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Continuous Medical Education Forum (CME from EB)

Continuous medical education activities; Answers to Case No. 5: Infection control for MRSA transmission

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Abstract

Methicillin-resistant *Staphylococcus aureus* (MRSA) is still recognized as one of the most important nosocomial pathogens. These isolates are usually resistant to all currently available β-lactam antibiotics (penicillins, cephalosporins and carbapenems). Vancomycin has historically been the drug of choice and sometimes the last resort for the treatment of serious MRSA infections, providing empirical coverage and definitive therapy. However, its increased use has now become questionable. Moreover, its increased use has already led to emergence of vancomycin-intermediate *S. aureus* (VISA) as well as vancomycin-resistant *S. aureus* (VRSA) in certain parts of the world.

In the early 1990s, MRSA was reported to account for 20 – 25 % of *S. aureus* isolates in hospitalized, worldwide. By the middle of the current decade, many hospitals experienced MRSA percentages in the range of 50-70% of total *S. aureus* isolates from clinical cultures. Recent studies have found that an increasing proportion of hospital-onset invasive MRSA infections are caused by community strains. The clinical scenario has been more dramatic by MRSA colonization which increases the risk of infection, and infecting strains match colonizing strains in as many as 50–80% of cases. Methicillin-resistant *Staphylococcus aureus* may persist within the hospital environment for a long time, complicating attempts of eradication. Besides, colonization is not static, as strains have been found to evolve and even to be replaced within the same host. Poor infection control measures as well as continues and indiscriminate use of antibiotics have resulted in this huge problem of acquisition and dissemination of MRSA.

Methicillin-resistant *Staphylococcus aureus* (MRSA) is still recognized as one of the most important nosocomial pathogens. These isolates are usually resistant to all currently available β-lactam antibiotics (penicillins, cephalosporins and carbapenems). Methicillin resistance is mediated by mecA and acquired by horizontal transfer of a mobile genetic element designated staphylococcal cassette chromosome mec (SCCmec). The gene mecA encodes penicillin-binding protein 2a (PBP2a), an enzyme responsible for crosslinking the peptidoglycans in the bacterial cell wall. Penicillin-binding protein 2a has a low affinity for β-lactams, resulting in resistance to this entire class of antibiotics [1].

Vancomycin has historically been the drug of choice and sometimes the last resort for the treatment of serious MRSA infections, providing empirical coverage and definitive therapy. However, its increased use has now become questionable. Moreover, its increased use has already led to

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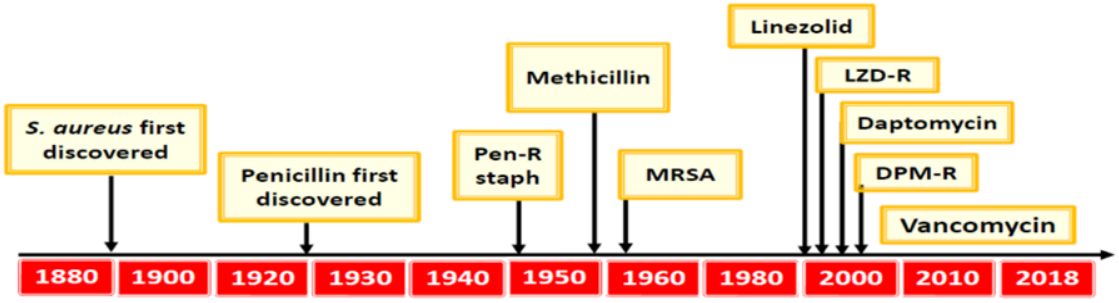
emergence of vancomycin-intermediate *S. aureus* (VISA) as well as vancomycin-resistant *S. aureus* (VRSA) in certain parts of the world [2]. The sequence of MRSA resistance to different antibiotics classes and subclasses are presented in **figure (1)**.

Figure 1. MRSA timeline.



In the early 1990s, MRSA was reported to account for 20–25 % of *S. aureus* isolates in hospitalized, worldwide. By the middle of the current decade, many hospitals experienced MRSA percentages in the range of 50-70% of total *S. aureus* isolates from clinical cultures.

