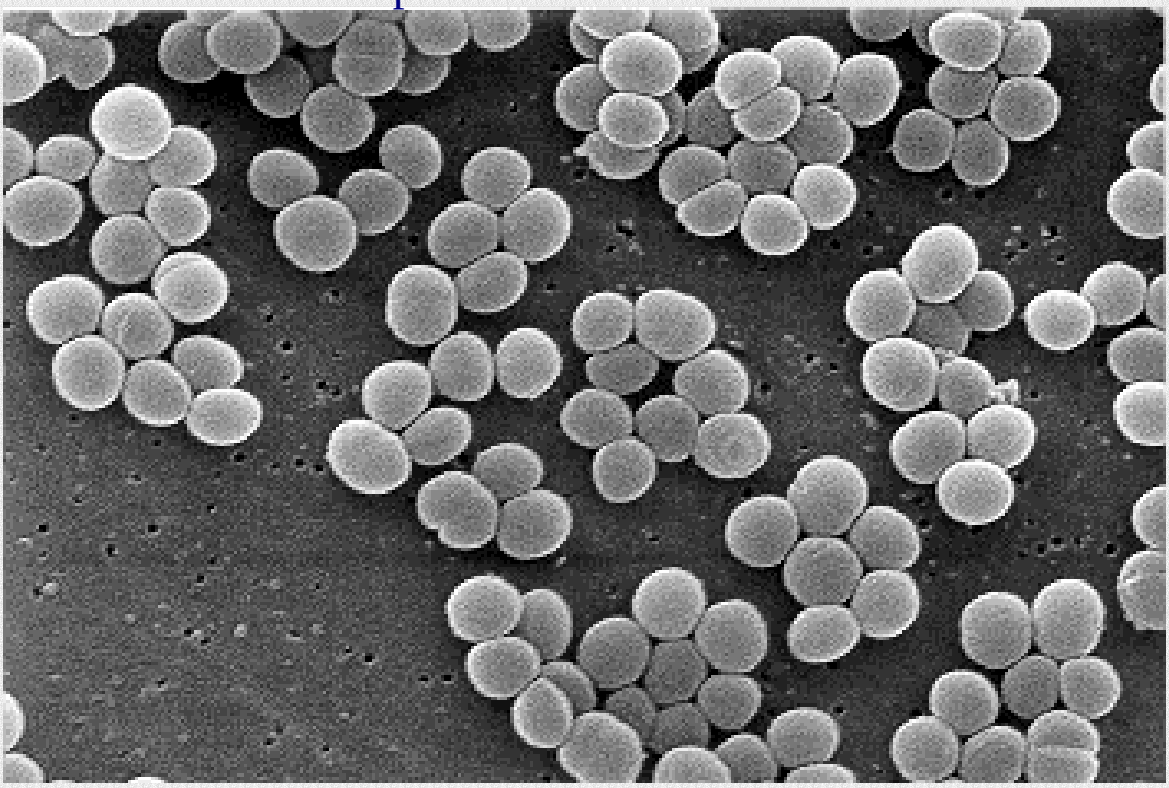
Investigation and Control of Vancomycin-Intermediate and -Resistant *Staphylococcus aureus* (VISA/VRSA)

A Guide for Health Departments and Infection Control Personnel



Vancomycin-Intermediate *S. aureus* magnified 10000x by scanning electron microscopy

Division of Healthcare Quality Promotion
National Center for Infectious Diseases
Centers for Disease Control and Prevention
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Prepared by:
Jeffrey C. Hageman, M.H.S.
L. Clifford McDonald, M.D.
Daniel B. Jernigan, M.D., M.P.H.
Jean Patel, Ph.D
Roberta Carey, Ph.D.
Fred C. Tenover, Ph.D.

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Division of Healthcare Quality Promotion's homepage....www.cdc.gov/ncidod/hip
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MASTER-laboratory training.....www.phppo.cdc.gov/dls/master/default.asp

Reporting and Confirmatory Testing
To report or request testing of suspected VISA/VRSA, send an email to SEARCH@cdc.gov with your contact information (i.e., name, facility or laboratory name, telephone number).

