.78 in the gloves only period (p=0.04)
- In proportional hazards model adjusted for LOS, gloves only precautions with a hazard ratio of 2.5 (p=0.02; 95% CI 1.2-5.3) were the only independent risk factor for VRE acquisition.

**Trautmann 2007:**
- MRSA transmission index fell from 2.1 (2002) to 0.8 (2006) (p<0.01)
- Rate of IV catheter-associated septicemia fell between 2002 and 2005-2006 (p<0.125)
- The rate of deep incisional and organ/space infections due to MRSA occurring after orthopedic surgery was lowered from 0.74 to 0.15% (p > 0.05)
Question 2: What adverse effects/outcomes are associated with contact precautions in patients colonized or infected with MRSA or VRE?

Recommendation: When patients are placed on contact precautions, efforts must be made by the healthcare team to counteract potential adverse effects. Contact precautions should be discontinued as soon as it is appropriate to do so.

Grade Criteria: Strong Recommendation; Moderate Quality Evidence

A number of studies have demonstrated negative, unintended consequences of contact precautions on patients. Two systematic reviews evaluating the impact of contact precautions, reported that the majority of studies included in the analyses showed precautions were associated with a number of adverse events. They had a negative impact on patient mental well-being and behavior, resulted in less patient-health care worker contact, and produced changes in systems of care that resulted in delays and more noninfectious adverse events (Abad 2010, Morgan 2009). Three prospective observational studies found that health care providers, including attending physicians, were less likely to enter the rooms of or examine patients on contact precautions (Kirkland 1999, Morgan 2013, Saint 2003). Other investigators have reported similar observations on surgical wards (Evans 2003). Four observational studies reported that patients on contact precautions had increased anxiety and/or depression scores (Day 2011, Gammon 1998, Kennedy 1997, Tarzi 2001). Other observational studies found that patients placed on contact precautions had significantly more preventable adverse events (Spence 2011, Stelfox 2003) expressed greater dissatisfaction with their treatment (Stelfox 2003), had less documented care than control patients who were not in isolation (Stelfox 2003), and experienced longer wait times for bed assignments (Shenoy 2012).

Recommendation(s): When patients are placed on contact precautions, efforts must be made by the health care team to counteract potential adverse effects. Contact precautions should be discontinued as soon as it is appropriate to do so. Strong Recommendation; Moderate Quality Evidence.
<table>
<thead>
<tr>
<th>Study</th>
<th>Sample</th>
<th>CI/RR</th>
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<td>Abad 2010:</td>
<td>Results not pooled for analysis</td>
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<td>Evans 2003:</td>
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<td>Gammon 1998:</td>
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<td>Isolated patients had less contact time overall (29 vs. 37 min/hr, p&lt;0.008)</td>
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<td>Gasnik 2008:</td>
<td>Mean self-esteem and sense of control scores were lower for subjects in the isolation group than in the non-isolation group (5.3 vs. 7.9, p&lt;0.001)</td>
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**Notes:**
- Results not pooled for analysis
- Majority of studies showed a negative impact on patient mental well-being and behavior, including higher scores for depression and anxiety and anger among isolated patients
- A few studies found that health care workers spent less time with patients in isolation
- Contact precautions were associated with depression (OR: 1.4, 95% CI 1.2-1.5) but not with anxiety (OR: 0.8, 95% CI 0.7-1.1) in the non-ICU population
- Depression was 40% more prevalent among general inpatients on contact precautions
- Isolated patients were visited fewer times than nonisolated patients (5.3 vs. 10.9 visits/hr, p<0.001)
- Isolated patients had less contact time overall (29 vs. 37 min/hr, p<0.008)
Kirkland (1999): Prospective observational study carried out over 7 months at Duke University Medical Center. Study consisted of 35 observation periods (14 involving patients in contact isolation and 21 involving patients not in contact isolation). The number of times health care workers entered the room, and whether or not the health care worker had direct contact with the patient were recorded.


Morgan (2013): Prospective cohort study of 7,743 healthcare worker visits in 4 acute care facilities in the US performing active surveillance for MRSA.

Saint (2003): Prospective cohort study on the inpatient medical services at 2 medical centers. Study authors observed senior medical residents and attendings during morning rounds, and recorded contact precaution status of patient and whether they were examined by physician.

Shenoy (2012): Descriptive study with survey design to evaluate patient access managers’ perceptions on the time to bed assignment for patients on contact precautions. 233 responses were received.

Spence (2011): Retrospective evaluation of incident reports filed on all patients admitted to acute care facility for 1 year. Study compared rate of adverse events between patients on contact precautions and those not on contact precautions.

Stelfox (2003): Prospective cohort study of 300 patients admitted to 2 large North American teaching hospitals. Matched controls were selected for each isolated patient, and the study compared quality of care measures between the 2 groups.

Tarzi (2001): Cross sectional matched-control study of 24 older adults undergoing rehabilitation. Standardized measures of depression, anxiety and anger were compared between MRSA positive adults and MRSA negative adults.

