AHC Media LLC

Rapid Reference Card Enclosed

The Practical Journal for Emergency Physicians

Emergency Medicine Reports®

Volume 28, Number 22 October 15, 2007

Infection Control and the Emergency Department

Author: **Jonathan M. Glauser, MD**, Department of Emergency Medicine, Cleveland Clinic Foundation, Cleveland, OH.

Peer Reviewers: **Ralph Riviello, MD, MS, FACEP**, Associate Professor and Associate Program Director, Department of Emergency Medicine, Thomas Jefferson University, Philadelphia, PA; and **John W. Hafner, Jr., MD, FACEP**, Clinical Assistant Professor of Surgery, Department of Emergency Medicine, University of Illinois College of Medicine at Peoria, Director of Research, Emergency Medicine Residency, Attending Physician, OSF Saint Francis Hospital, Peoria.

This issue of Emergency Medicine Reports *deals with infection control as it relates to the emergency department (ED). Several states now require infection control training for continued licensure, and it is hoped that this article may be useful to some in meeting that requirement. For the rest, knowledge of infection transmission and ways to prevent contamination are very important. The recent SARS epidemic led to significant morbidity and mortality primarily in emergency personnel who cared for patients, at least initially, with poor protection from the airborne infection.*

Some of the measures discussed in this issue may seem simplistic. For example, the greatest weapon we have against the spread of many infections is simply washing hands. Of all healthcare workers, physicians are the least likely to wash their hands between patients or even after using the bathroom. In a surveillance project of healthcare professionals attending a professional conference, a surprisingly large number of individuals did not wash their hands after using the toilet. Ironically that meeting was the Interscience Conference on Antimicrobial Agents and Chemotherapy, one of the largest infectious disease meetings! In response to the failure of physicians and other healthcare workers to simply wash their hands before and after caring for patients, some hospitals have deployed hand washing "police" to monitor compliance.

Beyond handwashing is the real impact that diseases such as methicillin-resistant Staphylococcus aureus *(MRSA) and vancomycin resistant enterococci (VRE) have on our healthcare system. In older facilities, there are few private rooms, and isolation of patients with MRSA or VRE often contribute to the hospital bed shortage by taking up two beds. Whether isolation truly will decrease the incidence of MRSA or even slow the spread of the dis-*

Statement of Financial Disclosure

To reveal any potential bias in this publication, and in accordance with Accreditation Council for Continuing Medical Education guidelines, we disclose that Dr. Farel (CME question reviewer) owns stock in Johnson & Johnson. Dr. Glauser (author), Dr. Riviello (peer reviewer), Dr. Hafner (peer reviewer), Dr. Schneider (editor), and Dr. Stapczynski (editor) report no relationships with companies related to the field of study covered by this CME activity.

ease may never been known. Still, we will continue to isolate and take appropriate precautions to control infection in our EDs.
—Sandra M. Schneider, MD, FACEP, Editor

Introduction

The recognition that infections might be transmitted by health care personnel within hospitals to susceptible patients is generally dated to the work of Semmelweis. He noted the association between the incidence of puerperal fever and lack of handwashing by physicians who also performed autopsies. The rate of infection was much lower among women who had their children delivered by non-physicians than those whose children were delivered by physicians. The Centers for Disease Control and Prevention (CDC) since 1970 have published isolation guidelines for use by hospitals. The AIDS epidemic and the growing concern regarding tuberculosis, both in the 1980s, have spurred further developments in shaping guidelines.[1] The CDC estimates that there are at least two million health-care-associated infections each year,[2] resulting in 90,000 deaths, and that at least one-third of deaths from hospital-acquired infections are preventable.[3] In fact, infection control programs resulted largely from mandates of the Joint Commission for Accreditation of Hospitals (JCAHO) (now the Joint Commission) and the leadership of the CDC.

Emergency Medicine Reports™ (ISSN 0746-2506) is published biweekly by AHC Media LLC, 3525 Piedmont Road, N.E., Six Piedmont Center, Suite 400, Atlanta, GA 30305. Telephone: (800) 688-2421 or (404) 262-7436.

Senior Vice President/Group Publisher: Brenda Mooney
Associate Publisher: Lee Landenberger
Specialty Editor: Shelly Morrow Mark
Marketing Manager: Shawn DeMario
GST Registration No.: R128870672

Periodicals postage paid at Atlanta, GA. **POSTMASTER:** Send address changes to ***Emergency Medicine Reports***, P.O. Box 740059, Atlanta, GA 30374.

Back issues: $31. Missing issues will be fulfilled by customer service free of charge when contacted within one month of the missing issue's date.

Multiple copy prices: One to nine additional copies, $359 each; 10 to 20 additional copies, $319 each.

Accreditation

AHC Media LLC is accredited by the Accreditation Council for Continuing Medical Education to provide continuing medical education for physicians.

AHC Media LLC designates this educational activity for a maximum of 60 *AMA PRA Category 1 Credits™*. Physicians should only claim credit commensurate with the extent of their participation in the activity.

Approved by the American College of Emergency Physicians for 60 hours of ACEP Category 1 credit.

Emergency Medicine Reports has been reviewed and is acceptable for up to 39 Prescribed credits by the American Academy of Family Physicians. AAFP accreditation begins 01/01/07. Term of approval is for one year from this date. Each issue is approved for 1.50 Prescribed credits. Credit may be claimed for 1 year from the date of each issue. The AAFP invites comments on any activity that has been approved for AAFP CME credit. Please forward your comments on the quality of this activity to cmecomment@aafp.org.

This is an educational publication designed to present scientific information and opinion to health professionals, to stimulate thought, and further investigation. It does not provide advice regarding medical diagnosis or treatment for any individual case. It is not intended for use by the layman. Opinions expressed are not necessarily those of this publication. Mention of products or services does not constitute endorsement. Clinical, legal, tax, and other comments are offered for general guidance only; professional counsel should be sought for specific situations.