Overview

This document provides guidance in conducting a public health evaluation for patients from whom vancomycin-intermediate *S. aureus* (VISA; minimum inhibitory concentration [MIC] = 8 or 16 µg/ml) and vancomycin-resistant *S. aureus* (VRSA, vancomycin MIC ≥32 µg/ml) has been isolated or is suspected. The information reflects the experience gained from several field investigations and consultations for addressing issues pertaining to VISA/VRSA and other isolates with reduced susceptibility to vancomycin (minimum inhibitory concentration [MIC] ≥4 µg/ml).

Staphylococcus aureus is an important cause of healthcare-associated infections. The diseases associated with this organism range from mild skin and soft-tissue infections to potentially fatal systemic illnesses such as endocarditis and toxic-shock syndrome. *S. aureus* is a common pathogen that affects individuals across the age spectrum.

At the time of the introduction of penicillin in the early 1940's, *S. aureus* was uniformly susceptible to this drug. However, during the 1950's widespread resistance to penicillin developed, followed in the 1970's by increasing resistance to the new semisynthetic penicillinase-resistant antimicrobials (i.e., methicillin, oxacillin, nafcillin). By the 1980's, resistance to semisynthetic penicillin had spread throughout the world, compromising the use of these drugs for empiric therapy for staphylococcal infections. This has led to increased reliance on vancomycin for treatment of documented methicillin-resistant *S. aureus* (MRSA) infections, as well as for empiric therapy of infections in populations where the prevalence of MRSA is high.

Reports in the 1990's indicated that the susceptibility of *S. aureus* to vancomycin was changing. In May 1996, the first documented infection with VISA was reported in a patient in Japan[1]. Subsequently, infections with VISA strains have been reported in patients from the United States, Europe, and Asia. Although healthcare-associated spread of VISA strains has not been observed in U.S. hospitals, one report from France suggests that spread has occurred in a hospital[2], and spread of heteroresistant *S. aureus* strains has occurred in Japan and Hong Kong[3]. In 2002, the first two VRSA infections were reported in patients from the United States[4,5]. Both VRSA isolates contained the vancomycin resistance gene, *vanA*, commonly found in vancomycin-resistant enterococci.

Vancomycin is ineffective for treatment of VRSA infections. In addition, data reported to CDC indicate that infections due to *S. aureus* strains for which the vancomycin MICs are 8 µg/ml are also refractory to vancomycin therapy[18]. Even patients with infections due to *S. aureus* for which the vancomycin MICs are 4 µg/ml may fail to improve clinically on vancomycin therapy, particularly when the patients have indwelling catheters.

Definitions

CDC definitions for classifying isolates of *S. aureus* with reduced susceptibility to vancomycin are based on the laboratory breakpoints published by NCCLS[6].

Vancomycin-susceptible *S. aureus* (VSSA)

- Vancomycin MICs ≤ 4 µg/ml

Vancomycin-intermediate *S. aureus* (VISA)

- Vancomycin MICs =8-16 µg/ml.

Vancomycin-resistant *S. aureus* (VRSA)

- Vancomycin MICs ≥32 µg/ml.

The acronyms AVRSA,@ AVISA,@ and AGISA@ (glycopeptide-intermediate *S. aureus*) have all been used to describe *S. aureus* strains with reduced susceptibility to vancomycin. The differences in terms reflect differences in definitions and the current state of uncertainty about the significance of such strains among microbiologists, infection control practitioners, and infectious disease specialists. The term VRSA has been used in the literature by Japanese and European investigators to denote strains of *S. aureus* with vancomycin MICs of 8 µg/ml that have been associated with apparent treatment failures. In the U.S., the term VRSA is reserved for *S. aureus* strains for which vancomycin MICs ≥32µg/ml. The acronyms VISA and GISA come from interpretive criteria published by the NCCLS. While the term GISA may be more specific for strains intermediate to both vancomycin and teicoplanin, not all VISA strains are intermediate to the glycopeptide teicoplanin; therefore, VISA is the more accurate term. *S. aureus* isolates for which the vancomycin MICs are ≥4 µg/ml should be **saved** and confirmed by a public health laboratory and/or CDC.