Recent studies have found that an increasing proportion of hospital-onset invasive MRSA infections are caused by community strains. In most community acquired MRSA (CA-MRSA) strains, methicillin resistance is encoded in a novel genetic element, staphylococcal cassette chromosome *mec* type IV. Many of these strains have been resistant only to B-lactams and macrolides (eg. erythromycin) and retain susceptibility to many non-β-lactam antimicrobial agents such as lincomycins (eg. clindamycin), fluoroquinolones, rifampin, trimethoprim-sulfamethoxazole, aminoglycosides and tetracyclines [3]. The main differences between HA-MRSA and CA-MRSA are listed in **table (1)**.

Table 1. Characteristics of HA-MRSA and CA-MRSA.

Character	HA-MRSA	CA-MRSA
Risk population	Healthcare facility residents, diabetics, hospitalized patients, ICU patients	Children, prisoners, homeless, homosexual males, soldiers, intravenous drug users, general population
SCCmec subtype	I, II, III	IV, V
Types of infection	Nosocomial infections: Surgical site infection Catheter-associated urinary tract infection Bacteremia Ventilator-associated pneumonia	Skin and soft tissue infection Post influenza necrotizing pneumonia Osteomyelitis
Antimicrobial resistance	Multi-drug resistance	B-lactams and erythromycin
Panton-Valentine leucocidin (PVL)	Rare (5%)	Present in >95% of cases
Discovery	1961	1980s

To answer adequately the questions which have been raised in the Continuous medical education activities, Case No. 5 [4], these data would be useful:

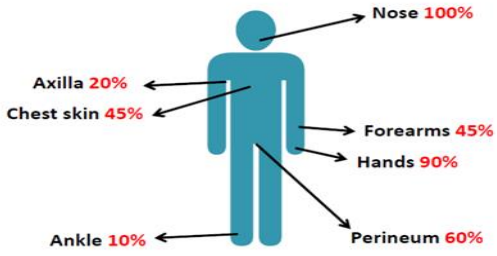
Factors related to the increase in MRSA infection rate:

Risk factors for MRSA colonization and transmission include severe underlying illness or comorbid conditions, prolonged hospital stay, exposure to broad-spectrum antimicrobials, presence of invasive devices (such as central venous catheters), and frequent contact with the health care system or healthcare personnel. Colonization pressure (the ratio of MRSA carrier–days to total patient-days) has been identified as an independent risk factor for hospital-associated acquisition of MRSA [1].

Impact of MRSA colonization

The clinical scenario has been more dramatic by MRSA colonization which increases the risk of infection, and infecting strains match colonizing strains in as many as 50–80% of cases. The anatomical sites of MRSA colonization among patients and healthcare workers are presented in **figure (2)**. Nearly any item in contact with skin can serve as a fomite in MRSA transmission, from white coats and ties to pens and mobile telephones. Colonization can persist for long periods of time. Methicillin-resistant *Staphylococcus aureus* may also persist within the hospital environment, complicating attempts at eradication. At the same time, colonization is not static, as strains have been found to evolve and even to be replaced within the same host [1-3].

Figure 2. Sites of MRSA colonization among patients and healthcare workers.



Guidelines for the control and prevention of MRSA in healthcare facilities

Guidelines for the control of MRSA infections in hospitals have been published previously [5-7]. Briefly, recommended strategies are categorized as either (1): basic practices that should be adopted by all acute care hospitals or (2): special approaches that can be considered for use in locations and/or populations within hospitals when hospital-associated infections (HAIs) are not controlled by use of basic practices**.**

Basic strategies:

1-Conduct an MRSA risk assessment

a. The risk assessment should be attentive to 2 important factors: the opportunity for MRSA transmission and estimates of the facility-specific MRSA burden and rates of transmission and infection.

i. The opportunity for transmission is affected by the proportion of patients who are MRSA carriers and produce a risk for transmission. Estimates of facility specific MRSA transmission and infection measure the ability of the facility's current activities to contain MRSA, regardless of the burden of MRSA that is imported into the facility.

ii. Both of these factors can be assessed either at the total hospital level or for specific hospital units.

b. Findings from the risk assessment should be used to develop the hospital's surveillance, prevention, and control plan and to develop goals to reduce MRSA acquisition and transmission.

2- Implement an MRSA monitoring program.

a. The MRSA monitoring program should have 2 goals:

i. Identify any patient with a current or prior history of MRSA to ensure application of infection prevention strategies for these patients according to hospital policy (e.g., contact precautions).

ii. Provide a mechanism for tracking hospital-onset cases of MRSA for purposes of assessing transmission and infection and the need for response.

3-Promote compliance with CDC or World Health Organization hand hygiene recommendations (Patient-to-patient transmission of MRSA commonly occurs through transient colonization of the hands of HCP).

4- Use contact precautions for MRSA-colonized and MRSA-infected patients.
5- Ensure cleaning and disinfection of equipment and the environment.
   a. Methicillin-resistant *Staphylococcus aureus* contaminates the patient's environment (e.g., overbed tables, bedrails, furniture, sinks, and floors) and patient care equipment (eg, stethoscopes, blood pressure cuffs, etc). Methicillin-resistant *Staphylococcus aureus* contamination on surfaces around the patient zone varies in bioburden concentration.
   b. Exposure to this contaminated environment has been associated with acquisition of MRSA.
   c. Cleaning and disinfection are parts of the bundle of practices to prevent transmission. Objective monitoring has value to optimize effective environmental cleaning practices and techniques in healthcare settings.
6- Educate HCP about MRSA.
7- Implement a laboratory-based alert system that notifies HCP of new MRSA-colonized or MRSA-infected patients in a timely manner.
   a. Timely notification of new MRSA-positive test results to clinical caregivers and/or infection preventionists facilitates rapid implementation of contact precautions and other interventions as appropriate per facility policy, assessment of risk, and timely surveillance for HAIs.
8- Implement an alert system that identifies readmitted or transferred MRSA-colonized or MRSA-infected patients.
   a. An alert system allows information regarding the MRSA status of the patient to be available at the first point of contact (e.g., emergency department arrival, presentation to admitting department), prior to bed assignment, to promptly initiate appropriate control measures and minimize opportunities for transmission.

Special approaches

Special approaches are recommended for use in locations and/or populations within the hospital that have unacceptably high MRSA rates despite implementation of the basic MRSA transmission and infection prevention strategies listed above. There are several controversial issues regarding prevention of MRSA transmission and infection. As a result, implementation of the recommendations beyond the basic practices should be individualized at each healthcare facility.

1-Active surveillance testing (AST)

Implement MRSA AST program as part of a multifaceted strategy to control and prevent MRSA (quality of evidence: II). An AST is based on the premise that clinical cultures identify only a small proportion of hospital patients who are colonized with MRSA and that these asymptomatic carriers serve as a substantial reservoir for person-to-person transmission of MRSA in the acute care hospital.

   i. Studies have reported that clinical cultures alone may underestimate the overall hospital prevalence of MRSA by as much as 85% and the monthly average prevalence of MRSA in ICUs by 18.6%–63.5%.
   ii. Active surveillance testing is used to identify these asymptomatic MRSA carriers so that additional infection control measures (e.g., contact precautions, decolonization) can be put into place to decrease the risk of transmission to other patients and HCP.

Active surveillance testing, however, may be beneficial in hospitals that have implemented and optimized adherence to basic MRSA prevention practices but that continue to experience unacceptably high rates of MRSA transmission or infection.

2-Screen HCP for MRSA infection or colonization if they are epidemiologically linked to a cluster of MRSA infections.

   a. HCP can become transiently or persistently colonized with MRSA, and this has been determined to be the source of several hospital outbreaks.
   b. Routine screening of HCP for MRSA is not currently recommended in the endemic setting.
   c. Screening of HCP can be an important component of an outbreak investigation if HCP have been epidemiologically linked to a cluster of new MRSA cases or if there is continued evidence of transmission despite comprehensive implementation of basic MRSA control measures.