This CME activity is intended for emergency and family physicians. It is in effect for 24 months from the date of the publication.

Subscriber Information

Customer Service: 1-800-688-2421

Customer Service E-Mail: customerservice@ahcmedia.com
Editorial E-Mail: shelly.mark@ahcmedia.com

World Wide Web page: http://www.ahcmedia.com

Subscription Prices

1 year *with* 60 ACEP/60 AMA/60 AAFP Category 1/Prescribed credits: $544
1 year *without* credit: $399
Add $12.95 for shipping & handling
Resident's rate $199
Discounts available for group subscriptions.
For pricing information, call Tria Kreutzer at (404) 262-5482.

All prices U.S. only.
U.S. possessions and Canada, add $30 plus applicable GST. Other international orders, add $30.

For Customer Service and CME questions,

Please call our customer service department at **(800) 688-2421.** For editorial questions or comments, please contact **Shelly Morrow Mark,** Specialty Editor, at shelly.mark@ahcmedia.com or (352) 351-2587.

AHC Media LLC

Handwashing Guidelines

The majority of nosocomial infections are spread by contact. In virtually all cases, the primary mechanism for contact spread is via the hands of hospital personnel.[4] Effective hand hygiene is felt to be the single most effective means of preventing their spread, and is at the heart of much of the work of Joint Commission.

Alcohol-based Hand Rubs

Alcohol-based hand rubs are recommended for general use by the CDC Hand Hygiene Guidelines.[5] These products are considered more effective than soap and water in reducing bacterial counts on the hands of healthcare workers. A six-year observational study found a decrease in the nosocomial acquisition of methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE) with a switch from handwashing to an alcohol-based hand rub.[6] A study from Switzerland verified a similar decrease in nosocomial MRSA infections following a switch from handwashing to the use of an alcohol-based hand rub. In contrast to the decrease in infection rates for MRSA and VRE with the use of alcohol-based hand rubs, the incidence of *Clostridium difficile* (*C. difficile*) colitis was unchanged in that study.[7] Since alcohol-based rubs do not seem to have an effect on spore-forming bacteria, hand-washing is still recommended after contact with patients with *C. difficile* infection. Use of an alcohol-based hand rub is also recommended before having direct contact with patients, after having contact with a patient's intact skin or bodily secretions, and before inserting indwelling urinary catheters or peripheral vascular catheters.[5]

Handwashing

Washing hands with plain soap and water or with an antimicrobial soap should be employed when hands are visibly soiled. One crossover study demonstrated a 27% decreased incidence of nosocomial infections in three adult intensive care units (ICUs) over eight months when a chlorhexidine soap was used versus a combination of 60% isopropyl alcohol and soap.[8] Handwashing is recommended by the CDC after touching blood, bodily fluids, secretions, and contaminated items whether or not gloves are worn, and between patient contacts. It is recommended before eating and after using a restroom.[9] (*See Table 1.*)

Of all healthcare workers, physicians have been particularly resistant to these guidelines. One observational study of 2834 opportunities for handwashing evaluated compliance by healthcare personnel. Overall compliance was 48%, with the highest among nurses and lowest among physicians.[10] In one study, compliance with hand rubs was higher than with handwashing, but physicians as a group were still poorly compliant.[7]

Standard Precautions

The category of standard precautions combines the features of body substance isolation policies and universal precautions. These aim to reduce the risk of transmission of infectious agents from patient to health care worker and vice versa. Standard precautions apply to all body fluids, secretions, and excretions except sweat. They entail:

Table 1. CDC Handwashing Recommendations

According to the CDC, handwashing is recommended:
- After touching blood, bodily fluids, secretions, and contaminated items, whether or not gloves are worn;
- Between patient contacts
- Before eating
- After using the restroom

- Handwashing before and after every patient contact;
- The use of gowns, gloves, and eye protection in situations in which exposure to body secretions or blood is likely or possible;
- The safe disposal of sharp instruments and needles in impervious containers, and;
- The placement of soiled linens in impervious bags and bloods or contaminated materials such as feces or urine in sanitary toilets.[11]

CDC Isolation Guidelines

The 1996 CDC guidelines include three isolation categories based on three means of infection transmission: contact, respiratory droplets, and airborne spread. Each is defined in turn.

Direct contact includes touching, sexual contact, percutaneous or mucous membrane exposure, or exposure via infectious vector, such as an insect. Organisms spread in this fashion include *C. difficile*, scabies, drug-resistant organisms in wounds, sputum, or in the gastrointestinal tract, or herpes simplex virus via mucocutaneous contact.

Airborne spread depends upon aerosolization of small particles of an infectious agent that can spread over long distances in the air. The most common nosocomial organisms spread via this route include *Mycobacterium tuberculosis*, varicella-zoster virus, and measles. In theory, smallpox might qualify in this category as a potential bioterrorism agent.[12]

Respiratory droplets are large particles (> 5 μm in size) expelled during coughing, sneezing, or talking. One study indicated that respiratory droplets travel less than six feet from the source patient.[13] Organisms spread in this fashion include *Neisseria meningitidis*, *Hemophilus influenza* type b, *Bordetella pertussis*, *Mycoplasma pneumoniae*, influenza virus, and rubella virus.