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Laboratory Surveillance and Diagnosis Issues

Testing Difficulties

Detecting emerging antimicrobial resistance in bacterial isolates is an increasing problem in clinical microbiology laboratories. In the following section, we describe some steps laboratories may take to improve their ability to detect emerging vancomycin resistance in *S. aureus.*

Testing Recommendations

- **Acceptable methods**[8,9] for testing vancomycin susceptibility in *S. aureus* include non-automated MIC methods (e.g., reference broth microdilution, agar dilution, agar gradient diffusion [Etest® using a 0.5 McFarland standard to prepare the inoculum suspension (AB Biodisk, Piscatway, NJ)]) using a full 24-hour incubation.

  *…Etest® using a **0.5** MacFarland standard to prepare the inoculum suspension…*

- **Unacceptable methods** for testing vancomycin susceptibility in *S. aureus* include 1) disk diffusion alone and 2) automated MIC methods. Two out of three VRSA were not reliably detected by automated MIC methods (CDC unpublished data). Therefore, laboratories using automated methods or disk diffusion **should add** a vancomycin agar screen plate [see page 7] to enhance detection of VISA/VRSA.

  *Disk diffusion **does not** reliably detect staphylococci with reduced susceptibility to vancomycin.*

Testing Algorithm

In addition to knowing the appropriate testing methodologies, all laboratories should develop a step-by-step problem-solving procedure or algorithm for detecting VISA/VRSA that is specific for their laboratory. A sample algorithm is available at www.cdc.gov/ncidod/hip/vanco/vanco.htm.

Options for enhancing detection of VISA/VRSA include:

1. Screening all clinical isolates of MRSA on a vancomycin agar screen plate.
2. Screening all clinical isolates of *S. aureus* on a vancomycin agar screen plate.
3. Retesting *S. aureus* isolated from patients who fail to respond to vancomycin therapy because resistance may have emerged during vancomycin therapy.

All *S. aureus* strains for which the vancomycin MIC ≥4µg/ml are unusual and should **not** be discarded until confirmation has been made either at the local or state health departments and/or CDC. Before sending for confirmation, laboratories should ensure that the strain is in pure culture and reconfirm the genus and species of the organism; then, repeat the susceptibility test for vancomycin using an acceptable MIC method or screen by using a vancomycin agar screen plate. If retesting confirms a

vancomycin MIC ≥4 µg/ml or growth (>1 colony) on a screen plate is observed, laboratories should notify infection control, the local and/or state health department and the Division of Healthcare Quality Promotion, National Center for Infectious Diseases, CDC, by telephone 800-893-0485 or by sending an email to SEARCH@cdc.gov. The isolate should be sent to the health department and/or CDC for confirmatory testing. If the isolate is confirmed to have a vancomycin MIC ≥4 µg/ml, CDC will work with the health department and infection control personnel to address any local infection control issues, and the health department to address broader public health implications.

Using Vancomycin Agar Screen Plates

The vancomycin agar screen test uses **commercially prepared** plates to screen pure cultures of bacteria for vancomycin resistance. These plates contain brain heart infusion agar (BHIA) and 6 µg/ml of vancomycin. In studies conducted at CDC when the vancomycin-containing BHI agar was prepared in house, some lots were less specific, allowing growth of the susceptible quality control strains. Thus, adequate quality control of the agar test medium is critical before evaluating isolates from clusters of infections. CDC recommends using an inoculum of 10^6 CFU/ml (10µl of broth containing a 0.5 McFarland standard) to identify these strains. Growth of 2 or more colonies is considered a positive result. All of the isolates for which the vancomycin MICs are 8 µg/ml grow on these plates[8]. All staphylococci that grow on the vancomycin screen plates should be inspected for pure culture, and the original clinical isolate should be tested by an MIC method for confirmation of vancomycin resistance.