**Kaslik 2008:**
- In multivariate analysis, isolated patients were not less satisfied with inpatient care than were nonisolated patients (p>0.05)

**Kennedy 1997:**
- MRSA positive group was only significantly more angry than the control group (POMSA score 12.4 vs. 4.9 in MRSA positive and MRSA negative groups, respectively, p=0.037)
- On all other psychological measures (e.g., FIM, BDI, STAI, POMSV, POMSF, POMSC), there was no statistically significant difference between controls and MRSA positive group

**Kirkland 1999:**
- Health care workers entered the rooms of patients in contact isolation less frequently (3.9 vs. 7.9 per hour, p=0.06)
- Health care workers had less frequent direct contact with patients in contact isolation (2.1 vs. 4.2 per hour, p=0.03)

**Morgan 2009:**
- Results not pooled for analysis
- Four main adverse outcomes related to contact precautions were identified in the literature: less patient-health care worker contact, changes in systems of care that produce delays and more noninfectious adverse events, increased symptoms of depression and anxiety and decreased patient satisfaction with care

**Morgan 2012:**
- Patients on contact precautions had 36.4% few hourly healthcare worker visits than patients not on contact precautions (2.78 vs. 4.37 visits per hour, P<0.01)
- As well as 17.7% less direct patient contact with health care workers (13.98 vs. 16.98 minutes per hour, p=0.02)

**Saint 2003:**
- Residents examined 26 of 31 patients (84%) in contact isolation vs. 94 of 108 (87%) not in contact isolation (RR 0.96, 95% CI 0.81-1.14, p=0.58)
- Attendings examined 11 of 31 patients (35%) in contact isolation vs.79 of 108 (73%) not in contact isolation (RR 0.49, 95% CI 0.30-0.79, p<0.001)

**Shenoy 2012:**
- Among 233 respondents, 168 (72.1%) and 164 (70.4) reported additional time to bed assignment for patients with MRSA and VRE, respectively

**Spence 2011:**
- 45 adverse events were in the 712 patients in the precautions group, and 256 adverse events were in the remaining 8,060 patients not on contact precautions (X2=19.5, P<0.001)

**Stelfox 2003:**
**Question 3: When should contact precautions be discontinued in hospitalized patients colonized or infected with MRSA or VRE?**

**Recommendation:** Contact precautions should be discontinued when three or more surveillance cultures for the target MDRO are repeatedly negative.

**Grade Criteria:** Weak Recommendation; Low Quality Evidence

The necessary duration of contact precautions for patients treated for infection with an MDRO remains an unresolved issue. Although MRSA and VRE colonization clear spontaneously, no national guidelines

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**Isolated patients were twice as likely as control patients to experience adverse events during their hospitalization (31 vs. 15 adverse events per 1000 days, p<0.001)**

**Isolated patients were more likely to formally complain about their care than control patients (8% vs. 1%, p<0.001)**

**Isolated patients were more likely to have their vital signs not recorded (51% vs. 31%, p<0.001) and more likely to have days with no physician progress note (28% vs. 13%, p<0.001)**


**References:**

exist to inform when or how contact precautions may be discontinued.

Seven observational studies demonstrate that patients may remain colonized with MDROs for prolonged periods, and surveillance cultures may fail to detect their presence (Huckabee 2009, MacKinnon 2000, Marshall 2006, Robicsek 2009, Scanvic 2001, Vikram 2013, Vriens 2005) The 1995 HICPAC guideline for preventing the transmission of VRE suggest three negative stool/perianal cultures obtained at weekly intervals as a criterion for discontinuation of contact precautions. Two observational studies find these criteria generally reliable (Byers 2002, Huckabee 2009).

Despite the uncertainty about when to discontinue contact precautions, the studies offer some guidance The CDC’s 2006 guidelines on the Management of Multidrug-Resistant Organisms in Healthcare Setting, states that it seems reasonable to discontinue contact precautions when three or more surveillance cultures for the target MDRO are repeatedly negative over the course of a week or two in a patient who has not received antimicrobial therapy for several weeks, especially in the absence of a draining wound, profuse respiratory secretions, or evidence implicating the specific patient in ongoing transmission of the MDRO within the facility. The British Society of Antimicrobial Chemotherapy, the Hospital Infection Society, and the Infection Control Nurses Association Working Party states it is not aware of any high quality evidence to guide the decision for discontinuing contact precautions, but on the grounds of practicality, suggest using three screens performed one week apart, beginning at least 48 hours after antibiotic and antiseptic therapy has stopped.

### Recommendation(s):

Contact precautions should be discontinued when three or more surveillance cultures for the target MDRO are repeatedly negative. Weak Recommendation; Low Quality Evidence.