Droplet precautions are applied for patients known or suspected to be infected with micro-organisms transmitted by droplets larger than 5 μm. The patient should be placed in a private room or with patients infected with the same micro-organism. The door may remain open, but patients should be separated by at least 3 feet from other patients or visitors if no private room is available. A mask should be worn when working within 3 feet of the patient, and the patient should be masked if transport is necessary.[14]

Respiratory Hygiene

The emergency department potentially has a critical role in limiting the spread of dangerous respiratory pathogens, including severe acute respiratory syndrome (SARS), avian influenza, influenza, and bioterrorism agents. Some of these respiratory pathogens may not be immediately identifiable. Threat of contagion exists for visitors as well as patients, healthcare workers, and in-patient populations. The population at risk includes the increasing number of immunocompromised patients who are status-post organ transplant, HIV-infected, or post-chemotherapy. However, one report indicated that 44% of SARS cases at the Prince of Wales Hospital in Hong Kong occurred in hospital workers who did not take special precautions during the SARS outbreak.[15] Other reports confirm that healthcare workers account for 42% of SARS cases in Canada and 25% of cases in Hong Kong.[16,17] The SARS epidemic, however, did demonstrate that isolation was helpful. In Vancouver, which instituted isolations early and intensely in the ED, there were only 5 cases of SARS (all but 1 imported). This is in contrast to Toronto where isolation was less intense and where there were 247 cases (3 imported) and 43 deaths.[18] Clearly, hospital workers are at risk of contracting respiratory infections, and just as clearly emergency physicians and nurses must participate in any effective response to respiratory threats in hospitals.

Personal protective equipment includes gowns, gloves, masks, and respirators. These provide barrier protection, protecting from skin and mucous membrane exposures. The personal air-filtration systems approved by both the CDC and Occupation Safety and Health Administration (OSHA) are N95, 99, or 100 masks and powered air-purifying respirators. N95 masks have the ability to filter particles 1 μm in size with a filter leakage of less than or equal to 5%. N95 masks require individual fit-testing. Powered air-purifying respirators are more expensive and cumbersome, but fit uniformly.[19]

Apart from droplet precautions outlined earlier, engineering controls may be employed to provide passive protection for healthcare workers, visitors, and patients. These measures include isolation rooms, including negative pressure, filtration devices, and physical separation, such as closing doors or cohorting patients with identical infections.[19]

Negative pressure isolation systems prevent contaminated air from traveling to other areas of the hospital. In this way, infectious respiratory pathogens from single rooms or small units can be controlled. High efficiency particulate air (HEPA) filtration systems supplement negative-pressure systems. HEPA filters have been demonstrated to remove 99.97% of particles greater than or equal to 0.3 μm in diameter. They are available as portable units, but also can be installed in ventilation ducts. These can remove fungi and bacteria greater than 0.1 μm from the atmosphere, having been demonstrated to remove aspergillus spores (1.5-6 μm) to undetectable levels.[20] Ultraviolet lights in addition allow killing of spores and active organisms.

Airborne precautions apply for patients with known or suspected infections with micro-organisms that remain suspended in the air and that can be widely dispersed by air currents within a room or over a long distance. Patients should be placed in a room with monitored negative air pressure in relation to the surrounding areas. There should be six to 12 air changes per hour, with discharge of air outdoors, or HEPA filtration of room air before recirculation. The door should be kept shut, or patients infected with the same micro-

organism should be cohorted. Susceptible caregivers, including pregnant caregivers, should not enter the rooms of persons with known or suspected varicella or measles if other immune caregivers are available. Immune persons entering do not need to wear respiratory protection, but susceptible persons should wear respiratory protection with an N95 respirator if they enter the room.[21]

Even with the new vaccine, chicken pox (varicella) cases are frequently seen in the ED. Most of these cases require only confirmation of the disease by a physician or mid level provider and are generally in and other of the ED before negative pressure rooms can be set up. For these patients, airborne precautions should be instituted as rapidly as possible. Patients with possible infection should be identified at triage and care provided only by staff with immunity to varicella. Transport of the stable patient should be limited. After the patient departs, the room should be throughly cleaned and sanitized on all surfaces. Interventional airway procedures in the ED, including nebulized therapy and endotracheal intubation, increase risk of exposure to healthcare personnel. When these are essential for patient care, healthcare workers should use N95 respirators or powered air-purifying respirators, along with gowns and gloves. After completion of the procedure, personal protective equipment should be safely discarded to avoid contaminating the worker or the environment.[22] The patient may require adequate sedation or paralysis to reduce the possibility of cough.[23]

Vaccination and Chemoprophylaxis

The CDC provides recommendations for influenza vaccination among healthcare workers.[24] It has been demonstrated that vaccination of healthcare workers contributes to a decrease in patient mortality.[25] There are no uniform recommendations for healthcare vaccination for other respiratory pathogens. Immunization against pneumococcus with either the 23-valent polysaccharide vaccine, currently recommended for adults over the age of 65, or with the 7-valent conjugated vaccine to children has been proposed to decrease mortality from influenza.[26] This is not currently mandated by any authority.

Pre-hospital Issues

The CDC provides specific recommendations for protection of EMS personnel during transport of suspected SARS patients. Although specific recommendations do not exist for each of the transmissible respiratory diseases, general principles apply to the transport of any patient with a suspected serious and contagious life-threatening respiratory infection:[27,28]

- Potentially contagious patients should be transported with as few personnel as possible;
- EMS personnel traveling with such patients should have barrier protection, including gown, double gloves, respirator N95 or higher or powered air-purifying respirators;
- Patients should wear a surgical mask if feasible;
- Patients should, if possible, be transported in a vehicle that has separate ventilation systems and compartments for patient and driver;
- Family members should not be allowed to ride in the ambulance with patients, and;
- Advance notification is given to the receiving ED to limit exposure at the hospital to other individuals. EMS equipment should be handled as medical waste, and EMS vehicles should be decontaminated before transporting another patient.

Immunization of prehospital providers is just as important as any other class of healthcare worker. However, most providers lack easy access to immunization against influenza. In a recent study only 21% of EMS providers stated that they received an influenza vaccine, compared to 65% of ED providers. Barriers included inability to receive the vaccine at work and "taking it from someone who may need it more."[29]

While ED personnel have routine access to N95 respirators (masks) and generally undergo FIT testing to assure they are protected, few programs in the country provide these materials or this testing to EMS personnel.

Specific Infectious Agents

Certain specific infectious agents have generated enough attention in recent months and years that they are worthy of individual discussion from the perspective of emergency medicine. These are addressed in turn.

Methicillin-resistant *Staphylococcus aureus* (MRSA). Staphylococci with a positive tube coagulase test are classified as *S. aureus*. This organism was uniformly sensitive to penicillin G until 1942. The prevalence of penicillin-resistant clinical isolates increased rapidly. In 1959 methicillin, the first of the semisynthetic "penicillin-resistant" antibiotics, was introduced, and others such as nafcillin, dicloxacillin, and oxacillin followed.[30] Resistance to these anti-staphylococcal medications in a nosocomial outbreak was reported as an outbreak at Boston City Hospital in 1968, and coined MRSA.[31] Methicillin resistance in *S. aureus* is defined as an oxacillin minimum inhibitory concentration (MIC) $\geq$ 4 mcg/mL.[32]

In 1975, the U.S. rate of isolation of MRSA in hospitals was 2-3%. By 1991, it had increased to 30%, and by 2000 MRSA had accounted for more than 50% of all nosocomial *S. aureus* infections. The most common mechanism for transmission is person to person, with the source being an individual with an asymptomatic nasal carriage state or with an open draining lesion.[30] Skin lesions such as abrasions, eczema, puncture wounds, cosmetic shaving, or skin-to-skin contact in football players have been reported as well. Antibiotic use within the past 3 months, hospitalization within the past 12 months, and HIV infection should also be considered risk factors for MRSA carriage.[32] Chronically indwelling lines, intravenous drug use, and prostheses have to be considered as sources. Large outbreaks of MRSA were first reported in the hospital setting, but in recent years there have been many more reports of MRSA emerging in the community, or community-acquired MRSA (CA-MRSA).[33] CA-MRSA infections have become more frequent in otherwise active, healthy young persons.[34]

Currently, MRSA has become the primary bacteria of concern when assessing skin conditions such as pemphigus and other blistering disorders. The prevalence of MRSA was 59% overall of skin and soft-tissue infections of *S. aureus* reported from 11 different EDs in one recent report, making it the most common identifiable cause of skin and soft-tissue infections among emer-

Table 2. Guidelines for Use of Vancomycin

- Treatment of serious infections caused by beta-lactam-resistant gram-positive microorganisms.
- Treatment of infections caused by gram-positive organisms in patients with serious allergies to beta-lactams.
- Treatment of antibiotic-associated colitis unresponsive to metronidazole.
- Prophylaxis for endocarditis following high-risk procedures as recommended by the American Heart Association.
- Prophylaxis for major surgical procedures involving implantation of prosthetic materials or devices at institutions with high rates of MRSA infections.

gency patients.[35]

MRSA can be screened within 2 hours with a polymerase chain reaction (PCA) test.[36] Without rapid testing, patients with MRSA are isolated often for days. Where private rooms are not readily available, this practice may increase the pressure on hospital capacity and lead to boarding of patients in the ED or in the hallways. Once a patient is identified as MRSA, isolation is generally indicated, though patients with the same strain identified can be cohorted when necessary. There have been recent reports of severe cases of community-acquired pneumonia caused by MRSA. These cases often affect young, otherwise healthy individuals and can be rapidly fatal. MRSA should be especially suspected during influenza season, and in those patients with cavitary infiltrates. Risk factors include a history of MRSA skin infection or exposure to an MRSA-infected individual. Of the six patients who died, the median onset of respiratory symptoms until death was 3.5 days, and of the six for whom vaccination status was available, none had been immunized against influenza.[37]

Although much less common, vancomycin resistance is also a growing concern. This may be Vancomycin Intermediate *Staph. aureus* (VISA) or Vancomycin Resistant *Staph. aureus* (VRSA). VRSA is defined as an MIC $\geq$ 16 mcg/mL, and VISA as an MIC of 4-8 mcg/mL.[38]

Most nosocomial MRSA isolates remain sensitive to rifampin, vancomycin, and linezolid.[30] For CA-MRSA, the empirical antibiotic therapy has been cited as trimethoprim-sulfamethoxazole and rifampin, the latter to reduce the likelihood of nasal carriage.[32] Clindamycin, daptomycin, and tetracyclines in children older than 8 years of age are options.[39] MRSA susceptibility to fluoroquinolones was only 60% in one recent report.[35]

Recommendations for hospital policies regarding infection control and MRSA have been formulated.[35] Standard precautions, including the use of gowns and gloves when contact with wound drainageis anticipated. Contact precautions, which include the use of gowns and gloves for all contact with patients or their environment, have been recommended for patients in acute care facilities who are known to be infected or colonized with MRSA.[40] Infection control strategies for MRSA include the following:

- Hand hygiene. This has been shown to decrease nosocomial infections in multiple reports.[32,41]
- Detection of asymptomatic colonization by surveillance cultures, generally from the nares, but also from open wounds. Active surveillance cultures may be particularly beneficial for patients in intensive care, burn, or oncology units, or those undergoing bone marrow transplant.
- Contact precautions, including private rooms, possibly cohorting colonized or infected patients when private rooms are scarce, and use of gowns and gloves for all patient contact.
- Decontamination of the environment: disinfecting bed rails, tables in close proximity to the patient.
- Eradication of MRSA carriage: intranasal mupirocin 2-3 times a days for three to five days, 4% chlorhexidine baths.[42]
- Possibly, judicious use of antibiotic drugs.