***Commercially prepared** plates that contain BHIA and 6µg/mL of vancomycin may be used for screening.*

Confirmatory Testing Methods Used by CDC

The following methods must yield the results listed in the table below before CDC defines the organism as a VISA or VRSA. All 3 tests can be performed on presumptive VISA/VRSA isolates at CDC. Email SEARCH@cdc.gov for information on how to send isolates to CDC**.**

Technique	VRSA Results	VISA Results	Comment
Reference Broth Microdilution	VA MIC ≥32 µg/ml in Mueller-Hinton broth	VA MIC = 8-16 µg/ml in Mueller-Hinton broth	Hold test for full 24 hr.
Brain Heart Infusion Agar containing 6 µg/ml of vancomycin obtained from a <u>commercial source</u>	Growth of > 1 colony in 24 hrs.	Growth of >1 colony in 24 hrs.	Two or more colonies is a positive result; For QC use *S. aureus* ATCC 25923 as susceptible control and *Enterococcus faecalis* ATCC 51299 as resistant control
Etest	VA MIC ≥ 32µg/ml on Mueller Hinton agar	VA MIC ≥ 6µg/ml on Mueller Hinton agar	Use a 0.5 McFarland standard to prepare the inoculum suspension. Hold test for full 24 hr.

Contact Investigation

When a patient has a laboratory confirmed VISA or VRSA infection, it is essential that the extent of transmission of the organism be assessed rapidly. This section discusses how and where to obtain cultures from healthcare workers, patient roommates, and others having had contact with a patient infected or colonized with VISA or VRSA.

Step 1: Identify and categorize contacts

Contacts should be categorized based on their level of interaction (i.e., extensive, moderate, or minimal) with the colonized or infected patient. Priority should be given to identifying contacts who have had **extensive interaction** with the VISA/VRSA patient during a period before the VISA/VRSA culture date. The length of this period depends on recent culture results, location the patient is receiving healthcare, and the clinical assessment and should be determined in consultation with public health authorities.

*First, identify contacts who have had **extensive interaction** with the VISA/VRSA patient.*

Extensive Interaction

A. Patient's who:

- share the VISA/VRSA patient's room

B. Nursing or patient-care providers involved in direct patient care who:

- clean/bathe/rotate/ambulate the patient
- change dressings
- make frequent visits (>3 visits per day including nurses assigned to the patient)
- handle secretions and body fluids (including respiratory secretions)

C. Physicians who:

- care for wound dressings or perform debridement
- conduct physical exams on the VISA/VRSA patient

D. Ancillary staff who:

- have documented prolonged and unprotected patient contact (including physical therapy or rehabilitation personnel and dialysis or respiratory technicians)

E. Family members/ household contacts who:

- provide primary care
- had/have close contact with patient (e.g., sleep in the same bed, or same room)

Moderate interaction

A. Nursing or patient-care providers who:
- deliver medications or manipulate intravenous lines (≤3 visits per day)
- cross-cover patient only

B. Physicians who:
- see patient on daily rounds, without conducting extensive exams
- perform surgical or invasive procedures where sterile barriers or aseptic technique are used

C. Ancillary staff who:
- monitor patient-care equipment without handling secretions
- have limited interactions, e.g., radiology technicians

Minimal interaction

A. Nursing or patient-care providers who:
- work on the same floor without formal cross-coverage of patient
- assist patient with eating
- perform predominately administrative duties

B. Physicians who:
- consult without extensive exam
- visit during teaching rounds only

C. Ancillary staff who:
- provide dietary or maintenance services

Step 2: Culture index patient and contacts

For patients colonized or infected with VISA or VRSA:
Culture anterior nares, wounds, drains, other clinically relevant sites (e.g., catheter exit site)

For persons having <u>EXTENSIVE INTERACTION</u> with colonized/infected patient:
- Culture anterior nares and skin lesions (e.g., abscess or dermatitis, open wounds)
- Only culture hands if concerned about transient colonization after recent contact (previous 48 hours)
- If no contacts among this group are identified as being VISA or VRSA positive, the decision to culture those with less interaction should be made in consultation with public health authorities.

For persons with moderate or minimal interaction:
- Only culture if "Extensive Interaction" contacts have positive results
- Culture anterior nares

If contacts are identified as MRSA carriers but not VISA/VRSA carriers, the MRSA isolates may still be of laboratory interest and should be saved for further testing.

Step 3: Evaluate Efficacy of Infection Control Precautions

Culturing the anterior nares of contacts with **extensive interaction** is recommended on a regular (e.g., weekly) basis to assess the efficacy of infection control precautions. The duration of evaluation and the decision to prospectively culture those with less interaction should be made in consultation with public health authorities.

Procedure for Culturing Anterior Nares

Anterior nares specimens should be obtained with a commercially prepared sterile swab (e.g., Culturette II, Becton Dickinson, Sparks MD)

- 1: Label swab with either the patient name or patient code.
- 2: Obtain consent from participants. Explain to the participants that you will only be touching the inside of the nostril (1-2 cm or the length of fingernail from cuticle to tip of finger). Inform them that it may make their nose itch, eyes water, or sneeze, but it shouldn't hurt.
- 3: Have participant lean head back
- 4: Remove swab from plastic sheath (the transport sleeve).
- 5: Insert swab into one nostril (about 2 cm on an adult) without touching anything but the inside or anterior part of the nostril.
- 6: Lightly rotate swab on the entire anterior, or forward, part of the nasal mucosa for about 3 seconds and remove.
- 7: Immediately return swab into its plastic sheath (the transport sleeve), taking care not to touch anything else with it, invert the swab, and then activate the ampule of transport medium if present (squeeze bottom bulb until you feel the bulb with transport medium break).
- 8: Tighten the cap of the swab container and ensure that the swab is firmly secured in the sheath and properly labeled.
- 9: Package swabs according to testing laboratory's instructions (e.g., sealed in biohazard plastic bags, properly labeled, in a suitable container with ice packs) and send swabs to the laboratory for processing.

Laboratory Processing of Culture Specimens

Step 1: Processing nares and hand cultures for *Staphylococcus aureus*

- Anterior nares specimens should be obtained with a commercially prepared sterile swab (e.g., Culturette II, Becton Dickinson, Sparks MD). The swab is inoculated onto mannitol salt agar (MSA) (i.e., swabbed over the first quadrant while rotating the swab, then streaked for isolation) and incubated at 35°C. The MSA plate should be examined daily for *S. aureus* for 72 hr. After incubation, colonies should be identified as *S. aureus* using standard laboratory methodology[10,12]**.** Alternatively, screening plates designed to isolate only MRSA may be used (e.g., oxacillin screen plate[11]), but definitive identification of isolates as *S. aureus* is still recommended. After specimen identification is complete, proceed to step 2.

- Hand cultures may be obtained by many different methods. One method, which is relatively simple and well-accepted by hospital personnel, is the wipe-rinse technique[13-14]. Supplies needed include 0.02% aqueous solution of Tween 80[7], Handi-Wipe[7] cleaning cloth, and sterile leak proof specimen containers. First cut the Handi-Wipe into 8 sections of equal size and moisten with 10 ml 0.02% Tween 80 solution. Wrap each wipe in aluminum foil and sterilize in an autoclave (refrigerate wipes until use). Have the subject open and remove the wipe and rub both hands carefully. Make sure to get between the fingers and up to the wrists. Have the subject place the wipe in a sterile specimen container and cap tightly. Label each container and send to the laboratory. Samples can be refrigerated overnight if they cannot be sent directly to the lab. Samples should be assayed within 48 hours. To assay, place approximately 100 ml sterile 0.02% Tween 80 into each specimen container with the Handi-Wipe. Place the container on a shaker for 15-30 minutes. Split the 100ml sample into two 50 ml samples. Filter the broth from the two samples to collect bacteria using the membrane filtration technique and 0.45 µ filters. Place one membrane filter on Columbia Nutrient Agar (Becton Dickinson Microbiology Systems, Cockeysville, MD) and one filter on an MSA plate. Hand cultures should be incubated for up to 72 hours at 35°C. Isolates should be identified as *S. aureus* using standard laboratory methodology[10,12].

Step 2: Detecting VISA/VRSA

After identification of isolates as *S. aureus* or MRSA, laboratories should perform susceptibility testing using an acceptable MIC method or vancomycin screen plates if a large number of isolates are being processed (see page page 7).

If after conducting susceptibility testing or screening, the *S. aureus* isolates are determined to have reduced susceptibility to vancomycin (vancomycin MIC >=4 µg/ml)**,** health departments should be notified in states where such isolates are reportable. The CDC may be contacted for confirmatory and susceptibility testing of these isolates by sending an email to SEARCH@cdc.gov.

Decolonization of MRSA, VISA, or VRSA in Contacts

Some patients, healthcare workers, or family members may be identified as carriers of MRSA, VISA, or VRSA during a contact investigation. Decolonization refers to reducing the organims burden of the colonized person with the goal of eradicating the organism. By colonized we mean the presence of microorganism in or on a person but without clinical signs or symptoms of infection. The rationale is that by decreasing the reservoir of MRSA, VISA, or VRSA, the risks of infection and of transmission of the organism are reduced. The decision to attempt decolonization therapy is based upon a number of considerations, including the following: 1) the individual=s underlying disease and/or immune status; 2) the ability of the individual to tolerate the recommended regimen; 3) the risk of transmission to others. In general, CDC does not recommend decolonization for carriers unless they are implicated in transmission during an outbreak.

Decision making for:

1. VISA- or VRSA-<u>infected</u> patients <u>colonized</u> with MRSA, VISA, or VRSA.

The decision to decolonize is made by the patient=s primary physician in consultation with the infection control team and local/state health department.

2. Healthcare workers colonized with MRSA, VISA, or VRSA:

The decision to decolonize is made by occupational health services, the infection control team, the healthcare worker, and the workers personal physician. For those colonized with VISA/VRSA, local/state health departments should be included.

3. VISA patient contacts colonized with MRSA, VISA, or VRSA:

The decision to decolonize contacts who are not healthcare workers is made by the contact and their primary care physician. For those colonized with VISA/VRSA, local/state health departments should be included.

Overview of nasal decolonization treatment:

A limited number of antimicrobial agents are available for the eradication of *S. aureus* colonization. Several approaches to decolonization exist, including oral rifampin, chlorhexidine scrub, bacitracin, nasal mupirocin, or a combination of these if the patient is believed to be colonized at multiple sites. For this document we will focus on mupirocin, since it has received the most attention in the current literature. Mupirocin, a topical antimicrobial with antistaphylococcal activity, is usually the agent of choice for eradication of staphylococcal nasal colonization in patients and healthcare workers during localized MRSA outbreaks.

Before the decision is made to use mupirocin, several limitations of the agent must be considered. First, elimination of colonization may be transient. In settings where MRSA is endemic, persons may be recolonized from external sources[17]. Second, *S. aureus* can develop resistance to mupirocin during therapy, and resistance has been attributed to widespread application of intranasal mupirocin ointment for hospitalized patients. Finally, in most studies of its use to eliminate MRSA carriage in outbreak situations, mupirocin was administered in conjunction with multiple infection control measures[15,16,17]. Therefore, it is difficult in these studies to attribute eradication of MRSA colonization to the use of mupirocin alone.

Infection Control Issues

CDC has issued specific recommendations intended to reduce the development and transmission of VISA/VRSA[9]. Below is a checklist of important infection control recommendations. However, these may need to be customized to special healthcare-settings (e.g., dialysis, home healthcare; see page 14). Infection control precautions should remain in place until a defined endpoint (e.g., patient has been culture-negative 3 times over 3 weeks or the patient's infection has healed). This endpoint should be determined in consultation with public health authorities.
For assistance contact CDC's Division of Healthcare Quality Promotion by telephone 800-893-0485 or send an email to SEARCH@cdc.gov.

Infection Control Checklist to Prevent the Spread of VISA/VRSA

- ❑ Isolate the patient in a private room.
- ❑ Minimize the number of persons caring for the patient (e.g., assign dedicated staff to care for VISA/VRSA patient).
- ❑ Implement the appropriate infection control precautions during patient care.
  - Use contact precautions (gown and gloves for room entry).
  - Wear mask/eye protection or face shield if performing procedures likely to generate splash or splatter (e.g., wound manipulation, suctioning) of VISA/VRSA contaminated material.
  - Perform hand-hygiene using appropriate agent (e.g., alcohol-based hand sanitizer or antibacterial soap)[20].
  - Dedicate non-disposable items that cannot be cleaned and disinfected between patients (e.g., adhesive tape, cloth-covered blood pressure cuffs) for use only on the patient with VISA/VRSA.
  - Monitor and strictly enforce compliance with contact precautions.
- ❑ Initiate epidemiologic and laboratory investigations with the assistance of the local/state health departments and CDC.
- ❑ Educate and inform the appropriate personnel about the presence of a patient with VISA/VRSA and the need for contact precautions:
  - Patient=s physicians
  - Admitting or emergency room personnel
  - Personnel admitting patients to unit
  - Personnel transporting patients between institutions
- ❑ Determine whether transmission has already occurred by performing baseline cultures of specimens from hands and nares of the following:
  - Those with physical contact (see page 8) with the patient
  - The patient=s healthcare providers
  - The patient=s roommates
- ❑ Assess efficacy of precautions by monitoring personnel for acquisition of the isolate (see page 10, step 3)
- ❑ Consult with the local/state health department and CDC before transferring the patient (for emergencies only) or discharging the patient

Dialysis Settings[19]

Infection control precautions recommended for all hemodialysis patients are adequate to prevent the transmission for most patients infected/colonized with VISA/VRSA.

1. Wear disposable gloves when caring for the patient or touching the patient's equipment at the dialysis station; remove gloves and wash hands between each patient or station.
2. Nondisposable items that cannot be cleaned and disinfected (e.g., adhesive tape, cloth-covered blood pressure cuffs) should be dedicated for use only on a single patient
3. Unused medications (including multiple dose vials containing diluents) or supplies (e.g., syringes, alcohol swabs) taken to the patient's station should be used only for that patient and should not be returned to a common clean area or used on other patients.
4. When multiple dose medications vials are used (including vials containing diluents), prepare individual patient doses in a clean (centralized) area away form dialysis stations and deliver separately to each patient. Do not carry multiple dose medication vials form station to station.
5. Do not use common medication carts to deliver medications to patients. Do not carry vials, syringes, alcohol swabs, or supplies in pockets. If trays are used to deliver medications to individual patients, they must be cleaned between patients.
6. Clean areas should be clearly designated for the preparation, handling, and storage of medications and unused supplies and equipment.
7. Use external venous and arterial pressure transducer filters/protectors for each patient treatment to prevent blood contamination of the dialysis machines' pressure monitors. Change filter/protectors between each patient treatment, and do not reuse them. Internal transducer filters do not need to be changed routinely between patients.
8. Clean and disinfect the dialysis station (e.g., chairs beds, tables, machines) between patients.
9. For dialyzers and blood tubing that will be reprocessed, cap dialyzer ports and clamp tubing. Place all used dialyzers and tubing in leakproof containers for transport from station to reprocessing or disposal area.

Additional infection control precautions should be considered for treatment of patient who might be at increased risk for transmitting pathogenic bacteria. For these patients, consider adding the following precautions:

1. Staff members treating the patient should wear a separate gown over their usual clothing and remove the gown when finished caring for the patient
2. Dialyze the patient at a station with as few adjacent stations as possible (e.g., at the end or corner of the unit).

Home Healthcare Settings

1. Home healthcare providers should follow the same VISA/VRSA precautions as hospital-based healthcare providers.
   a. Wear gown and gloves upon entering the area where the patient care will be provided
   b. Wear mask/eye protection or face shield if performing procedures likely to generate splash or splatter (e.g., wound manipulation, suctioning) of VISA/VRSA contaminated material.
   c. Perform hand-hygiene using appropriate agent (e.g., alcohol-based hand sanitizer or antibacterial soap)[20].
   d. Develop systems to monitor and strictly enforce compliance with contact precautions in the home.

2. Minimize the number of persons with access to the VISA/VRSA colonized/infected patient (dedicate a single staff person to care for this patient).
3. Dedicate non-disposable items that cannot be cleaned and disinfected between patients (e.g., adhesive tape, cloth-covered blood pressure cuffs) for use only on a single patient.

References

1. CDC. Reduced susceptibility of *Staphylococcus aureus* to vancomycinCJapan, 1996. MMWR 1997;46:624-4.
2. **Kac G, Podglajen I, Buu-Hoi A, et al.** Infections and colonizations due to methicillin-resistant *Staphylococcus aureus* with decreased susceptibility to glycopeptides (GISA) in a medical intensive care unit (ICU). 39th Interscience Conference on Antimicrobial Agents and Chemotherapy 1999
3. **Wong SSY, PL Ho, PCY Woo, KY Yuen.** Bacteremia caused by staphylococci with inducible vancomycin heteroresistance. Clin Infect Dis 1999;29:760-7.
4. **CDC**. *Staphylococcus aureus* Resistant to Vancomycin --- United States, 2002. MMWR, July 5, 2002 51(26); 565-567 www.cdc.gov/mmwr/preview/mmwrhtml/mm5126a1.htm.
5. **CDC**. Public Health Dispatch: Vancomycin-Resistant *Staphylococcus aureus* --- Pennsylvania, 2002. MMWR, October 11, 2002 51(40);902. http://www.cdc.gov/mmwr/preview/mmwrhtml/mm5140a3.htm
6. **National Committee for Clinical Laboratory Standards.** Methods for dilution antimicrobial susceptibility test for bacteria that grow aerobically. 6th ed. Approved standard, M7-A6, Wayne, PA: National Committee for Laboratory Standards, 2003
7. **CDC.** Laboratory capacity to detect antimicrobial resistance, 1998. MMWR 2000;48(51):1167-71.
8. **Tenover FC, Lancaster MV, Hill BC, et al.** Characterization of staphylococci with reduced susceptibilities to vancomycin and other glycopeptides. J Clin Microbiol 1998;36:1020-7. [Erratum, J Clin Microbiol;36:2167.]
9. **CDC**. Interim guidelines for prevention and control of staphylococcal infections associated with reduced susceptibility to vancomycin. MMWR 1997;46:626-8,635.
10. **Ruoff KL.** Algorithm for identification of aerobic Gram-positive cocci. *Manual of Clinical Microbiology, 7th ed.* p.262-282. ASM Press, Washington D.C., 1999.
11. **Swenson MJ, Hindler JA, Peterson.** Special Phenotypic Methods for Detecting Antibacterial Resistance. *Manual of Clinical Microbiology, 7th ed.* p.1563-1577. ASM Press, Washington D.C., 1999.
12. **Kloos W, Bannerman TL**. Staphylococcus and Micrococcus. In: Murray PR, American Society for Microbiology, eds. Manual of clinical microbiology. Washington, D.C.: ASM Press, 1999:264-282.
13. **Peterson NJ, Collins DE, Marshall JH.** A microbiological assay technique for hands. Health Lab Sci 1973;10:18-22.
14. **Peterson NJ, Collins DE, Marshall JH.** Evaluation of skin cleansing procedures using the wipe-rinse technique. Health Lab Sci 1974;11:182-87.
15. **Kluytmans J, van Belkum A, Verbrugh H**. Nasal Carriage of *Staphylococcus aureus*: Epidemiology, Underlying Mechanisms, and Associated Risks. Clinical Microbiology Reviews. 1997;10:505-520.
16. **Boyce J.** Preventing Staphylococcal Infections by Eradicating Nasal Carriage of *Staphylococcus aureus:* Proceeding with Caution. Infection Control and Hospital Epidemiology. 1996;17:775-779.
17. **Harbarth S, Dharan S, Liassine N, Herrault P, Auckenthaler R, Pittet D.** Randomized, Placebo-Controlled, Double-Blind Trial to Evaluate the Efficacy of Mupirocin for Eradicating Carriage of Methicillin-Resistant *Staphylococcus aureus.* Antimicrobial Agents and Chemotherapy. 1999;43:1412-1416.
18. **Fridkin S.K.** Vancomycin-Intermediate and -Resistant *Staphylococcus aureus:* What the Infectious Disease Specialist Needs to Know. Clinical Infectious Diseases. 2001;32:108-115.
19. **CDC.** Recommendations for preventing transmission of infections among hemodialysis patients. MMWR. 2001;50:2-32.
20. CDC. Guideline for hand hygiene in health-care settings: recommendations of the Healthcare Infection Control Practices Advisory Committee and the HICPAC/SHEA/APIC/IDSA Hand Hygiene Task Force. MMWR 2002;51(No. RR-16).