MRSA decolonization therapy

Methicillin-resistant *Staphylococcus aureus* decolonization therapy can be defined as the

administration of topical antimicrobial or antiseptic agents, with or without systemic antimicrobial therapy, for the purpose of eradicating or suppressing the carrier state. Methicillin-resistant *Staphylococcus aureus* decolonization can be targeted to MRSA colonized persons or applied universally to populations deemed to be at high risk for infection.

Methicillin-resistant *Staphylococcus aureus* decolonization regimen should include:

- Nasal decolonization with intranasal topical Mupirocin (BID for 5 days).
- Skin antisepsis (i.e., chlorhexidine baths*) concurrently with the decolonization regimen).
- Oral antimicrobials (usually rifampin and trimethoprim- sulfamethoxazole or rifampin and doxycycline or rifampin and minocycline) under the direction of a physician

Targeted decolonization therapy has also been used in certain patient populations in an attempt to reduce the risk of subsequent S. aureus infection among colonized persons.

These populations have included dialysis patients, patients with recurrent *S. aureus* infections, and patients undergoing certain surgical procedures.

Provide universal decolonization to ICU patients.

Recent studies have demonstrated that universal decolonization of adult ICU patients may reduce the burden and transmission of MRSA. In contrast to targeted decolonization of MRSA carriers, this practice focuses on high-risk patient populations through horizontal rather than vertical pathogen directed strategies and does not rely on AST to identify carriers.

Use of gowns and gloves for all contact with patients and the patient care environment.

The following basic MRSA outcome measures for all acute care hospitals:

1. MRSA-specific line lists (e.g., electronic databases) for tracking patients who have MRSA.
2. Annual antibiograms for monitoring antimicrobial susceptibility patterns (e.g., rates of methicillin resistance) among isolates recovered from patients
3. Estimates of the MRSA infection burden that use objective, laboratory-based metrics, such as the incidence (or incidence density) of hospital-onset MRSA bacteremia.
4. Proxy measures of healthcare-acquisition of MRSA, such as incidence (or incidence density) of hospital onset MRSA based on clinical culture data. Supplemental/advanced outcome measures that acute care hospitals can consider utilizing include additional measures of the burden of healthcare-associated infection (e.g., incidence or incidence density of hospital-associated MRSA infections), estimates of burden of MRSA exposure within the facility (e.g., rates of overall and admission MRSA prevalence, point prevalence), and the burden of hospital-associated acquisition of MRSA (e.g., incidence of hospital-onset MRSA based on clinical culture data and AST data). In calculating these outcome measures, guidelines recommend careful consideration of how duplicate isolates from the same patient during the selected surveillance period will be handled. Of note, duplicate isolates may be handled differently depending on the metric being calculated. For example, when creating antibiograms, the Clinical and Laboratory Standards Institute guidelines recommend that "only the first isolate recovered from a patient during a surveillance period should be included," whereas current definitions for a laboratory-identified event and clinical infection surveillance address duplicates somewhat differently. More specific details regarding these metrics (e.g., definitions, methods of calculation) are available in the original SHEA/HICPAC position paper. In addition to calculating outcome measures locally, hospitals that report MRSA data to the CDC's NHSN Multidrug Resistant Organism and *C. difficile* Infection (MDRO/CDI) Module have the option of having a number of outcome measures calculated automatically using the NHSN system. The metrics included in this NHSN module are similar to some of those described in the SHEA/HICPAC position paper. Relative to MRSA, certain outcome measures are available to hospitals that submit only bloodstream isolate data (e.g.,

hospital-onset MRSA BSI incidence), while additional outcome data are available to those who submit information regarding MRSA isolates from other clinical specimens or from AST.

MRSA monitoring program

1. A common detection strategy used by IPC programs to identify and track patients from whom MRSA has been isolated from any clinical or AST specimen includes a daily review of laboratory results to identify patients from whom MRSA has been isolated.
2. A common method of tracking MRSA is a line list.
   a. The line list includes each patient's first (and often subsequent) MRSA isolate, regardless of body site, and includes isolates identified by clinical cultures and AST, when available.
   b. Initial isolates as well as subsequent clinical infections should be classified as either hospital or community onset using prespecified definitions.
   c. In addition, patients known to be MRSA colonized or infected on the basis of testing performed at another healthcare facility should be included in the line list.
   d. Additional information commonly contained in the line list includes date of collection of specimens from which MRSA was isolated, site from which specimen was obtained, and hospital location at time of collection.
   e. Ideally, the line list is an electronic database that is integrated into relevant hospital data systems (e.g., the ADT [admission, discharge, transfer] data).

Contact precautions

1. Place patients in a single or private room when available.
2. Cohorting of MRSA patients is acceptable when a single or private room is not available. a. Cohorting does not eliminate the need for compliance with hand hygiene and other infection prevention measures between patient contacts.
3. Don gown and gloves on entry into the patient's room and remove gown and gloves before exiting the room.
4. HCP should have a thorough understanding of the benefits, and potential adverse effects associated with the use of contact precautions.

- Patients placed under contact precautions should continue to receive the same level and quality of care as those who are not under contact precautions.

5. Dedicate noncritical patient care items, such as blood pressure cuffs, stethoscopes, and so on, to a single patient when they are known to be colonized or infected with MRSA. When equipment must be shared among patients, clean and disinfect the equipment between patients.
6. Establish institutional criteria for discontinuation of contact precautions. A single negative surveillance test may not adequately detect persistence of MRSA colonization.

   A reasonable approach to subsequent discontinuation would be to document clearance of the organism with 3 or more surveillance tests in the absence of antimicrobial exposure. When to consider retesting MRSA patients to document clearance is debatable, but waiting at least a few months (e.g., 4–6 months) since the last positive test is often advised. Some hospitals may choose to consider MRSA-colonized patients to be colonized indefinitely.

Criteria for AST among patients:

1) Select the patient population that will be included in the screening program (e.g., all patients or only high-risk patients or patients in high-risk units).
2) Develop a reliable system to identify patients who meet the criteria for screening.
3) Determine how screening specimens will be ordered (e.g., standardized nursing protocol, admission order set, or individual patient order), who will initiate the order (e.g., physician or nurse), and who will obtain the specimens (e.g., unit-based nursing personnel, designated MRSA monitoring program personnel, or patient).
4) Determine when screening will be performed.
5) Determine the anatomic sites that will be sampled.
6) Select the laboratory method that will be used to detect MRSA.

7) Determine how to manage patients while awaiting the results of screening tests.
8) Assess the availability of single rooms and develop a plan and protocol for situations in which the number of single rooms is insufficient. When there is not a sufficient number of single rooms, the following options may be considered:
   a. Prioritize patients with MRSA who are at greater risk for transmission (e.g., those with draining wounds) for a single room.
   b. Cohort MRSA-colonized or MRSA-infected persons (i.e., group multiple MRSA-positive patients in the same room). Ideally, MRSA patients who are colonized or coinfected with other MDROs should not be cohorted with other MRSA patients unless those patients are also colonized or coinfected with the same organism(s).
   c. When neither placement in a single room nor cohorting with another patient with MRSA is possible, options include keeping the patient with the existing roommate or identifying a low-risk patient with whom the MRSA-positive patient can share a room and keeping the patients physically separated (e.g., keep privacy curtains drawn).

Decolonization therapy

1- Select the population(s) to be included in the decolonization therapy protocol and determine which decolonization strategy will be used.
   a. Targeted decolonization of MRSA-positive patients who have been identified through AST or clinical cultures using intranasal mupirocin with or without daily bathing with chlorhexidine.
   b. Universal decolonization of all patients in high-risk units as identified in the MRSA risk assessment using daily bathing with chlorhexidine with or without intranasal application of mupirocin.
2- Consider developing standardized or protocol-based order sets to optimize compliance.
3- Standardize care processes. Determine the method of chlorhexidine application. A variety of chlorhexidine products that could be used for patient bathing are available. These include single-use bottles of aqueous chlorhexidine that can be added to a basin of water or applied in the shower and 2% no-rinse chlorhexidine-impregnated cloths. It should be noted that the use of undiluted no-rinse 4% aqueous chlorhexidine solution for skin cleansing has been associated with a relatively high rate of reversible adverse skin effects (e.g., skin fissures, itching, and burning of the skin). In contrast, lower skin**.**

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