Vancomycin-resistant Enterococci (VRE). Since 1989, a rapid increase in the incidence and infection and colonization with VRE has been reported by hospitals, prompting recommendations published by the CDC in 1995.[43] This posed particular concerns not only because of resistance to traditional drugs such as ampicillin and aminoglycosides, but also because of the potential that the vancomycin-resistant genes present in VRE could be transferred to other gram-positive organisms such as *Staphylococcus aureus*. Because enterococci can be found in normal gastrointestinal and female gastrointestinal tracts, historically most enterococcal infections have been attributed to endogenous sources within the individual patient. However, reports of outbreaks by VRE have indicated that transmission can occur through direct hand contact with personnel or via contaminated patient-care equipment. From 1989 to 1993, the reported percentage of nosocomial enterococcal infections resistant to vancomycin increased from 0.3% to 7.9%. The occurrence of VRE was associated with larger hospital size and with university affiliation.[44] Patients at risk include those with severe underlying disease including immunosuppression, those with indwelling urinary or central venous catheters, and persons with history of prolonged hospital stay, especially with antimicrobial therapy.

Recommendations by the CDC's Hospital Infection Control Practices Advisory Committee (HICPAC) formulated recommendations for preventing and controlling the spread of vancomycin resistance.

Since vancomycin has been reported consistently as a risk factor for infection and colonization with VRE, the CDC has formulated the following guidelines for acceptable use of vancomycin:[45]

- Treatment of serious infections caused by beta-lactam-resistant gram-positive microorganisms.
- Treatment of infections caused by gram-positive organisms in patients with serious allergies to beta-lactams.
- Treatment of antibiotic-associated colitis unresponsive to metronidazole.
- Prophylaxis for endocarditis following high-risk procedures as recommended by the American Heart Association.
- Prophylaxis for major surgical procedures involving implantation of prosthetic materials or devices at institutions with high rates of MRSA infections. (*See Table 2.*)

Situations that arise in emergency care in which the use of vancomycin should be **discouraged** include:

- Routine surgical prophylaxis other than in a patient who has a life-threatening allergy to beta-lactam antibiotics.
- Empiric antimicrobial therapy for a febrile neutropenic patient, unless there is evidence that the patient has an infection caused by gram-positive organisms (as at the site of an inflamed Hickman catheter) and the presence of MRSA in the hospital is substantial.
- Treatment in response to a single blood culture positive for coagulase-negative staphylococcus (where contamination of the blood culture is likely).
- Primary treatment of antibiotic-associated colitis.
- Treatment for beta-lactam sensitive gram-positive infections in patients with renal failure.
- Use of vancomycin solution for topical irrigation.
- Local prophylaxis for infection or colonization of indwelling central or peripheral intravascular catheters.

Tuberculosis. Multiple factors have contributed to the resurgence of tuberculosis (TB) in the general population. These relate to the HIV epidemic; outbreaks of multi-drug resistant TB; increasing numbers of other immunosuppressed patients including those on steroids, on dialysis, and post-transplantation; and the presence of unrecognized pulmonary or laryngeal TB, notably among immigrant and homeless populations. Alcohol-dependent patients and injection drug users are also at risk. The ED treats all of these groups routinely.

Health care personnel should wear an N95 respirator when entering a room of a patient with known or suspected tuberculosis. If possible, a surgical mask should be placed on the patient, and movement and transport of the patient minimized. Patients should be educated about the purpose of such isolation, and encouraged to cover their nose and mouth when coughing or sneezing.[21] Any patient with significant suspicion for active pulmonary or laryngeal TB should be placed in a negative pressure isolation room.[20] Person-to-person transmission of TB occurs via transmission of airborne particles, or droplet nuclei, 1-5 µm in diameter. Airborne infection isolation rooms ideally should have >12 air exchanges per hour, but at least 6 exchanges, with incoming air HEPA filters. Air exhaust should be directed outside.[19] If recirculation to general ventilation is unavoidable, HEPA filters should be installed in the exhaust ducts.[20]

It is important to note that the clinical and radiographic presentations of TB are often atypical in patients infected with HIV, especially when the CD4 count is < 200/ µL. These patients have a high incidence of extra-pulmonary TB and may have pulmonary disease with a normal chest x-ray.[46]

Particular procedures that place providers at increased risk of TB transmission have been shown to include: endotracheal intubation, bronchoscopy, sputum induction, and aerosol treatments.[20] Multi-drug resistant TB was reported from the New York City Department of Health in 1996. The authors noted that 86% of patients infected with TB resistant to isoniazid, rifampin, ethambutol, and streptomycin were HIV-infected.[47] This has implications for healthcare workers administering aerosol treatments in the ED, for example, with pentamidine.[48]

Discontinuation of TB isolation may be permitted, including release from a negative pressure isolation room, if all of the following conditions have been met: the patient is on effective therapy, is improving clinically, and three consecutive sputum samples collected on different days are smear-negative for acid-fast bacilli.[20] Management of healthcare workers infected with TB is beyond the scope of this report.

Influenza. Influenza is a seasonal disease, with the vast majority of cases occurring during the winter months from November through March. While the avian strain A (H5N1) has received much publicity due to its high virulence and over 200 deaths worldwide,[49] this discussion will focus on transmission of Influenza A and B in general. Influenza can be transmitted from person to person via direct contact with contaminated articles, by droplet (> 10 µm) transmission released by sneezing or coughing, resulting in contact with nasal, oral, or conjunctival mucosa of another person, or by airborne transmission leading to inhalation of small (< 5 µm) nuclei suspended in the air. Laboratory tests, some commercially available in the ED that provide confirmation of infection within 30 minutes include rapid antigen testing, polymerase chain reaction, immunofluorescence, serology from various respiratory specimens: nasopharyngeal swab, throat swab, nasal wash, nasal aspirate, sputum, bronchial wash. Sensitivity exceeds 70% and specificity is greater than 90% for these tests.[19]

The principal known preventive measure to decrease the likelihood of individuals contracting influenza and lessen the burden of a public health crisis from influenza is immunization. Data indicate the value of using the ED for influenza immunization; the number of patients at high risk, including the elderly and nursing home patients who have been un-immunized presenting for emergency care has been well-documented.[50,51]

The American College of Emergency Physicians has endorsed the following principles regarding the use of the emergency department in outbreaks of influenza:

- All healthcare workers, including ancillary staff, nurses, and EMS personnel, should be immunized against influenza.
- Rapid screening, identification, and infection control intervention should be implemented in the ED.
- The practice of boarding in-patients in the ED should be ended, with a view to distributing admitted ill influenza patients together in the hallways of the ED.
- Regional protocols should be developed and implemented to monitor in-patient and ED capacity, as well as ambulance diversion status.
- Require hospitals and communities severely affected by influenza to postpone elective admissions until the crisis abates.
- Provide federal and state funding to compensate hospitals and EDs for unreimbursed costs incurred during a public health challenge.[52]

Disease Reporting and Quarantine

The list of reportable diseases varies by state, and timeliness for reporting varies by disease. Cases of gonorrhea may be reported weekly, while smallpox must be reported immediately. Quarantine is authorized for SARS, cholera, diphtheria, plague, smallpox, yellow fever, tuberculosis, and viral hemorrhagic fever.[19]

Conclusions

Healthcare-associated bacterial infections are most commonly transmitted on the hands of healthcare workers. As a result, good hand hygiene is considered an essential measure for reducing the spread of pathogens. A number of approaches can be tried to eliminate bacterial carriage in patients. The efficacy of such treatments is controversial. The principal means for healthcare workers to decrease the spread of influenza is immunization.

References

1. Garner JS. Hospital Infection Control Practices Advisory Committee. Guideline for isolation precautions in hospitals, second edition: Part 2: Rationale and recommendations. *Infect Control Hosp Epidemiol* 1996;17:53.
2. Weinstein RA. Nosocomial infection update. *Emerg Infect Dis* 1998;4:416.
3. O'Leary DS. The Joint Commission. Comments at Infection Control Conference, November 17, 2003.
4. Friedman ND, Sexton DJ. General principles of infection control. UpToDate at http://patients.uptodate.com/topic.asp?file=hosp_inf/5465. Accessed 5/20/2007.
5. Centers for Disease Control and Prevention. Guidelines for Hand Hygiene in Healthcare Settings. *MMWR Recomm Rep* 2002;51(RR-16):1.
6. Gordin FM, Schultz ME, Huber RA, et al. Reduction in nosocomial transmission of drug-resistant bacteria after introduction of an alcohol-based handrub. *Infect Control Hosp Epidemiol* 2005;26:650-653.
7. Pittet D, Hugonnet S, Harberth S, et al. Effectiveness of a hospital-wide programme to improve compliance with hand hygiene. *Lancet* 2000;356:1307.
8. Doebelling BN, Stanley GL, Sheetz CT, et al. Comparative efficacy of alternative handwashing agents in reducing nosocomial infections in intensive care units. *N Engl J Med* 1992;327:88.
9. Centers for Disease Control and Prevention web site. http://www.cdc.gov/ncidod/dhqp/gl_isolation_standard.html. Accessed 5/20/07.
10. Pittet D, Mourouga P, Perneger TV. Compliance with handwashing in a teaching hospital. *Ann Intern Med* 1999;130:126.
11. Whitehouse JD, Sexton DJ, Kirkland KB. Infection control: past, present, and future issues. *Compr Ther* 1998;24:71.
12. Weinstein JW. Isolation Guidelines for Hospitals. http://patients.uptodate.com/topic.asp?file=hosp_inf/6104. Accessed 5/20/07.
13. Hall CB, Douglas RO. Modes of transmission of respiratory syncytial virus. *J Pediatr* 1981;99:100.
14. Centers for Disease Control and Prevention web site. http://www.cdc.gov/ncidod/dhqp/gl_isolation_droplet.html. Accessed 5/20/07.
15. Lau JT, Fung KS, Wong TW, et al. SARS transmission among hospital workers in Hong Kong. *Emerg Infect Dis* 2004;10:280-286.
16. Ho AS, Sung JJ, Chan-Yeung M. An outbreak of severe acute respiratory syndrome among hospital workers in a community hospital in Hong Kong. *Ann Intern Med* 2003;139:564-567.
17. Varia M, Wilson S, Sarwal S, et al. Investigation of a nosocomial outbreak of severe respiratory syndrome in Toronto, Canada. *CMAJ* 2003;169:285-292.
18. Skowronski DM, Petric M, Daly P, et al. Coordinated response to SARS, Vancouver, Canada. *Emerg Infect Dis* 2006;12:115-118.
19. Rothman RE, Irvin CB, Moran GJ, et al. Respiratory hygiene in the emergency department. *Ann Emerg Med* 2006;48:570-582.
20. Centers for Disease Control and Prevention. *MMWR Recommendations and Reports* 1994;43(RR13):1-132.
21. Centers for Disease Control and Prevention web site. http://www.cdc.gov/ncidod/dhqp/gl_isolation_airborne.html. Accessed 5/20/07.
22. US Department of Health and Human Services. HHS Pandemic Influenza Plan. Supplement 4 Infection Control, Part 4 D. Occupational Health issues. Available at http://www.hhs.gov/pandemicflu/plan/sup4.html#occ. Accessed 10/02/07.
23. Kamps BS, Hoffman C, eds. Prevention. *SARSReference*. Flying Publisher; 2006. Available at http://www.sarsreference.com/sarsref/prevent.htm. Accessed 10/02/07.
24. Centers for Disease Control and Prevention. Key facts about seasonal flu vaccine. Available at http://www.cdc.gov/flu/protect/keyfacts.htm. Accessed 10/02/07.
25. Carman WF, Elder AG, Wallace LA, et al. Effects of influenza vaccination of health care workers on mortality of elderly people in long-term care: A randomized control trial. *Lancet* 2000;355:93-97.
26. Klugman KP, Mahdi SA. Pneumococcal vaccines and flu preparedness. *Science* 2007;316:49-50.
27. Centers for Disease Control and Prevention. Interim guidance: ground emergency medical transport for severe acute respiratory syndrome patients. Available at http://www.cdc.gov/ncidod/sars/guidance/I/prehospital.htm. Accessed 10/02/07.
28. Silverman A, Simor A, Loutfy MR. Toronto emergency medical services and SARS. *Emerg Inf Dis* September 2004.
29. Rueckmann EA, Shah M, Humiston S. Cross-sectional investigation of influenza vaccination among prehospital and emergency department health care providers. *Prehosp Emerg Care* 2007;11:119-120.
30. Singer J, Dowler M, Bosscher B. Emergency department perspective on methicillin-resistant *Staphylococcus aureus*. P*ed Emerg Care* 2006;22:270-279.
31. Barrett FF, McGehee RF Jr, Finland M. Methicillin-resistant *Staphylococcus aureus* at Boston City Hospital. Bacteriologic and epidemiologic observations. *N Engl J Med* 1968;279:441-448.
32. Boyce JM. Prevention and control of methicillin-resistant or vancomycin-resistant *Staphylococcus aureus*. UpToDate at http://patients.uptodate.com/topic.asp?file=gram_pos/6908. Accessed 8/8/2007.
33. Naimi TS, LeDell KH, Como-Sabetti K, et al. Comparison of community and healthcare-associated methicillin-resistant *Staphylococcus aureus* infection. *JAMA* 2003; 290:2976-2984.
34. Herold BC, Immergluck LC, Maranan MC, et al. Community-acquired methicillin-resistant *Staphylococcus aureus* in children with no identified predisposing risk. *JAMA* 1998;279:593-598.
35. Moran GJ, Krishnadasan A, Gorwitz RJ, et al. Methicillin-resistant *S. aureus* infections among patients in the emergency department. *N Engl J Med* 2006;355:666-674.
36. Bates B. Quicker, simpler tests sought for MRSA screening. *ACEP News* April 2007:9.
37. Centers for Disease Control and Prevention. Severe methicillin-resistant Staphylococcus aureus community-acquired pneumonia associated with influenza—Louisiana and Georgia December 2006–January 2007. *MMWR* 2007;56:325-329.
38. Boyce JM. MRSA patients: Proven methods to treat colonization and infection. *J Hosp Infect* 2001;48(suppl A):S9-14.
39. Zetola N, Francis JS, Nuermberger EL, et al. Community-acquired methicillin-resistant *Staphylococcus aureus*: An emerging threat. *Lancet Infect Dis* 2005;5:275-286.
40. Garner JS. Guidelines for isolation precautions in hospitals. Part I. Evolution of isolation practices. *Am J Infect Contro*l 1996;24:24-31.
41. Thompson RL, Cabezudo I, Wenzel RP. Epidemiology of nosocomial infections caused by methicillin-resistant *Staphylococcus aureus*. *Ann Intern Med* 1982;97:309.
42. Shitrit P, Gottesman BS, Katzir M, et al. Active surveillance for methicillin-resistant *Staphylococcus aureus* (MRSA) decreases the incidence of MRSA bacteremia. *Infect Contol Hosp Epidemiol* 2006;27:1004.
43. Centers for Disease Control. Recommendations for preventing the spread of vancomycin resistance. Recommendations of the Hospital Infection Control Practices Advisory Committee. *MMWR* September 22,1995;44(RR12):1-13.

44. Centers for Disease Control and Prevention. Nosocomial enterococci resistant to vancomycin—United States 1989-1993. *MMWR* 1993;42:597-991.
45. Centers for Disease Control. Recommendations for preventing the spread of vancomycin resistance. Recommendations of the Hospital Infection Control Practices Advisory Committee. *MMWR* September 22,1995;44(RR12):1-13. Centers for Disease Control and Prevention web site. http://www.cdc.gov/MMWR/preview/MMWRhtml/00039349.htm. Accessed 7/16/2007.
46. Perlman DC, el-Sadr WA, Nelson ET, et al. Variation of chest radiographic patterns in pulmonary tuberculosis by degree of human immunodeficiency virus-related immunosuppression. *Clin Infect Dis* 1997;25:242-246.
47. Frieden TR, Sherman LF, Maw KL, et al. A multi-institutional outbreak of highly drug-resistant tuberculosis: Epidemiology and clinical outcomes. *JAMA* 1996;276:1229-1232.
48. Zachary KC. Infection control issues in tuberculosis. UpToDate April, 2007: 1-13 at http://patients.uptodate.com/topic.asp?file=tubercul/10452.
49. Monto A. The threat of an avian influenza pandemic. *N Engl J Med* 2005;352:323-325.
50. Polis M, Smith J, Sainer D. Prospects for an emergency department-based adult immunization program. *Arch Intern Med* 1987;147:1999-2001.
51. Polis M, Davey V, Collins E, et al. The emergency department as part of a successful strategy for increasing adult immunization. *Ann Emerg Med* 1988;17:1016-1018.
52. American College of Emergency Physicians. Emergency Department Utilization During Outbreaks of Influenza. Policy # 400558, Approved November 2004. Available at http://www2.acep.org/3,34389,0.html. Accessed 10/02/07.

Physician CME Questions

81. The recognition that infections might be transmitted by healthcare personnel within hospitals to susceptible patients is generally dated to the spread of what infectious process?
    A. Methicillin-resistant *S. aureus*
    B. Tuberculosis
    C. Vancomycin-resistant enterococcus
    D. Puerperal fever from lack of handwashing

82. The CDC has estimated that healthcare-associated infections each year result in approximately how many deaths annually in the United States?
    A. 9000
    B. 23,000
    C. 90,000
    D. 300,000

83. The majority of nosocomial infections are spread by what means?
    A. Respiratory droplets
    B. Airborne infections
    C. Contact via the hands of hospital personnel
    D. Contamination of food

84. Which has *not* been found to be true regarding handwashing?
    A. Alcohol-based hand rubs are recommended for general use by the CDC Hand Hygiene Guidelines.
    B. Alcohol-based hand rubs are considered more effective than handwashing in reducing bacterial counts on the hands of healthcare workers.
    C. An observational study found a decrease in the nosocomial acquisition of methicillin-resistant *Staphylococcus aureus* (MRSA) and vancomycin-resistant enterococci (VRE) with a switch from handwashing to an alcohol-based hand rub.
    D. With the use of alcohol-based handrubs, the incidence of *Clostridium difficile* (*C. difficile*) colitis in hospitals has been demonstrated to decrease.

85. When is handwashing recommended by the CDC?
    A. When the hands are visibly soiled
    B. After touching blood
    C. Between patient contacts and before eating
    D. All of the above and after using a restroom

86. What is *not* an element of standard precautions to reduce the risk of transmission of infectious agents from patient to healthcare worker and vice versa?
    A. Cleansing clothing with chlorhexidine
    B. Handwashing before and after every patient contact
    C. The use of gowns, gloves, and eye protection in situations in which exposure to body secretions or blood is likely or possible
    D. The safe disposal of sharp instruments and needles in impervious containers

87. Which organism tends *not* to be spread via airborne spread or respiratory droplets?
    A. *Neisseria meningitides*
    B. *Clostridium difficile*
    C. *Mycobacterium tuberculosis*
    D. Varicella-zoster virus

88. There is uniform agreement that healthcare workers should be immunized specifically against which one entity?
    A. Hepatitis A
    B. Influenza
    C. Hemophilus Type B
    D. *Neisseria meningitides*

89. The most common mechanism of MRSA transmission is contact from person to person.
    A. True
    B. False

90. Which of the following is considered a risk factor for MRSA carriage?
    A. Antibiotic use within the past 3 months
    B. Hospitalization within the past 12 months
    C. HIV infection
    D. All of the above

CME Answer Key

81. D; 82. C; 83. C; 84. D; 85. D; 86. A; 87. B; 88. B; 89. A; 90. D

Emergency Medicine Reports®
The Practical Journal for Emergency Physicians

ED Infection Control

CDC Handwashing Recommendations

According to the CDC, handwashing is recommended:

- After touching blood, bodily fluids, secretions, and contaminated items, whether or not gloves are worn;
- Between patient contacts
- Before eating
- After using the restroom

Infection Control Strategies for MRSA

- Hand hygiene. This has been shown to decrease nosocomial infections in multiple reports.
- Detection of asymptomatic colonization by surveillance cultures, generally from the nares, but also from open wounds. Active surveillance cultures may be particularly beneficial for patients in intensive care, burn, or oncology units, or those undergoing bone marrow transplant.
- Contact precautions, including private rooms, possibly cohorting colonized or infected patients when private rooms are scarce, and use of gowns and gloves for all patient contact.
- Decontamination of the environment: disinfecting bed rails, tables in close proximity to the patient.
- Eradication of MRSA carriage: intranasal mupirocin 2-3 times a days for three to five days, 4% chlorhexidine baths.
- Possibly, judicious use of antibiotic drugs.

Guidelines for Use of Vancomycin

- Treatment of serious infections caused by beta-lactam-resistant gram-positive microorganisms.
- Treatment of infections caused by gram-positive organisms in patients with serious allergies to beta-lactams.
- Treatment of antibiotic-associated colitis unresponsive to metronidazole.
- Prophylaxis for endocarditis following high-risk procedures as recommended by the American Heart Association.
- Prophylaxis for major surgical procedures involving implantation of prosthetic materials or devices at institutions with high rates of MRSA infections.

ED Situations in which Vancomycin Use Should Be Discouraged

- Routine surgical prophylaxis other than in a patient who has a life-threatening allergy to beta-lactam antibiotics.
- Empiric antimicrobial therapy for a febrile neutropenic patient, unless there is evidence that the patient has an infection caused by gram-positive organisms (as at the site of an inflamed Hickman catheter) and the presence of MRSA in the hospital is substantial.
- Treatment in response to a single blood culture positive for coagulase-negative staphylococcus (where contamination of the blood culture is likely).
- Primary treatment of antibiotic-associated colitis.
- Treatment for beta-lactam sensitive gram-positive infections in patients with renal failure.
- Use of vancomycin solution for topical irrigation.
- Local prophylaxis for infection or colonization of indwelling central or peripheral intravascular catheters.

Recommendations for the Use of Emergency Departments in Outbreaks of Influenza

- All healthcare workers, including ancillary staff, nurses, and EMS personnel, should be immunized against influenza.
- Rapid screening, identification, and infection control intervention should be implemented in the ED.
- The practice of boarding in-patients in the ED should be ended, with a view to distributing admitted ill influenza patients together in the hallways of the ED.
- Regional protocols should be developed and implemented to monitor in-patient and ED capacity, as well as ambulance diversion status.
- Require hospitals and communities severely affected by influenza to postpone elective admissions until the crisis abates.
- Provide federal and state funding to compensate hospitals and EDs for unreimbursed costs incurred during a public health challenge.

Supplement to *Emergency Medicine Reports*, October 15, 2007: "Infection Control and the Emergency Department." *Author:* **Jonathan M. Glauser, MD**, Department of Emergency Medicine, Cleveland Clinic Foundation, Cleveland, OH.