**Number of Studies:** Total # 8

**Case Reports** Publication Bias Evident

<table>
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<tr>
<th>Design Limitations</th>
<th>Summary of Consistency</th>
<th>Indirectness of Comparison</th>
<th>Imprecision of Results</th>
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<tbody>
<tr>
<td>Large losses to F/U</td>
<td>Outcomes varied (e.g., diminishing effect over time)</td>
<td>Different outcomes measured</td>
<td>Continuous outcomes</td>
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<tr>
<td>Incorrect analysis of ITT</td>
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<td>95% CI includes no effect and the upper or lower limit crosses the minimal important difference (MID), either for benefit or harm</td>
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<tr>
<td>Stopped early for benefit</td>
<td>Selective reporting of measured outcomes (e.g., no effect outcome)</td>
<td>Comparisons not applicable to question/outcome</td>
<td>Upper or lower limit crosses an effect size of 0.5 in either direction (if MID is not known or differences in outcomes require the calculation of an effect size)</td>
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</tbody>
</table>
| Sample CI/RR
Byers (2002): Retrospective cohort study of 116 patients colonized with VRE who had 423 cultures to determine the duration of colonization with VRE and adequacy of 3 consecutive negative cultures to determine clearance.

Huckabee (2009): Multicenter observational study analyzing surveillance cultures for VRE and MRSA to determine if 3 negative surveillance cultures collected at weekly intervals predicts clearance of VRE or MRSA from colonized patients.

MacKinnon (2000): Retrospective cohort study of 79 patients who initially acquired MRSA during hospital admission and were readmitted at least once during the study period (28 months total) to determine frequency of and risk factors for long-term carriage of MRSA.

Marschall (2006): Retrospective cohort study of 116 patients with first-time detected MRSA followed for a mean duration of 18.2 months. Objective of study was to examine duration of MRSA carriage.

Robicsek (2009): Cohort study of 1564 admissions of patients positive for MRSA who were retested for MRSA colonization to determine duration of colonization.

Scanvic (2001): Prospective 10-month study of 78 patients with MRSA who were readmitted to hospital.

Vikram (2013): Prospective observational study of 102 patients placed on contact precautions for MRSA to determine if surveillance cultures on readmission can identify patients with a history of MRSA carriage who are no longer colonized.

Vriens (2005): Cohort study of 135 patients in Netherlands colonized with MRSA to determine how long patients remained colonized after discharge and which risk factors were important.

### Byers 2002:
- First follow-up culture collected a mean of 125 days after initial positive isolate, was negative in 64%
- After 1 negative follow-up culture, the next one was negative in 92% of patients
- After 2 negative cultures, 95% remained negative
- After 3 sequential negative cultures, 35 of 37 patients (95%) remained culture-negative

### Huckabee 2009:
- 72% of VRE colonized patients and 94% of MRSA colonized patients were culture negative after 3 consecutive negative cultures

### MacKinnon 2000:
- Of 52 patients who were rescreened during their readmissions, 33 (63%) had positive MRSA screens on at least one rescreening and 19 (37%) had all negative screens
- Presence of skin lesions significantly increased the risk of prolonged MRSA carriage (p=0.032)

### Marschall 2006:
- 68 patients (58.6%) cleared colonization with a median time to clearance of 7.4 months
- Independent determinants for shorter carriage duration were the absence of an modifiable risk factor (receipt of antibiotic, use of indwelling device, or presence of skin lesion) (HR 0.20, 95% CI: 0.09-0.42)
- Absence of immunosuppressive therapy (HR 0.49, 95% CI: 0.23-1.02)
- Absence of hemodialysis (HR 0.08, 95% CI: 0.01-0.66)

### Robicsek 2009:
- During the first year after the positive culture was obtained, 48.8% of patients (95% CI 45.8-51.7%) remained colonized
- At 4 years, 21.2% of patients (95% CI:13.1-31.4%) remained colonized

### Scanvic 2001:
- 31 patients (40%) were persistent carriers of MRSA, with an estimated mean time of 8.5 months to MRSA clearance
- Only factor associated with consistent carriage was presence of break in the skin at readmission (odds ratio: 3.65, p=0.004)

### Vikram 2013:
- 102 patients were readmitted with no positive results for MRSA during the previous 6 months; 98 patients remained colonized with MRSA (95%)
- 41 (42%) of the 98 patients had negative results for culture
- 21 (21%) had 3 sets of surveillance cultures with negative results and were removed from contact precautions
- Of 21 patients removed from contact precautions, 16 had no subsequent positive results for MRSA
- 5 of the 21 patients who were removed from contact precautions had a subsequent positive result for MRSA within 5 years
<table>
<thead>
<tr>
<th>Vriens 2005:</th>
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<tbody>
<tr>
<td>- 18% of patients were dismissed from follow-up 1 year after discharge (to be dismissed patient had to have 3 sets of negative swabs within 1 hr interval at 6 months post-discharge)</td>
</tr>
<tr>
<td>- Only 5 patients were dismissed after 6 months</td>
</tr>
<tr>
<td>- Among patients with no risk factors (e.g., infections of the skin, tracheostomy, CF, drain, catheter or tube), eradication treatment was effective for 95% within 1 year</td>
</tr>
<tr>
<td>- Among patients with risk factors, treatment was effective for 89% within 2 years</td>
</tr>
</tbody>
</table>

References: