

Evidence-Based Monitoring Strategies and Interventions for Antibiotic Resistant Organisms

January 2008



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Executive Summary

Since the 1960s, multidrug-resistant organisms (MDROs) have caused serious infections and have been transmitted in hospitals around the world. One of these organisms, methicillin-resistant *Staphylococcus aureus* (MRSA) is receiving increased attention due to a national report on the growing number of cases in hospitals and in communities.

Severely ill patients are the most vulnerable to serious MRSA infections. Much like national trends, MRSA rates in Washington have increased significantly in hospital and community settings. The incidence of new infection is similar across the regions of the state.

Governor Christine O. Gregoire directed the Department of Health to convene a Scientific Expert Panel to answer the following question: *“What are evidence-based recommendations for the most effective monitoring strategies and interventions for all antibiotic resistant organisms, including MRSA?”*

Options for responding to MRSA and other multidrug-resistant organisms include effectively treating infections, preventing person-to-person transmission and taking steps to prevent drug resistance. Monitoring MDROs is required to successfully implement and measure any of these responses. Measures for MDRO control that have been successful in health care facilities include hand washing, surveillance, infection control measures, environmental cleaning, and restrictions on, or oversight of, antibiotic use in certain clinical settings. Other measures are advocated as useful by experts based on suggestive evidence but are not proven, such as environmental cleaning and improved communication about patients with MDROs within and between health care facilities.

Since 2005, hospitals in Washington with the help of the Washington State Hospital Association have been collaborating to reduce the incidence of hospital acquired infections like MRSA. Washington is the first state to begin such a statewide collaboration with hand hygiene as the first focus of this work. National guidelines and performance bundles (a collection of evidence-based processes) for preventing the most common types of hospital infections have been implemented including those related to ventilators, central lines, and surgery which are essential for the reduction of MRSA. All Washington hospitals have joined the Institute for Healthcare Improvement’s “5 Million Lives Campaign” which focuses heavily on reducing infections, including MRSA. Hospitals currently conduct routine surveillance for certain MDROs based on the numbers and types of patients served. Variation in the methods and definitions that are used limit the ability to compare data from different facilities.

Community-associated MRSA infections are primarily evaluated and treated on an outpatient basis. There are limited methods of tracking occurrence other than laboratory-based surveillance. Unlike the health care setting, there is no national standard for surveillance of MRSA infections in the community. While there are multiple options for conducting community-based surveillance, all require significant resources.

The Centers for Disease Control and Prevention (CDC), the Washington State Department of Health and local health agencies have published a variety of targeted MRSA educational materials to inform health care providers, high-risk populations, MRSA-infected patients, and the general public about what MRSA is, how to prevent and treat MRSA, and how to reduce transmission.

Recommendations from the panel emphasize keeping patients and the public safe from infectious pathogens. It is the panel's hope that the necessary administrative, fiscal and human resource support will be provided to implement the following recommendations to prevent and control multidrug-resistant organisms.

The expert panel recommends the following monitoring and intervention strategies to:

- Inform and support infection control measures to decrease and prevent transmission of MRSA
- Monitor trends in the incidence of MRSA infections in Washington
- Help guide the development of educational materials for the public and health care providers on ways to prevent and treat MRSA infections

Monitoring Recommendations

Monitoring Recommendation #1:

Conduct standardized hospital-based surveillance to prevent transmission of multidrug-resistant organisms (MDROs) among high risk patients for that hospital.

Monitoring Recommendation #2:

Conduct voluntary, sentinel surveillance to include community-associated MRSA and reporting of results through state and local health.

Monitoring Recommendation #3:

Monitor trends in antibiotic resistance patterns using laboratory data.

Intervention Recommendations – Inpatient Setting

Intervention Recommendation #1:

Standardize the implementation of the Centers of Disease Control and Prevention/Healthcare Infection Control Practices Advisory Committee guideline, *Management of Multidrug-Resistant Organisms in Healthcare Settings, 2006*.¹⁶

Intervention Recommendation #2:

Routinely implement a collection of evidence-based processes known as performance bundles to prevent central line infections and promote best ventilator care to prevent occurrence and transmission of infections due to multidrug-resistant organisms (MDROs).

Intervention Recommendation #3:

Promote judicious antibiotic use.

Intervention Recommendations – Community Setting

Intervention Recommendation #4:

Adopt guidelines intended to prevent transmission of MDROs in the community.

Intervention Recommendation #5:

Inform and educate health care providers, patients, high-risk populations, and the public about MRSA and MDROs.

Intervention Recommendation #6:

Increase resources to facilitate wound care and MRSA transmission prevention in underserved populations.

Intervention Recommendation #7:

Promote the judicious use of antibiotics in outpatient settings and in animals (agricultural).

Context

Multidrug-resistant organisms (MDROs) pose a serious and increasing health threat in Washington and nationally. These organisms are infection-causing bacteria that can inactivate antibiotics or change the antimicrobial activity of drugs typically used to treat them.

Multidrug-resistant organism infections are a serious cause for concern for a variety of reasons:

- Infectious diseases are the third leading cause of death in America
- More than 70 percent of infection-causing bacteria acquired in American hospitals are resistant to at least one of the principal drugs used to treat them
- The greatest increase in MRSA, one type of MDRO, is in community-based purulent (containing pus) skin and soft tissue infections
- Infections caused by MDROs pose a higher risk of death than infections caused by strains that can be treated with antibiotics
- Multidrug-resistant organism infections result in longer hospital stays and higher treatment costs
- Options for treating MDRO patients are often very limited
- Transmission of MDROs within health care institutions commonly reflect deficiencies in patient care practices
- Continued overuse of antibiotics in humans and agriculture contributes to the proliferation of potentially serious MDROs

The most common MDRO is methicillin-resistant *Staphylococcus aureus* (MRSA). Staph and other skin organisms can persist on a person without causing infections. The organisms are transmitted by person-to-person contact or through contact with contaminated objects. Like all *S. aureus*, MRSA can cause mild to serious infections. It is resistant to the antibiotics typically used to treat *S. aureus*, including commonly used antibiotics related to methicillin (a semi-synthetic penicillin).

Methicillin-resistant *Staphylococcus aureus* arose soon after the introduction of methicillin in the 1960s, initially in health care settings. Transmission has been associated with serious infections around the world. Currently, MRSA accounts for 64 percent of *S. aureus* in American intensive care units. Severely ill patients are the most vulnerable to serious MRSA infections, especially people with compromised immune systems, those who had recent surgeries or implanted medical devices. Both hospitals and long-term care facilities have experienced increased incidences of MRSA infection.

Methicillin-resistant *Staphylococcus aureus* infections are categorized as health care-associated and community-associated, depending on where the infection was likely to have

been acquired. Methicillin-resistant *Staphylococcus aureus* (MRSA) infections likely to have been acquired from health care settings (including hospitals, long-term care facilities, and outpatient clinics) or procedures are considered health care-associated. The infection may be diagnosed in the health care facility or after discharge to the community. Risk factors and interventions to decrease health care-associated MRSA infections have been extensively studied, and recommendations to decrease them have been developed by authoritative professional organizations.

More recently, MRSA has been recognized as an increasing cause of infection in the community in people without previous health care contact. Community-associated infections are acquired and usually diagnosed outside a health care facility. A recent national study estimated that 85 percent of serious invasive MRSA infections are hospital associated and 15 percent occur in the community.⁹

Community-associated infections mostly affect the skin and soft tissue; however, more invasive infections involving the blood, bone and joints, and lungs have been reported. In Pierce County and Region 7 (Chelan, Douglas, Okanogan, Kittitas, and Grant counties), 78-80 percent of reported MRSA cases are skin and soft tissue infections.

Most community-associated MRSA infections can be treated with drainage alone or a combination of abscess drainage and using other readily available antibiotics. A small proportion of community-associated MRSA infections result in severe disease, including death.

Risks for contracting MRSA in the community include living in over-crowded conditions, low socioeconomic status, practicing poor hygiene, and having a cut or other open wound. Methicillin-resistant *Staphylococcus aureus* can be spread from person-to-person and through sharing equipment or personal hygiene items such as towels, razors and bar soap. It may also be contracted by touching an infected surface. Sports teams, military personnel, correctional facility inmates, people with chronic skin disorders, and intravenous drug users are groups that are often at risk because of these factors.

Although health care-associated and community-associated MRSA were distinct in the past, with different genetic strains identifiable from each setting, the distinction is now less clear. Methicillin-resistant *Staphylococcus aureus* acquired in the hospital may be transmitted in the community and persons infected in the community may transmit MRSA in the hospital. Since the onset of infection may be different than the setting where the infection was acquired, infections are also considered hospital onset or community onset. A health care-associated infection may start in the hospital or after discharge to the community.

Governor Gregoire directed the Washington State Department of Health to convene the Scientific Expert Panel in the winter of 2007. The panel was tasked with answering the following question: “*What are evidence-based recommendations for the most effective monitoring strategies and interventions for all antibiotic resistant organisms, including MRSA?*” The panel made its recommendations based on the best available science.

Introduction

Methodology

The Scientific Expert Panel, co-chaired by Drs. Maxine Hayes and Robert Thompson, included expert members from multiple disciplines. (Appendix One) The panel convened December 7 and 21, 2007, to examine and discuss data, references, and resources from publications, national organizations (Centers for Disease Control and Prevention (CDC), Association for Professionals in Infection Control and Epidemiology (APIC), Healthcare Infection Control Practices Advisory Committee (HICPAC), Society for Healthcare Epidemiology of America (SHEA), and health care facilities and infectious disease experts across the state of Washington.

Research to determine the most effective measures in preventing the transmission of multidrug-resistant organisms (MDROs) such as methicillin-resistant *Staphylococcus aureus* (MRSA) has been mainly conducted in the health care setting, with very little data available on community interventions. Due to the small number of randomized controlled studies in infection control, it is difficult to determine the effectiveness of individual interventions. It is also difficult to identify effective individual interventions because multiple interventions are often used simultaneously to reduce transmission.

National infection control organizations have developed the guidelines for the prevention and management of MDROs based on the best available evidence. In those areas where there is a lack of scientific evidence, expert panels developed consensus recommendations. The preventive measures in the documents listed below were used to guide the panel's recommendations:

SHEA Guideline for Preventing Nosocomial Transmission of Multidrug-Resistant Strains of *Staphylococcus aureus* and *Enterococcus*. May 2003.¹²

HICPAC Management of Multidrug-Resistant Organisms in Healthcare Settings, 2006.¹⁶

APIC Guide to the Elimination of Methicillin-Resistant *Staphylococcus aureus* (MRSA) Transmission in Hospital Settings. March 2007.⁵

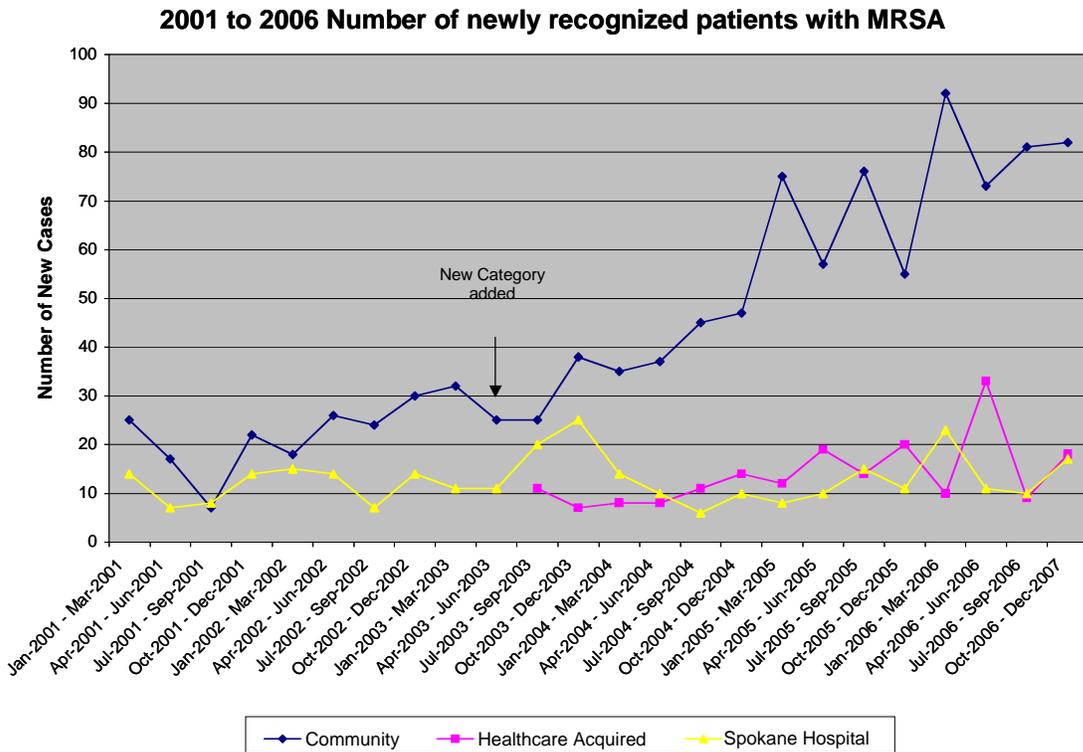
Expert Panel of Canadian Infectious Disease, Infection Prevention and Control and Public Health Specialists -- Guidelines for the Prevention and Management of community-associated methicillin-resistant *Staphylococcus aureus*: A perspective for Canadian health care practitioners. October 2006.¹

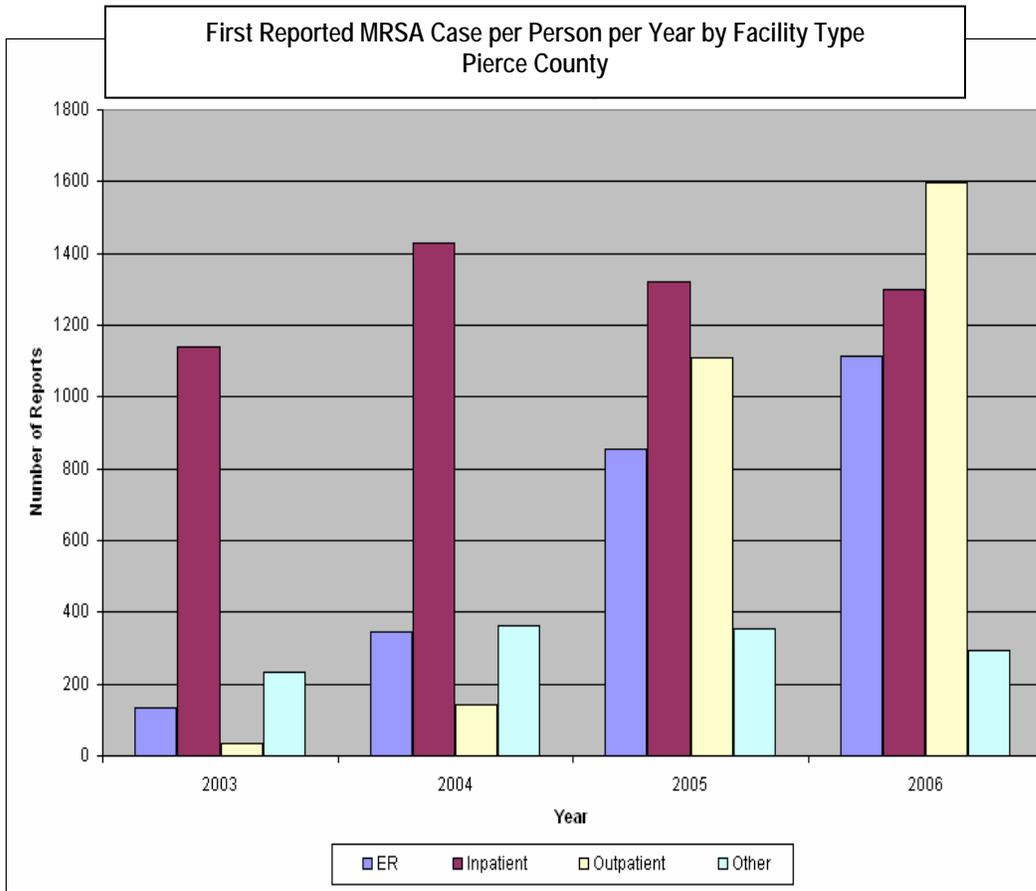
Current Situation in Washington

The Department of Health conducted laboratory antibiogram based surveillance statewide from 2002-2004 of over 2,200 methicillin-resistant *Staphylococcus aureus* (MRSA) and other drug-resistant bacterial isolates from sentinel sites across the state. The department

found that the overall MRSA rate increased from 28 percent of all laboratory-reported *S. aureus* isolates to 43 percent and the community-associated rate increased from 19 percent to 35 percent.¹⁹

Population-based surveillance performed by Region 7 in Central Washington, Tacoma-Pierce County Health Department, Group Health Cooperative in five counties in Western Washington, and a hospital in Spokane, demonstrated increased incidence of new community-onset MRSA infections in well-defined populations. The incidence of new MRSA infection increased at least 20 fold between 2001 and 2006. Similar trends were reported from King County hospitals beginning in 2002 until the present. These data from sentinel sites indicate that the incidence of new infection is similar across the regions of the state. These trends are similar to those seen nationally.





Current Activity in Washington to Address Multidrug-Resistant Organisms (MDROs)

Many activities are underway to reduce the spread and incidence of MDROs in Washington. This includes activities by hospitals around the state with support from the Washington State Hospital Association, Department of Health, local health agencies, and various professional societies such as Association for Professionals in Infection Control and Epidemiology (APIC).

Since 2005, hospitals in Washington began the first statewide collaborative to share best practices and learn strategies to reduce hospital acquired infections from local and national experts. The experts include the Centers for Disease Control and Prevention (CDC), Institute for Healthcare Improvement (IHI), and Pittsburgh Veterans Administration. These organizations have shared best practices and the latest medical evidence. Improving hand hygiene compliance is a core strategy to reduce infection. Washington hospitals have implemented the first statewide 24 hour a day, seven days a week hand hygiene compliance measurement through soap and sanitizer use and/or observation.

Washington is also the first large state to have 100 percent of hospitals participate in the Institute for Healthcare Improvement's "5 Million Lives Campaign." This campaign focuses on implementation of a group of evidence-based processes to reduce hospital acquired infections. Washington hospitals with the assistance of the Washington State Hospital Association have been using these processes to reduce the rates of ventilator infections and central line infections to close to zero in many hospitals.

In addition, Washington's community and patient education efforts are being held up as a national example. The locally developed brochure, "Living with MRSA,"¹⁰ along with toolkits for schools, outpatient clinics/offices, and child care centers are being used around the country. These resources were developed by the Washington State Department of Health, Tacoma-Pierce County Health Department, and Group Health Cooperative in conjunction with the hospitals in Pierce County. These materials along with other MRSA fact sheets for various audiences are available on the Internet.

Guidelines for the evaluation and management of community-associated MRSA skin and soft tissue infections in outpatient settings (Appendix B) were developed in 2004 and updated in 2007 for health care providers in Washington through a collaborative effort of the Infectious Disease Society of Washington, Public Health – Seattle & King County, Tacoma-Pierce County Health Department, and the state Department of Health. This document is available to clinicians in the state and has been requested by public health agencies outside of Washington.

Research on the effectiveness of interventions is limited in all settings. That is especially true regarding MDROs in the community. Interventions that have been adopted by public health practitioners in the United States and Canada include educational brochures and other printed information for the public, schools, and businesses, Web-based resources, and guidelines for health care providers.

Information on Surveillance

It is important to make a distinction between surveillance and individual case reporting. Surveillance is the ongoing, systematic collection, analysis, interpretation, and dissemination of disease data for use in public health actions to reduce morbidity and mortality and to improve health.² Surveillance is accomplished through a variety of methods depending on the setting (i.e., hospitals versus community versus laboratory-based) and may include individual case-reporting when necessary. For example, it is often important for hospital infection control professionals to identify individual cases to control transmission in health care facilities. This surveillance is very resource intensive and is focused on the organisms that put patients in that hospital or health care institution at risk.

Reporting of individual cases of community-associated MRSA infection is highly resource intensive for both health care providers and public health agencies. This type of tracking is not necessary to guide prevention interventions because less costly and more reliable methods are available to provide the information needed (e.g., monitoring aggregate data sources such as antibiotic resistance data and sentinel surveillance systems).

Health care-associated multidrug-resistant organism (MDRO) Surveillance

Health care-associated MDROs include multidrug-resistant organisms that are primarily acquired or are transmitted in health care settings. In addition to MRSA, there are a number of other MDROs that cause serious human infections including *S. aureus* and enterococci with reduced susceptibility to vancomycin, *Enterobacteriaceae* resistant to powerful extended spectrum beta-lactamase drugs, and multi-drug resistant *Acinetobacter* and *Pseudomonas* species.

The CDC in “Management of Multidrug- Resistant Organisms in Healthcare Settings, 2006”¹⁶ provides directions to health care settings on surveillance. The expert panel recommends using these surveillance guidelines with consistent methods and definitions so every patient gets the recommended care.

This surveillance should be designed to provide care based upon the MDROs impacting that health care facility. For example, the organisms under surveillance at a multi-state regional trauma center will have to be different than the organisms under surveillance at a small rural hospital. The organisms will also likely change with time.

Community-associated methicillin-resistant *Staphylococcus aureus* (MRSA) Surveillance

Although precise figures are not available, national estimates suggest that there are several thousand community-associated MRSA infections each year in Washington. The majority of community-associated MRSA infections are uncomplicated skin and soft tissue infections that are evaluated and treated on an outpatient basis in a variety of health care settings. Mild infections may not be seen or tested by a health care provider.

Unlike the health care setting, there are no national standards for surveillance of MRSA infections in the community and no practical way to track individual cases of these infections. However, there are options for conducting community-based surveillance to guide prevention activities, including sentinel surveillance systems and laboratory-based surveillance. These systems require significant resources.

In addition, severe or life threatening community-associated cases could be identified by hospital surveillance systems that have that ability to classify cases as community versus health care associated.

Recommendations

The panel's recommendations are focused on keeping patients and the public safe from infectious pathogens. It is the panel's hope that the necessary administrative, fiscal and human resource support will be provided to help implement the following recommendations in order to prevent and control multidrug-resistant organisms.

Existing structures such as the Washington State Hospital Association's (WSHA) Safe Tables, which have been working to reduce infections in hospitals, will be used as a vehicle to continue implementing and sustaining the process of reducing MDROs in hospitals. At these WSHA Safe Tables more than 60 participants from large and small hospitals across the state come together to collaborate and improve care.

Options for responding to MDROs include preventing transmission, effectively treating infections, and preventing drug resistance through appropriate antibiotic use. Monitoring MDROs is required to successfully implement and measure any of these responses.

Some measures for MDRO control have proven effective. According to *Management of Multidrug-Resistant Organisms In Healthcare Settings, 2006*¹⁶:

“Successful control of MDROs in healthcare setting has been documented in the United States and abroad using a variety of combined interventions. These include improvements in hand hygiene, use of Contact Precautions until patients are culture-negative for a target MDRO, active surveillance cultures (ASC), education, enhanced environmental cleaning, and improvements in communication about patients with MDROs within and between health care facilities.”

The expert panel recommends the following monitoring and intervention strategies for a statewide program addressing MRSA. Infection control and prevention strategies for MRSA are expected to have a beneficial effect on the transmission of other MDROs, as well. Reducing health care-associated infections also reduces the need for antibiotics, which can slow the emergence of new MDRO strains.

Additional research is needed to define the most effective preventive measures for reducing MRSA transmission in the community setting. Pending additional research, the panel endorses the type of practical advice outlined in the “Living with MRSA”¹⁰ booklet, other currently available resources from the Centers for Disease Control and Prevention (CDC) and local health agencies, and MRSA guidelines for the prevention and management of community-associated MRSA from the *Expert Panel of Canadian Infectious Disease, Infection Prevention and Control, and Public Health Specialist*.¹

Monitoring recommendations are listed in order of priority along with the rationale for their ranking. Intervention recommendations are not ranked, and their rationale is provided jointly at the end of the two intervention recommendation subsections, those for hospital and community settings.

Monitoring Recommendations

Monitoring Recommendation #1:

Conduct standardized hospital-based surveillance to prevent transmission of multidrug-resistant organisms (MDROs) among high risk patients for that hospital.

Surveillance is a key component of hospital infection control strategies for MDROs. The panel agrees on the importance of hospital-based surveillance for invasive disease through hospital infection control or epidemiology programs. The panel recommends the standardized surveillance CDC definitions and methods as described in the “*Management of Multidrug-Resistant Organisms in Healthcare Settings, 2006.*”¹⁶

Multidrug-resistant organisms that are a frequent cause of serious human illness and for which there are interventions to prevent transmission or disease should be the targets of surveillance. Surveillance could be done for invasive MRSA cases among hospitalized patients to identify hospital-associated (nosocomial) and community-associated cases (those admitted with invasive disease) within each hospital. Other MDROs may also be considered.

The rationale behind making this recommendation the top priority is as follows:

Hospital-based surveillance (by infection control programs) provides an opportunity for the standardization of information and data. Hospital infection control programs, using standardized criteria, can identify invasive cases and differentiate between health care-associated versus community-associated infections. Hospital-based surveillance for infection is already being done on the national level, and those results can be used to help interpret data from Washington.

Recognizing the importance of using standard definitions and the advantage of comparison with national data, the panel recommends exploring the use of the CDC National Healthcare Safety Network MDRO module for surveillance of MDRO when it becomes available. However, this level of data entry may require significant resources and must be revisited once the module is completed, possibly summer 2008.

Monitoring Recommendation #2:

Conduct voluntary sentinel surveillance to include community-associated methicillin-resistant *Staphylococcus aureus* (MRSA) and reporting of results through state and local health agencies.

Sentinel surveillance provides information from a sample of the population that is representative of the larger population. The data are aggregated to identify trends, for example, in disease rates, antibiotic resistance patterns, and characteristics of the affected population.

Sentinel surveillance for incidence in defined populations (with known population size) is being done in Washington by:

- Region 7 (Central Washington) (surveillance already exists)

- Pierce County (surveillance already exists)
- HMO e.g., Group Health Cooperative (surveillance already exists)

Other local public health agencies could initiate sentinel programs if resources are available.

Sentinel surveillance programs may not provide complete information about specific sub-populations for which more complete data are needed. Point prevalence surveys with specific groups in the community would require additional resources but could provide valuable data.

The rationale behind making this recommendation the second-highest priority is as follows:

Conducting ongoing sentinel surveillance would provide health officials the necessary information to guide public health prevention activities. Point prevalence surveillance may lend additional data in select community settings. Individual health care organizations may choose to perform enhanced surveillance such as point prevalence studies for their patients, but such studies would be cumbersome and resource intensive to implement statewide.

Monitoring Recommendation #3:

Monitor trends in antibiotic resistance patterns using laboratory data

Antibiograms are reports generated by clinical laboratories that describe the susceptibility of infectious agents to a panel of commonly used antibiotics. The Department of Health should work with local health agencies and clinical laboratories in Washington to develop standardized antibiogram surveillance. Data would be provided in a format that can be analyzed by local public health professionals and aggregated into a statewide annual report by the Department of Health.

The rationale behind making this recommendation the third-highest priority is as follows:

Monitoring trends in resistance patterns using antibiograms is the most practical method to track and monitor changes in antibiotic resistance for a variety of infectious agents. Laboratory reporting of antibiograms for certain multidrug-resistant organisms provides useful data to guide clinical treatment decisions. Whenever possible, results from inpatient and outpatient should be separated to estimate health care onset and community onset rates.

Intervention Recommendations – Inpatient Setting

Intervention Recommendation #1:

Standardize the implementation of the Centers for Disease Control and Prevention (CDC)/Healthcare Infection Control Practices Advisory Committee (HICPAC) guideline *Management of Multidrug-Resistant Organisms in Healthcare Settings, 2006.*¹⁶

The CDC's MDRO transmission precautions should be adopted throughout all Washington health care institutions. These guidelines allow flexibility for individual institutions, where interventions should be based on institutions' individual assessments, and active surveillance screening can be used where indicated. The precautions include following Standard Precautions in all health care settings, using Contact Precautions, and recommendations for several specific health care settings (e.g. acute care settings).

The Safe Table led by the Washington State Hospital Association will be used to implement these guidelines. This information will be used by hospitals to guide infection control practices and share information on incidence and prevention strategies for MDROs including MRSA, vancomycin resistant enterococci, C.-difficile as well as other more serious infections.

Intervention Recommendation #2:

Routinely implement evidence-based processes, known as performance bundles, for preventing central line infections and promoting best ventilator care to prevent occurrence and transmission of infections due to multidrug-resistant organisms (MDROs).

Performance bundles prevent health care associated infections and increase the consistency of care delivery between institutions. Implementing these evidence-based practices reduces health care related infections that can result in decreased antibiotic use.

The Safe Table on Eliminating Hospital Acquired Infections led by the Washington State Hospital Association will continue to be used to implement the latest medical evidence including the performance bundles to prevent infections in hospitalized patients.

Intervention Recommendation #3

Promote judicious antibiotic use.

Leadership and medical staff of health care facilities should be encouraged to develop antimicrobial resistance programs to monitor and curb antibiotic use. The CDC/HICPAC guideline¹⁶ suggests that hospitals do the following:

- Review antibiograms to identify local susceptibility patterns and review “antimicrobial agents in the formulary, to foster appropriate antimicrobial use”
- “Implement systems...to prompt clinicians to use the appropriate agent and regimen” where possible
- “Provide clinicians with antimicrobial susceptibility reports and analysis of current trends...to guide antimicrobial prescribing practices” or, where infrastructures for such prompts are lacking, “implement a process to review antibiotic use” where possible

Clinical laboratories will routinely supply antibiograms to the hospitals and associated physicians they serve based on that hospital and clinician's data.

Rationale for inpatient setting intervention recommendations

The CDC's precautions¹⁶ for MDROs referenced in Recommendations 1 and 3, and performance bundles, referenced in Recommendation 2, are all national standards. These recommendations will facilitate agreement across the health care field and make care and practice consistent to ease the movement of health care providers and patients between facilities.

There is evidence to support some components of the CDC's precautions. In some cases there is no conclusive evidence to support an element of the CDC precautions; however, these recommendations come from experts in infection control and are based on the best available evidence.

Performance bundles are examples of evidence-based best processes developed by quality organizations such as the Institute for Healthcare Improvement to prevent health care-associated infections and increase the consistency of care delivery between institutions. Health care-associated infections are frequently due to MDROs. These infections are associated with increased patient morbidity and mortality, and require treatment with antibiotics that may further select for the emergence of resistance. Implementation of best-practice measures to prevent health care-associated infections may prevent infections due to MDROs and curb unnecessary antibiotic use.

Intervention Recommendations – Community Setting

Intervention Recommendation #4:

Adopt guidelines intended to prevent transmission of multidrug-resistant organisms (MDROs) in the community.

The panel recommends that settings with increased risk for transmission of MRSA (e.g. households of MRSA-infected persons, child care centers, schools, athletic facilities, wound care clinics, needle exchanges, correctional facilities and shelters) adopt basic infection control and personal hygiene practices based on information gathered from both community outbreak investigations and health care facility-based infection control studies. Proper management of people with active skin lesions should also be adopted in these community settings. Skin lesions are the wound type most likely to transmit infection.

According to the *Guidelines for the Prevention and Management of Community-Associated MRSA* from the Expert Panel of Canadian Infectious Disease, Infection Prevention and Control, and Public Health Specialists¹, prevention of transmission of MRSA and other common skin pathogens “requires consistent application and reinforcement of good hygienic practices with emphasis on handwashing, not sharing potentially contaminated personal articles, and covering of draining skin lesions to prevent direct or indirect contact with infected secretions of another person.” (Appendix C – pages 15C – 19C)

Recommendations for prevention of MRSA in the community should be reassessed as new information becomes available.

Intervention Recommendation #5:

Educate providers, high-risk populations, the public and patients about methicillin-resistant *Staphylococcus aureus* (MRSA) and multidrug-resistant organisms (MDROs).

Given the importance of person-to-person transmission, community-based health care providers have an important role in implementing recommendations for diagnosis, management, and infection control for MRSA. Patient education can inform adherence to hygienic practices and wound management which can decrease risk of transmission of MDROs. Public education efforts can help provide a more balanced perspective on the actual risk from MRSA, help those at increased risk for MRSA infections become aware of prevention measures, and inform adherence to hygienic practices that may decrease risk of infection.

Targeting educational materials to specific high risk populations and working with them to determine their needs may promote behavior change that will help prevent transmission of multidrug-resistant organisms. Pre-testing all educational materials can help assure that the right information is provided in an understandable and motivating format.

Public education focused on prevention, management and treatment should be delivered using a variety of approaches (brochures and handouts, audio/visual messaging, online message, face-to-face, etc.) to keep the public informed and to dispel any incorrect information they have heard. Prevention materials should emphasize precautions known to work in outbreak situations, e.g., hand washing and covering open wounds.

Standardized guidelines³ are available for health care providers on the outpatient management of skin and soft tissue infections. They were updated in December 2007 and are available on the Public Health-Seattle & King County and the Tacoma-Pierce County Health Department Web sites.

Methicillin-resistant *Staphylococcus aureus* patients should receive information to help them understand how to take care of themselves and how they can avoid transmitting MRSA to others. “*Living with MRSA*”¹⁰ is an excellent booklet developed with and for this population.

Intervention Recommendation #6:

Increase resources to facilitate wound care and methicillin-resistant *Staphylococcus aureus* (MRSA) transmission prevention in underserved populations.

Facilities serving people who live in overcrowded conditions, have little access to hygiene facilities or medical care and are at high risk for MRSA infections (e.g. shelters, soup kitchens, needle exchanges) should receive infection control and prevention recommendations that are targeted to their specific situations. Their clients should also receive this information.

Efforts should be made to determine and provide for wound care needs of underserved

populations, including the feasibility of providing care where and when they want it. When medically underserved populations use hospitals and emergency rooms for wound care, public agencies incur high costs, vulnerable patients are unnecessarily exposed to MRDO infections, and hospital beds are taken that could better be used for more acute conditions.

In Pierce County, the health department and local hospitals have funded a wound clinic that operates five days a week. Demand for services at this clinic, while never large, has diminished over time. However, the number of wound dressing kits provided through needle exchanges/shelters as well as the number of ER visits for MRSA continues to increase.

Rationale for community setting intervention recommendations

Studies of the effectiveness of community-based prevention and control interventions are lacking. In the absence of any evidence based evaluation of the effectiveness of potential community prevention measures, the panel considered indirect evidence from outbreak settings, the epidemiology and mechanism of transmission of MRSA, the persistence of the organism in the environment, and recommendations for prevention of MRSA in health care settings. One area that is particularly unclear is the role of a contaminated environment as compared with direct person-to-person contact in the transmission of MRSA.

Given that we know the importance of person-to-person transmission, health care providers, patients, and their families and caregivers all have important roles in implementing recommendations for diagnosis, management, and infection control for MRSA infections. Education for infected persons and their household members is important to prevent the spread of MRSA to people in close contact with those infected.

Educating people at high risk for MRSA and those who manage high-risk settings (e.g. sports team members and coaches, child care providers, injection drug users, people living in overcrowded conditions with little access to health care) may benefit the larger community and decrease transmission within specific high-risk groups.

Education of the general public can dispel incorrect information and help provide a more balanced perspective on the actual risk from MRSA. Education will help those at increased risk for MRSA infections become aware of prevention measures, and inform adherence to hygienic practices for the general public that may decrease risk of infections.

Recommendations for prevention of MRSA in the community should be reassessed as new information becomes available.

Intervention Recommendation #7:

Promote judicious use of antibiotics in the outpatient setting and in animals (agriculture)

Rationale: Although much of the focus on antibiotic use and MDROs has been within the hospital, antimicrobial resistance has also increased among community-acquired pathogens such as *S. aureus*, *Streptococcus pneumoniae*, and *Escherichia coli* (*E. coli*). Similar to use

within hospitals, it is estimated that 50 percent of antimicrobial use is inappropriate in the outpatient setting for illness such as viral upper respiratory tract infections.^{13,18}

In North America and Europe, an estimated 50 percent in tonnage of all antimicrobial production is used in food-producing animals and poultry. The largest quantities are used as regular supplements for prophylaxis or growth promotion. Such widespread use of antimicrobials for disease control and growth promotion in animals has been paralleled by and associated with an increase in resistance in those bacteria (such as *Salmonella* and *Campylobacter*) that can spread from animals, often through food, to cause infections in humans.^{21,4,14,11}

Rejected Options

The panel recommends against impractical or extreme measures and those with little added value, including the following practices:

1. Laboratory surveillance of all isolates.
2. Surveillance in every inpatient institution. Mandatory reporting would add little value to our understanding, and its expense and resource-use would detract from other education and intervention offerings to the community.
3. Mandatory universal screening in both patients and health care employees.
4. Radical cleaning of facilities and closures such as cancellation of athletic events and closing schools, except in consultation with local public health officials.
5. Exclusion of individuals with MRSA and other MDROs from participation in activities when reasonable cautions, such as ensuring their wounds are covered and kept dry, are taken.

Conclusions

Multidrug-resistant organisms and published research on evidence-based best practices to address them are continually evolving, and public health policies must evolve with them. In order to do so, the governor may wish to develop an ongoing coordinating body to address evolving issues, consider new research findings and monitor implementation (including the move toward standardization and providing incentives to reduce the rates of hospital acquired infections).

This report does not address the manner in which the panel’s recommendations should be implemented (it addresses the “what” but not the “how”). Consequently, a monitoring body may be desirable to ensure that implementation of adopted recommendations occurs in accord with the intent of the Scientific Expert Panel.

Appendix A

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Appendix B

Guidelines for Evaluation and Management of Community-Associated Methicillin-Resistant Staphylococcus Aureus Skin and Soft Tissue Infections in Outpatient Settings, December 2007.

GUIDELINES FOR EVALUATION & MANAGEMENT OF COMMUNITY-ASSOCIATED METHICILLIN- RESISTANT *STAPHYLOCOCCUS AUREUS* SKIN AND SOFT TISSUE INFECTIONS IN OUTPATIENT SETTINGS

DECEMBER, 2007

Revised from the original, published September 2, 2004

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I. Introduction

This document is intended to provide clinical guidance for management of *Staphylococcus aureus* skin and soft tissue infections (SSTI) in outpatients in the setting of increasing levels of community-associated methicillin-resistant *S. aureus* (CA-MRSA) until more definitive guidelines are available from the Centers for Disease Control and Prevention and/or medical professional organizations. The guidelines were initially developed collaboratively in 2004 by the Infectious Diseases Society of Washington and Public Health – Seattle and King County, Tacoma-Pierce County Department of Health, and Washington State Department of Health, and were updated in December, 2007. The main recommendations remain largely unchanged. Some revisions were made in the 2007 version to simplify the text, some points have been expanded for additional detail, and references were updated and key resources added. Key points in the document are highlighted in bold.

Clinicians should consider other relevant potential etiologies in addition to MRSA when evaluating patients with SSTI. These guidelines do not address the general approach to management of skin and soft tissue infections or management of hospitalized patients, for which other references are available.

Figure 1, a flow diagram (*Management of Suspected S. aureus Skin and Soft Tissue Infection*) and Tables 1 and 2 (*Empiric Oral Antimicrobial Agents for Treatment of Outpatients with Suspected MRSA* and *Eradication of MRSA Colonization*) can be removed from the document and posted for reference in clinical settings.

II. Background

Methicillin-resistant *S. aureus* (MRSA) are resistant to β -lactam antibiotics, including penicillinase-resistant penicillins (methicillin, oxacillin, nafcillin) and cephalosporins. MRSA have been long recognized as pathogens among hospitalized patients and persons with certain healthcare-associated risk factors. Available data suggest that in recent years, the frequency of MRSA infections among otherwise healthy persons without typical healthcare-associated MRSA (HA-MRSA) risk factors has also been increasing in Washington State and nationally. In a multicenter study of patients presenting to the emergency department with purulent skin and soft tissue infections in 11 US cities (none in Washington State), MRSA was the most common identifiable cause accounting for 59% of the cases¹. The full clinical spectrum, epidemiology, and risk factors for CA-MRSA have yet to be defined. Current evidence suggests that these strains are genetically distinct from HA-MRSA, cause a different spectrum of illness (including SSTI that may be severe), and have different antibiotic susceptibility patterns than HA-MRSA. Severe invasive disease (e.g., bacteremia/sepsis syndrome, pneumonia, pyomyositis, bone and joint infections) due to CA-MRSA has been reported less frequently than SSTI.^{2,3,4}

III. Clinical approach to potential *S. aureus* skin and soft tissue infections (SSTI)

The clinical approach is based on information about risk factors for MRSA, the clinical presentation and severity of the infection, and the presence of co-morbidities (see Figure 1).

- **Incision and drainage (I & D) is of paramount importance in treatment of abscesses and should be done whenever possible. For mild uncomplicated abscesses, local wound care including I & D of fluctuant lesions without antibiotic use is a reasonable treatment option.⁵**
 - Antibiotic therapy alone without I & D is NOT recommended for treatment of fluctuant abscesses.
- **For outpatients with skin and soft tissue infection, it is important to obtain specimens for culture and susceptibility testing (before initiating antibiotic treatment).**
 - If I & D is not performed, other options include culture of spontaneously draining wounds and/or culture and biopsy of the central area of cellulitis (note: superficial culture of open wounds may yield skin-colonizing bacteria and not the true pathogen).
- **Clinicians should determine if household or other close contacts of the patient have SSTI or other infections compatible with MRSA, and facilitate their evaluation and treatment if indicated.**
- **Patient education is a critical component of SSTI management. Clinicians should educate patients, caretakers and household members on specific measures to limit spread of infection to close contacts, including in the household and other living environments (See section VIII. Information for patients with *S. aureus* infection (including MRSA) and their caregivers.**

IV. Assessment of risk factors for MRSA

MRSA should be considered in the differential diagnosis of all patients presenting with skin and soft tissue infections as well as those with more severe illness compatible with *S. aureus* infection (sepsis syndrome, osteomyelitis, septic arthritis, severe pneumonia and post-influenza pneumonia). A presenting complaint of spider bite should raise suspicion for MRSA infection.

Risk factors associated with CA-MRSA are not well defined and infections have occurred among previously healthy persons with no identifiable risk factors.^{4,6} Clinical suspicion for MRSA infection can guide empiric antibiotic selection and avoid use of agents ineffective against MRSA (particularly cephalosporins).

Risk factors that should increase the level of suspicion for healthcare and/or community associated MRSA:^{7,8}

- High prevalence of MRSA in the community or patient population (as indicated by results of antimicrobial susceptibility testing, clinical experience and surveillance data)
- History of MRSA infection or colonization
- Close contact with someone known to be infected or colonized with MRSA
- Recent or frequent antibiotic use
- Recurrent skin disease
- Crowded living conditions (e.g., incarceration, homeless shelters, barracks)
- Cluster of infections among sports participants or other groups who have skin-to-skin contact or shared clothing, equipment, or personal hygiene items
- Complaint of “spider or insect bite”
- SSTI with failure to respond to β -lactam antibiotics
- MRSA transmission through sexual contact has been reported⁹
- History in the past year of:
 - Hospitalization
 - Admission to a long term care facility (nursing home, skilled nursing, or hospice)
 - Dialysis and end-stage renal disease
 - Diabetes mellitus
 - Surgery
 - Indwelling catheters or medical devices that pass through the skin into the body
 - Injection drug use

V. Management of *S. aureus* SSTI based on severity (adapted from Eron criteria)⁹

- **Mild:** Patient has no signs or symptoms of systemic toxicity and no uncontrolled co-morbidities (e.g., peripheral vascular disease, diabetes mellitus, chronic venous insufficiency, morbid obesity) that may complicate treatment.
 - Outpatient management without oral antimicrobials including I & D of abscesses and wound care (with or without topical antimicrobials) may be sufficient in the majority of cases.¹⁰
 - Consider oral antimicrobials, based on clinical judgment, particularly if I & D is not possible and when the skin lesion is ≥ 5 cm^{10,11}
 - If MRSA is suspected based on the presence of one or more risk factors (including high prevalence of MRSA locally) consider empiric therapy with agents active against MRSA (see Table 1).
 - Monitor patients for response to therapy and adjust antimicrobials based on culture and susceptibility results.
 - Therapy with a β -lactam (e.g., cephalexin or dicloxacillin) is preferred for susceptible *S aureus* and *Group A streptococci*.

- **Moderate:** Patient is either systemically ill (e.g. febrile) with stable co-morbidities or systemically well with co-morbidities that may increase risk for severe or complicated SSTI
 - Treat empirically for MRSA.
 - Manage as in- or outpatient, depending on degree of illness and co-morbidity; may require initial hospitalization and parenteral antimicrobials with subsequent conversion to oral therapy once signs and symptoms of infection are improving.
 - Monitor outpatients carefully for response to initial oral therapy.
 - Adjust antimicrobials based on culture and susceptibility results.

- **Severe:** Patient appears toxic (e.g., tachycardia, tachypnea, hypotension, altered mental status), or non-toxic, but has unstable co-morbidities that may complicate therapy; **AND**

- **Critically Ill:** Patient has sepsis syndrome or life-threatening infection such as necrotizing fasciitis
 - Manage as inpatient with empiric broad-spectrum parenteral antimicrobial coverage including vancomycin for activity against MRSA.
 - Surgical intervention may be necessary.
 - Adjust antimicrobials based on culture and susceptibility results.
 - Consult infectious disease specialist if patient does not improve or alternative antimicrobials (e.g., linezolid or daptomycin) are being considered.
 - Consider discharge to complete a course of outpatient parenteral or oral therapy based on clinical improvement, toleration of therapy and availability for follow-up.

VI. Empiric oral antimicrobial therapy for suspected MRSA infections (see Table 1)

- There are no data from randomized clinical trials on which to base treatment recommendations.
- **In many patients with mild infections, I & D of abscesses without oral antimicrobial therapy is an adequate treatment option.**
- **Antimicrobial therapy should be reserved for mild infections that cannot be treated with I & D and for more serious infections.**
- **All patients should be monitored for response to therapy, particularly those treated with I & D alone.**
- **Empiric antibiotic regimens should be modified based on results of culture and susceptibility testing of isolates from affected skin and soft tissue or wound drainage.**
- ***S. aureus* isolates resistant to erythromycin and susceptible to clindamycin should be evaluated for inducible clindamycin resistance (MLS_B phenotype) using a “D test.”²⁵ Consult your clinical laboratory to determine if the “D test” is done routinely or must be specifically requested.**
 - **If inducible clindamycin resistance is present, an alternative agent should be considered, particularly if the clinical response to clindamycin is poor.¹⁹**
- **Although vancomycin has been the “gold standard” for *invasive* MRSA infections, most CA-MRSA infections are localized SSTI that do not require hospitalization or vancomycin therapy.**
 - Initial empiric coverage of infections should be based on the prevalence of MRSA in the clinical setting or patient population (ideally guided by local antimicrobial susceptibility patterns for MRSA, if available), as well as the presence of risk factors for, or factors potentially associated with, MRSA.
 - Therapy should be modified as necessary based on results of culture and susceptibility testing.
 - In patients initially hospitalized for IV therapy, criteria allowing the switch to oral therapy and discharge include:
 - Patient is afebrile for 24 hours, *and*
 - Clinically improved, *and*
 - Able to take oral medication, *and*
 - Has adequate social support, *and*
 - Is available for close outpatient follow-up

NOTE: Group A streptococci (GAS) are another common cause of SSTI, particularly cellulitis and impetigo. If Group A streptococcal infection is suspected, therapy should include an agent active against this organism (β -lactam or clindamycin). Tetracyclines and trimethoprim-sulfamethoxazole, although active against many MRSA, are not recommended treatments for suspected GAS infections.

VII. Infection control for outpatient management of *S. aureus* SSTI, including MRSA

MRSA is transmitted primarily through skin-to-skin contact, including via hands (especially healthcare workers' hands) which may become contaminated by contact with a) colonized or infected patients, b) one's own colonized or infected body sites, or c) devices, items, or environmental surfaces contaminated with body fluids containing MRSA.^{26,27}

A combination of standard and transmission based precautions (i.e., contact precautions), is recommended for patients with MRSA colonization and infection in the outpatient setting²⁷⁻³⁰. Contact precautions (gown and gloves) should be used for ALL patients with open or draining SSTI and when contact with uncontrolled infectious secretions is possible.

Patient Placement and Room Usage:

- Place patient in private exam room, if feasible.
- Patients may be placed in a room with another patient as long as there is spatial separation and adherence to standard and transmission based precautions.
- A “dirty” procedure room for MRSA patients is not necessary.
- Patients do not have to wait until the end of the day for procedures, ambulatory surgery or care.

Standard Precautions include:

- Perform **hand hygiene** before and after each patient contact. This may consist of an alcohol-based hand sanitizer if hands are not visibly soiled or soap and water.
- **Mask coughing patients**; if coughing patient is unable to mask or when performing a respiratory exam the healthcare worker, including provider, will wear a mask with eye protection.
- After glove removal and hand hygiene, do not touch potentially contaminated environmental surfaces or items in the patient's room to avoid transfer of microorganisms to other patients and environments.
- Use **barrier protective coverings** as appropriate for noncritical surfaces that are 1) touched frequently with during the delivery of patient care; 2) likely to become contaminated with blood or body substances; or 3) difficult to clean

Contact Precautions include:

- Wear **gloves** when touching non-intact skin or mucous membranes, visibly soiled linen, or visibly soiled equipment and surfaces.
- **Gown** if body contact with patient or contaminated secretions is anticipated
- Wear gloves, gown, and **face protection** (surgical mask with eye shield) when performing wound care procedures: irrigating, debriding, performing I & D, or working with complex wounds.
- Discard gloves/gown and perform hand hygiene immediately before leaving exam room.
- Minimize environmental contamination through use of environmental barriers (blue pads, trash bags).
- Do not close room down when patient is discharged.

Environmental Cleaning

- Use an EPA registered cleaner/disinfectant for environmental cleaning and follow manufacturer's instructions for use. Do not use alcohol alone to disinfect the environment or equipment.
- Wear gloves when cleaning/disinfecting the environment. Always perform hand hygiene after removing gloves.
- Wear gown if clothing is likely to be soiled during the cleaning process.
- Wipe thoroughly all environmental surfaces touched by patient or staff during encounter with a disinfectant and allow to air dry.
- If surface has visible body substance contamination: clean surface, discard towel, re-wipe or spray with disinfectant, and let dry.
- Change cleaning cloths (paper towel or wipes) frequently between surfaces.
- Room may be used immediately after cleaning/disinfecting environmental surfaces.

Equipment and Supplies

- Perform hand hygiene prior to accessing clean and sterile supplies to prevent cross contamination of supplies.
- Clean all equipment touched by patient and staff with an approved disinfectant.
- Disinfect or sterilize, as appropriate, all reusable items immediately after use and prior to storage (includes bandage scissors).
- Discard unused contaminated disposable supplies, i.e., unopened supplies on a used procedure tray.

Trash and Laundry

- Contain trash and laundry at the point of use.
- Discard soiled cloth laundry in a fluid resistant laundry hamper or plastic bag.
- Discard disposable paper sheets and gowns in regular trash

For additional information on infection control, see:

- CDC. Information About MRSA for Healthcare Personnel
http://www.cdc.gov/ncidod/dhqp/ar_mrsa_healthcareFS.html
- CDC. Management of Multidrug-Resistant Organisms In Healthcare Settings, 2006. Siegel JD, et al; the Healthcare Infection Control Practices Advisory Committee.
<http://www.cdc.gov/ncidod/dhqp/pdf/ar/mdroGuideline2006.pdf>
- What to do about MRSA Toolkit for Outpatient Clinics/Medical Offices (Handbook and wall charts on infection control included), <http://www.tpchd.org/mrsa>:

VIII. Information for patients with *S. aureus* infection (including MRSA) and their caregivers⁶

- **Patient education is a critical component of SSTI management. Clinicians should educate patients, caretakers and household members on specific measures to limit spread of infection to close contacts, including in the household and other living environments.** *Washington Administrative Code (WAC 246-101-105) specifies that healthcare providers shall provide adequate and understandable instruction in disease control measures to each patient who has been diagnosed with a case of a communicable disease, and to contacts who may have been exposed to the disease (<http://apps.leg.wa.gov/WAC/default.aspx?cite=246-101-105>).*
- **Key infection control messages for patients to prevent transmission of *S. aureus* SSTI, including MRSA:**
 - Take antibiotics as prescribed until the all the medicine is taken.
 - Notify your healthcare provider immediately if you are having trouble taking the medication, or the infection is getting worse.
 - Frequent hand hygiene is very important for everyone in the patient’s environment to prevent spread.
 - Alcohol based hand sanitizers will kill MRSA and other pathogens within 15 seconds.
 - Use soap and water when hands are visibly soiled and after touching dressings or anything else soiled.
 - Keep wounds and lesions covered with clean, dry bandages, especially when drainage is present.
 - Patients that can not maintain adequate hygiene and keep wounds covered with clean, dry bandages should be excluded from activities where close contact with other individuals occurs, such as daycare or athletic practice, until their wounds are healed.
 - Use clean, disposable, nonsterile gloves to change bandages.
 - Put disposable waste (e.g., dressings, bandages) in a separate trash bag and close the bag tightly before putting it in with the regular garbage.
 - Do not share personal items (e.g., towels, washcloths, razors, clothing, or uniforms) or other items that may have been contaminated by wound drainage.
 - Use an environmental disinfectant or dilute bleach solution to regularly clean and disinfect contaminated surfaces, i.e., doorknobs, light switches, counters, phones, toilets, sinks, computer keyboards and mouse. MRSA can live for weeks to months on surfaces.
 - Wash soiled linens and clothes with hot water and laundry detergent. Drying clothes in a hot dryer, rather than air-drying, may also help kill bacteria in clothes.
 - Wash utensils and dishes in the usual manner with soap and hot water or use a standard home dishwasher.
 - Avoid skin-to-skin contact including contact sports until the infection has healed.
 - Be sure to tell any healthcare providers who treat you that you have a MRSA, a “resistant staph infection”.

VIII. Information for patients with *S. aureus* infection (including MRSA) and their caregivers, continued

Additional information for patients can be found at the following websites:

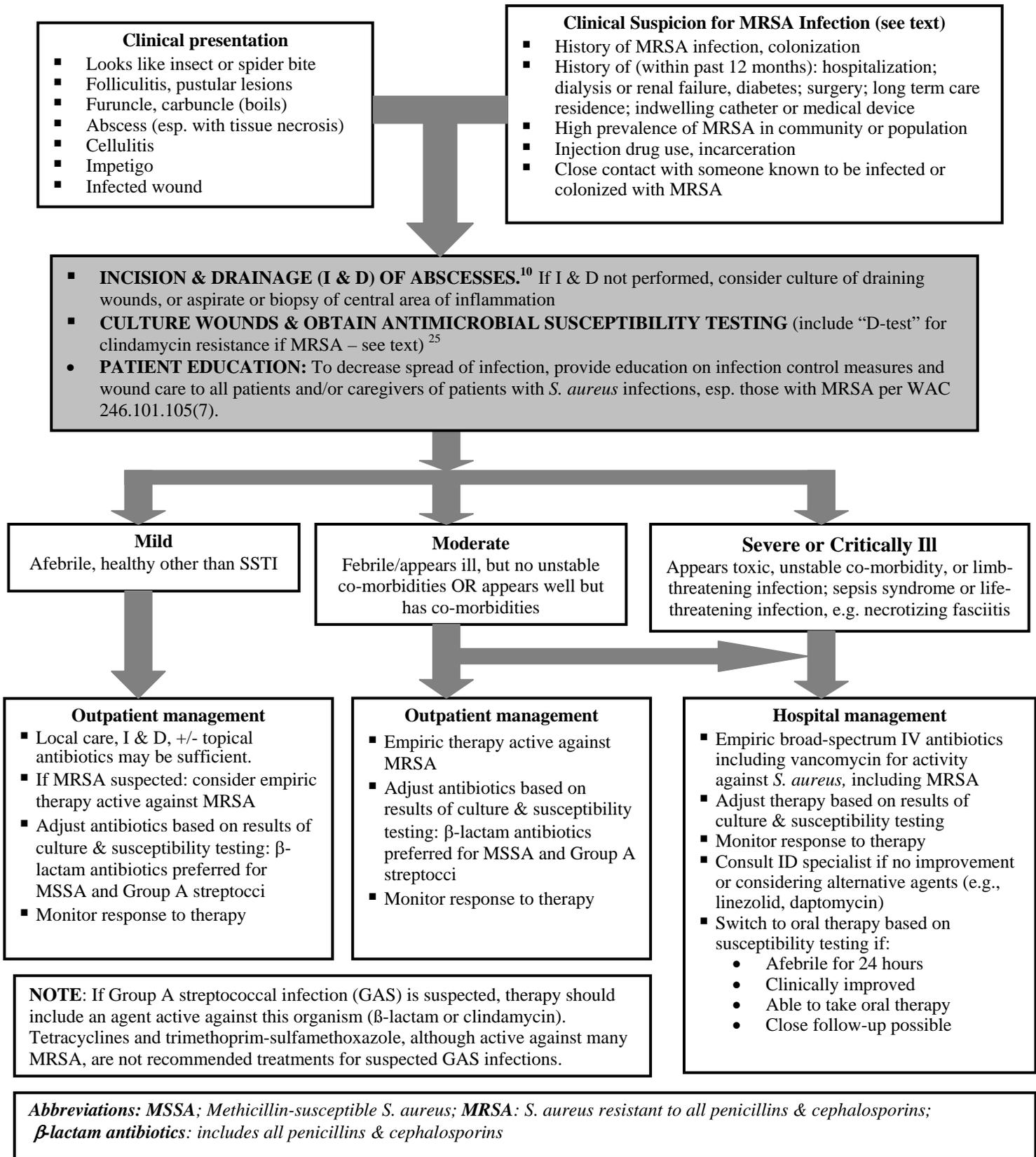
- Centers for Disease Control and Prevention
 - http://www.cdc.gov/ncidod/dhqp/ar_mrsa_ca.html
- Tacoma-Pierce County Department of Health
 - <http://www.tpchd.org/MRSA> (Includes *Living with MRSA*, a booklet that was developed with and for patients and their families, provides guidance on wound care, personal hygiene, environmental cleaning, and prevention of transmission.)
- Public Health – Seattle & King County
 - <http://www.metrokc.gov/health/prevcont/mrsa.htm>
- Washington State Department of Health
 - <http://www.doh.wa.gov/Topics/Antibiotics/default.htm>

IX. Eradication of MRSA colonization (decolonization).

- **Treatment to eradicate MRSA colonization is not routinely recommended.** Consultation with an infectious disease specialist is recommended before eradication of colonization is initiated.
- The efficacy of methods to reduce MRSA recurrence and transmission by decolonizing persons in the outpatient setting has not been established. It may be reasonable to consider decolonization for:
 - Patients with recurrent MRSA infections despite appropriate therapy, and
 - MRSA infections with ongoing transmission in a well-defined cohort with close contact.
- Optimal regimens for eradication of colonization have not been established and may include one or more of the following:
 - Nasal decolonization with intranasal topical 2% mupirocin (bid for 5 days)
 - Skin antiseptics (i.e. chlorhexidine or dilute bleach baths)^{31, 32}
 - Oral antimicrobials (usually rifampin plus trimethoprim-sulfamethoxazole, or rifampin plus doxycycline, or rifampin plus minocycline)
- ***Rifampin should never be used as a single agent to treat infection or colonization with MRSA***

See Table 2. Eradication of MRSA colonization

X. Figure 1. Management of Suspected *S. aureus* Skin and Soft Tissue Infection (see text)



XI. Table 1. Interim Guidelines for Empiric Oral Antimicrobial Treatment of Outpatients with Suspected MRSA Skin and Soft Tissue Infections (SSTI)

<p>Selection of empiric therapy should be guided by local <i>S. aureus</i> susceptibility and modified based on results of culture and susceptibility testing. The duration of therapy for most SSTI is 7-10 days, but may vary depending on severity of infection and clinical response. NOTE: Before treating, clinicians should consult complete drug prescribing information in the manufacturer’s package insert or the PDR.</p>		
Antimicrobial	Adult Dose	Pediatric Dose
Trimethoprim-sulfamethoxazole (TMP-SMX) DS ^{12,13,14}	1 tablet (160 mg TMP/800 mg SMX) PO bid	Base dose on TMP: 8-12 mg TMP (& 40-60 mg SMX) per kg/day in 2 doses; not to exceed adult dose
Minocycline ^{14,15,16} or doxycycline ¹⁴	100 mg PO bid	<i>Not recommended for pediatric use – suggest consultation with infectious disease specialist before use</i>
Clindamycin ^{a,14,17,18,22}	300-450 mg PO qid	10-20 mg/kg/day in 3-4 doses; not to exceed adult dose
<p>NOTE: If Group A streptococcal infection is suspected, oral therapy should include an agent active against this organism (β-lactam or clindamycin). Tetracyclines and trimethoprim-sulfamethoxazole, although active against many MRSA, are not recommended treatments for suspected GAS infections.</p> <p>NOTE: Outpatient use of quinolones or macrolides. Fluoroquinolones^{14,20,21,22} (e.g., ciprofloxacin, levofloxacin, moxifloxacin, gatifloxacin) and macrolides (e.g., erythromycin, clarithromycin, azithromycin) are NOT recommended for treatment of MRSA because of high resistance rates. If fluoroquinolones are being considered, consult with infectious disease specialist before use.</p> <p>NOTE: Outpatient use of Linezolid in SSTI^{23,24}. Linezolid is costly and has great potential for inappropriate use, inducing antimicrobial resistance, and toxicity. Although it is 100% bioavailable and effective in SSTI, it is not recommended for empiric treatment or routine use because of these concerns. It is strongly recommended that linezolid only be used after consultation with an infectious disease specialist to determine if alternative antimicrobials would be more appropriate.</p> <p>^aIf considering clindamycin, isolates resistant to erythromycin and sensitive to clindamycin should be evaluated for inducible clindamycin resistance (MLS_B phenotype) using the “D test.” Consult with your reference laboratory to determine if “D testing” is routine or must be specifically requested. If inducible resistance is present, an alternative agent to clindamycin should be considered.¹⁹</p>		

XII. Table 2: Eradication of MRSA Colonization

Efficacy of decolonization in preventing re-infection or transmission in the outpatient setting is not documented, and is NOT routinely recommended. Consultation with an infectious disease specialist is recommended before eradication of colonization is initiated. Possible regimens may include one or more of the following:

Topical intranasal 2% mupirocin may be used bid for 5 days.
Skin antiseptics (i.e. chlorhexidine or dilute baths)
Rifampin (Adult dose: 300mg PO bid x 5 days; pediatric dose: 10-20 mg/kg/day in 2 doses not to exceed 600 mg/d x 5 days) may be used in combination with TMP-SMX, OR with doxycycline, OR with minocycline, for recurrent MRSA infection despite appropriate therapy. <i>Never use rifampin monotherapy, due to the rapid emergence of resistance. Rifampin interacts with methadone, oral hypoglycemics, hormonal contraceptives, anticoagulants, protease inhibitors, phenytoin, theophylline, cardiac glycosides and other drugs.</i>

Recommended Resources

Information for health care providers

- Strategies for Clinical Management of MRSA in the Community: Summary of an Experts' Meeting Convened by the Centers for Disease Control and Prevention. March 2006. (http://www.cdc.gov/ncidod/dhqp/pdf/ar/CAMRSA_ExpMtgStrategies.pdf)

General Information on MRSA

- Tacoma Pierce County Health Department (www.tpchd.org/files/library/72640dd923f76e37.pdf): "Living with MRSA" pamphlet and fact sheets
- Public Health - Seattle & King County (www.metrokc.gov/health/prevcont/mrsa.htm): MRSA fact sheet and links to other MRSA resources
- Centers for Disease Control and Prevention (http://www.cdc.gov/ncidod/dhqp/ar_mrsa_ca.html): Information on community-associated MRSA for public and clinicians
- Public Health Grand Rounds (www.publichealthgrandrounds.unc.edu/antimicrob_resist/): Webcast featuring interviews with Public Health Seattle & King County and local health care providers

MRSA in schools

- Centers for Disease Control and Prevention: MRSA in Schools (http://www.cdc.gov/ncidod/dhqp/ar_mrsa_in_schools.html)
- *Journal of School Nursing*, "Community-acquired methicillin-resistant Staphylococcus aureus: Considerations for school nurses," 23(4), 210-213 (nasn.allenpress.com): Review article for school nurses; abstract available for free, subscription required for full text
- Tacoma Pierce County Health Department (www.tpchd.org/page.php?id=364): MRSA Toolkit for middle and high schools
- County of Los Angeles Public Health (lapublichealth.org/acd/MRSA.htm): See "[Community Associated MRSA/Staph: A Guideline for Athletic Departments](#)" as well as "Information for Athletes about MRSA" at the bottom of the "Frequently used resources" list – includes handouts for athletes

MRSA in athletes

- From CDC, http://www.cdc.gov/ncidod/dhqp/ar_MRSA_AthletesFAQ.html

MRSA in the workplace

- National Institute for Occupational Safety and Health (www.cdc.gov/niosh/topics/mrsa/): "MRSA and the workplace," including frequently asked questions
- EPA registered disinfectants effective against MRSA (epa.gov/oppad001/chemregindex.htm): See "List H"

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Appendix C

Guidelines for The Prevention and Management of Community-Associated Methicillin-Resistant *Staphylococcus Aureus*: A Perspective for Canadian Health Care Practitioners, 9.0 Prevention, pages 15C-19C.

Guidelines for the prevention and management of community-associated methicillin-resistant *Staphylococcus aureus*: A perspective for Canadian health care practitioners

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EXECUTIVE SUMMARY

Methicillin resistance among community isolates of *Staphylococcus aureus* has reached a staggering high of 75% in some communities in the United States (US) (1). These organisms, which are resistant to the entire class of beta-lactam antibiotics, have evaded an important component of the physician's armamentarium and may require clinicians to change their management of presumed staphylococcal infections. The recent emergence of community-associated (CA) methicillin-resistant *S aureus* (MRSA) strains as dominant clones signals their adaptation to survive and spread outside the hospital setting. Descriptions of severe disease and characterization of their virulence factors warn of their potential to inflict significant morbidity and mortality. Thus, we are faced with an emerging and formidable foe – a pathogen combining virulence, resistance and an ability to disseminate at large (2). At present, the prevalence of CA-MRSA in Canada is unknown but thought to be low based on the collective clinical experience of infectious disease experts across the country. If Canada is to delay or prevent the emergence of CA-MRSA in its communities, vigilance and determined control efforts are needed.

The purpose of the present document is to convey basic information regarding the epidemiology and microbiology of CA-MRSA, as well as to suggest recommendations related to the clinical management, prevention and control of CA-MRSA infections. It complements existing publications on hospital-associated (HA) MRSA and CA-MRSA, including a recent statement from the US Centers for Disease Control and Prevention (CDC) (3).

Sources of information and recommendations were derived from a comprehensive literature review, a Working Group meeting of Canadian and US experts, and extensive discussions within an expert panel writing group. When available, published and unpublished Canadian data are presented. The highlights of the present document include clinician-oriented treatment guidelines addressing the various presentations of presumed and confirmed CA-MRSA infection and their management. Guidelines for infection prevention and control in a variety of settings, such as homes, daycare centres and schools, sports settings, pet-owning households, prisons and homeless shelters, and neonatal care facilities, are included. The document does not address health care settings other than nurseries; existing guidelines for infection control in hospitals and clinics should be followed in these settings. Directions for future research are also suggested. The content of the present document will be modified and updated as microbiologists and public health specialists find evolving regional prevalence of CA-MRSA, and as new studies are published.

Front-line physicians need to be aware of the increasing prevalence and potential severity of CA-MRSA infections. They are advised to obtain specimens for culture from all serious skin and soft tissue infections (SSTIs), including abscesses and other infected sites. The management of presumed *S aureus* infection should include the use of surgical drainage when appropriate, and empirical antibiotic therapy should be adjusted when regional rates of clinical infections due to CA-MRSA increase. Judicious use of antibiotics is emphasized as a prevention strategy. Families, school and daycare centre personnel, and sports teams should be actively encouraged to practice meticulous handwashing, the most important measure to control or attenuate community transmission of CA-MRSA.

1.0 PREAMBLE

A dramatic increase in the rate of methicillin resistance among community isolates of *S aureus* has recently been observed in the US (4). CA-MRSA has emerged as the dominant pathogen in some communities in the US, with a prevalence as high as 75% of all *S aureus* isolates (1). These CA strains are genetically and clinically distinct from strains of HA-MRSA, which has been a familiar problem in health care institutions for several decades. Currently, the prevalence of CA-MRSA in Canada is unknown but thought to be low based on the collective clinical experience of infectious disease experts. However, as the prevalence of CA-MRSA increases, clinicians may need to change their approach to the management of presumed *S aureus* infections. Furthermore, if Canada is to limit the emergence of CA-MRSA in its communities, vigilance and determined control efforts are needed.

To date, there are no Canadian consensus guidelines for the management and prevention of CA-MRSA infections in children and adults. Recent reports (unpublished data, 5,6) of serious invasive disease and mortality due to CA-MRSA in Canada emphasize the need for such guidelines. Focus has centred for years on the challenge of controlling the spread of MRSA in hospitals and chronic care institutions. The present document addresses MRSA in the community and complements previously published guidelines (Appendix). The reader is specifically referred to other excellent existing documents on CA-MRSA, including a statement from the CDC (3), the BC Centre for Disease Control (7) and the Canadian Paediatric Society (8). The present CA-MRSA document is unique because it has a national focus; underwent a rigorous methodology, which included a Working Group meeting of national experts and an expert panel review process; consists of practical, clinician-oriented treatment guidelines addressing multiple possible presentations of CA-MRSA; and has a multidisciplinary focus on the prevention of transmission.

The goal of the present document is to provide information about the epidemiology and microbiology of CA-MRSA in Canada as well as recommendations on its treatment, prevention and control. The document is directed toward health care workers, including public health practitioners, laboratory personnel, clinicians, nurses, infection control practitioners, veterinary medicine personnel and other health care practitioners involved in outbreak management and direct patient care. While the guidelines provide suggestions for specific patient management, they are not meant to replace clinical judgment in the care of the individual patient. The scope of the present document includes the following:

- definitions and a general description of the epidemiology highlighting the Canadian experience, where available;
- microbiology of MRSA emphasizing differences between traditional HA strains and emerging CA strains;
- clinical management guidelines;
- recommendations for screening and decolonization;
- recommendations for the prevention and management of outbreaks and infections occurring in the community; and
- directions for future research, based on ideas generated at the Working Group meeting.

TABLE 1
Strength of recommendations and quality of evidence

Strength	Definition
A	Strong recommendation Should always be offered Experts agree
B	Moderate recommendation Should usually be offered Most experts agree
C	Optional recommendation May be offered Expert opinion varies
Grade	Definition
I	Evidence from at least one proper randomized, controlled trial
II	Evidence from at least one well-designed clinical trial without randomization from cohort or case-controlled analytical studies, or from dramatic results of uncontrolled experiments
III	Evidence from opinions of respected authorities based on clinical experience, descriptive studies or reports of expert committees

Data from reference 9

2.0 METHODOLOGY

The information and recommendations presented in the current document result from a comprehensive literature review, a Working Group meeting of Canadian and US experts, and discussions of an expert panel writing committee.

A review of the English-language medical literature from 1980 to March 2006 was conducted. Data sources included MEDLINE, EMBASE and the Cochrane Central Register of Controlled Trials. Published abstracts of papers presented at local and international infectious disease or microbiology conferences were cited when they were the only available information from ongoing trials or emerging reports.

An interdisciplinary Working Group meeting held on October 27 and 28, 2005, in Toronto, Ontario, assembled 70 Canadian experts in pediatric and adult infectious disease, infection control, microbiology and public health, as well as US experts in CA-MRSA from Texas and from the CDC. The meeting was supported by the Public Health Agency of Canada, the Canadian Committee on Antibiotic Resistance, and the Ontario Ministry of Health and Long-Term Care. A rich dialogue emerged around issues in CA-MRSA treatment, prevention and control, including important questions for future research.

Recommendations were developed based on the literature review, the Working Group meeting and the opinions of the expert panel. Recommendations were graded on the basis of strength and quality of the supporting evidence (Table 1) (9). The consensus statements were proposed, debated, revised and agreed on by members of the expert panel through conference calls and face-to-face meetings. The document was rigorously reviewed and debated by the expert panel committee using electronic mail in an iterative process with multiple revision steps. Suggestions were then evaluated by the panel and incorporated into the final document.

The present document was approved for publication by the Guidelines Committee of the Association of Medical Microbiology and Infectious Disease Canada. These guidelines will be reviewed annually by the CA-MRSA expert panel and

will be considered current unless they are revised or withdrawn from distribution.

3.0 DEFINITIONS

3.1 General definitions

MRSA: MRSA demonstrates resistance to the semisynthetic penicillins (methicillin, oxacillin and cloxacillin). It is also resistant to cephalosporins, monobactams and carbapenems. Resistance to other antibiotic classes may occur, but it is strain dependent.

HA-MRSA: MRSA strains that circulate and are transmitted to individuals within health care facilities.

CA-MRSA: MRSA isolates obtained from individuals in the community who have not had recent exposure to the health care system, or from patients in health care facilities in whom the infection was present or incubating at the time of admission.

3.2 Operational definition of CA-MRSA

The case definition for CA-MRSA endorsed by the expert panel, consistent with that used by the US CDC, is MRSA infection in a person who has none of the following risk factors for HA-MRSA: isolation of MRSA more than 48 h after hospital admission; history of hospitalization, surgery, dialysis or residence in a long-term care facility within one year of the MRSA culture date; the presence of an indwelling catheter or a percutaneous device at the time of culture; or previous isolation of MRSA (10).

3.3 Definition limitations

Using a standard definition is important for consistently estimating the burden of CA-MRSA infection (11); however, operational definitions of CA-MRSA have varied among studies. MRSA detected within 24 h, 48 h or 72 h of admission has been variably considered to be of community origin (12). Isolates from patients with health care contact, such as recent hospitalization, hemodialysis or indwelling catheters, have been excluded in some studies but not in others (12).

It is not always possible to identify the source of MRSA with certainty, making the classification of 'CA' and 'HA' strains based on epidemiological criteria somewhat imprecise. Because genetic and molecular distinctions between CA and HA strains have been described, molecular markers can now be used to define isolates as CA-MRSA or HA-MRSA. The onset of MRSA disease in the community may be attributable to bacterial strains acquired by discharged inpatients or health care personnel and subsequently transmitted to close contacts in the community (13,14). In a meta-analysis, approximately one-half of community-based patients colonized with MRSA had a health care-associated risk factor, suggesting a hospital origin of the isolates (12). Conversely, the ability to track strains using molecular epidemiological markers has enabled investigators to describe the spread of CA-MRSA strains within the hospital (15-17). Because hospital strains have moved into the community and community strains have spread within hospitals, it has become increasingly difficult to distinguish CA-MRSA and HA-MRSA by epidemiological criteria (18). Figure 1 illustrates a classification scheme for MRSA based on molecular and epidemiological characteristics, and the challenge of accurately discriminating between 'community' and 'hospital' isolates.

4.0 EPIDEMIOLOGY

4.1 The rise of CA-MRSA

MRSA was first described in 1961 (19), shortly after the introduction of semisynthetic penicillins (methicillin, oxacillin and cloxacillin). MRSA has long been recognized as a nosocomial pathogen. In the US, up to 40% of hospital *S aureus* strains are methicillin-resistant, while in Canada, nosocomial MRSA rates have increased from 0.95% in 1995 to 10.4% in 2003 (20). A new phenomenon has been observed over the past 10 years: MRSA strains have emerged, increased in prevalence and become the dominant strains in some US communities. These clones are genetically distinct from HA-MRSA, are well adapted to spread within the community and have the potential to cause severe disease. The rise of MRSA, first in hospitals and now in the community, has been likened to the historically similar trend of resistance of *S aureus* to penicillin, which emerged first in hospitals in the 1940s and later in the community throughout the 1960s (21).

Cases of severe MRSA infection in patients without contact with health care institutions were reported in a remote Aboriginal population in Australia in 1993 (22). The pathogen gained North American attention when the CDC reported four pediatric deaths from CA-MRSA in 1999 (23). Since then, methicillin resistance among isolates of *S aureus* outside of health care institutions has reached epidemic proportions in some US communities (24-27). Over a 10-year period, the Driscoll Children's Hospital in Corpus Christi, Texas, documented an increase in the rate of methicillin resistance among community isolates from 2.9% in 1990 to 40.3% in 2001 (4). The Texas Children's Hospital in Houston now reports that over 75% of community isolates are methicillin resistant, so MRSA, rather than methicillin-sensitive *S aureus* (MSSA), is now the dominant community pathogen (1). Increasingly, CA-MRSA is being detected around the globe (28), with multiple reports from Europe (29-31), Southeast Asia (32-35) and Australia (36,37).

To date, a spectrum of clinical manifestations of CA-MRSA infection have been described. The most common manifestation of CA-MRSA infection is SSTI (38). However, there are accumulating reports of severe disease, including sepsis (39), necrotizing fasciitis (40), purpura fulminans (41), toxic shock syndrome (42,43), necrotizing pneumonia (44,45) and empyema (46,47), caused by CA-MRSA. These severe presentations may occur in otherwise healthy children and young adults.

4.2 CA-MRSA in Canada

The first reported cases of CA-MRSA in Canada occurred in an Aboriginal community in Alberta between 1986 and 1989 (48). A cluster of 15 cases of CA-MRSA infections, predominantly soft tissue in origin, with organisms that remained relatively susceptible to non-beta-lactam antibiotics was reported from a small, rural town in southern Manitoba from 1997 to 1998 (49). This strain is rapidly emerging in several neighbouring communities in northern Manitoba and Saskatchewan (50). In 1998, the first case of CA-MRSA disease and transmission in a child care centre was reported in Toronto, Ontario (51). In Ontario in 2004, 11% of 10,301 MRSA isolates were thought to be CA (52). However, it is possible that the overall prevalence of this emerging pathogen has been underestimated.

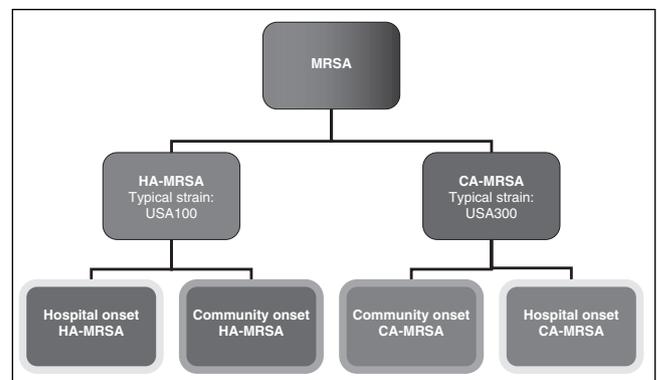


Figure 1) Classification scheme for methicillin-resistant *Staphylococcus aureus* (MRSA). Molecular techniques allow MRSA strains to be identified as community-associated (CA) MRSA (eg, the epidemic USA300 strain) or hospital-associated (HA) MRSA (eg, the USA100 strain [strain nomenclature described in section 5.3]). Epidemiological information can be used to further determine whether the infection arose in the community or in the hospital. Although, typically, HA-MRSA strains are isolated within health care facilities (ie, hospital-onset HA-MRSA), 'spillover' of these strains into the community (ie, community-onset HA-MRSA) has been observed (12). Conversely, CA-MRSA strains were first described in the population at large (ie, community-onset CA-MRSA) but have since been observed in health care settings (ie, hospital-onset CA-MRSA) (15-17)

This pathogen's potential to cause severe disease has been demonstrated in several Canadian reports. Severe soft tissue infections due to CA-MRSA have been reported in western Canada, including an outbreak in the Calgary Health Region in Alberta in 2004 involving illicit drug users and homeless people (53). The first case of fatal necrotizing pneumonia in a young, otherwise healthy adult was reported recently from the Calgary Health Region (5), and the first fatal pediatric case was described in Ontario (unpublished data). Several additional cases of severe necrotizing pneumonia without clinical or laboratory evidence of antecedent viral respiratory tract infection have been reported in southern Alberta (6).

4.3 Origin of CA-MRSA and its ability to disseminate

Because CA-MRSA has emerged very recently, several questions regarding its origin and ability to spread in the community have been the focus of intensive investigation. Where did CA-MRSA come from? Among other hypotheses, horizontal gene transfer of the resistance determinants from coagulase-negative staphylococci to CA strains of MSSA has been postulated (54). Did antibiotic pressure contribute to the emergence of this pathogen? *S aureus* and coagulase-negative staphylococci may coexist on the skin of patients treated with beta-lactam antibiotics, providing an environment conducive to the selection of CA-MRSA strains after horizontal transfer of resistance genes (55). What properties of CA-MRSA have allowed it to propagate in the community and indeed arise as the dominant clone in some settings? CA-MRSA strains are genetically distinct and do not simply represent the 'spillover' of hospital strains into the community (55,56). CA-MRSA grows more rapidly in vitro than does HA-MRSA (57), likely because HA-MRSA strains carry many antibiotic resistance genes and have a high 'fitness cost' of resistance (58). The genome of the epidemic CA-MRSA USA300 strain (strain nomenclature

TABLE 2
Risk factors for community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) infections

Risk categories and factors	References
High-risk populations	
Young people	Age distribution for CA-MRSA younger than for hospital-associated MRSA (38) High rate of CA-MRSA in children younger than two years (61) CA-MRSA more common in Canadian children than adults (62)
Minority populations	
Native or Aboriginal, and African-American people	Higher risk in Aboriginal communities in midwestern United States (23,63,64) Higher risk in Alaskan natives (65) More common in African-Americans (61,66,67) Aboriginal communities in Canada (48,49,62,68,69)
Athletes – mainly those involved in contact sports	Outbreaks in football teams (70-74) Outbreak in wrestling team (75) Outbreaks in other competitive sports (71,76)
Intravenous drug users	San Francisco intravenous drug users (77) Western Canadian report of USA300 strain outbreak documents higher risk in intravenous drug users (78)
Men who have sex with men	CA-MRSA described in HIV-positive population of men who have sex with men (79,80)
Military personnel	3% of United States army soldiers colonized (81)
Inmates of correctional facilities	Reports of outbreaks in United States prisons (82-86) Two outbreaks (total of 10 inmates) in Hamilton, Ontario (87)
Previous positive MRSA cultures	
MRSA carriage	Colonized soldiers more likely to get CA-MRSA disease (81)
Past MRSA infection	Prior abscess a risk factor for CA-MRSA (88)
Medical history	
Chronic skin disorder	Dermatological condition most common underlying medical disorder for CA-MRSA infection (38) Classroom contact of an index CA-MRSA case had chronic dermatitis (51)
Recurrent or recent antibiotic use	Antibiotic use associated with CA-MRSA infection in rural Alaska (65)
Environmental risks	
Low socioeconomic status	Medically underserved populations at higher risk of CA-MRSA (88,89)
Overcrowding	Close contact implicated in jail outbreak (84), neonatal intensive care unit transmission (90)
Contact with colonized pet	Family dog a source of recurrent infection (91)
Veterinary work	Cases documented in veterinarians working with horses (92-94), small animal veterinarians (95,96) and pig farmers (97)

described in section 5.3) has recently been sequenced in its entirety and reveals a novel mobile genetic element – the arginine catabolic mobile element, also present in the ubiquitous skin commensal *Staphylococcus epidermidis* – that may enhance fitness and pathogenicity (59). Thus, CA-MRSA may be better suited to competition with other bacteria in the environment, whereas HA-MRSA dominates in hospital settings under intense antibiotic pressure. Interested readers are referred to several comprehensive reviews of these topics for more detailed explanations (54,55,60).

4.4 Populations at risk

CA transmission of MRSA has been documented in several identifiable populations (23,38,61-97). These groups, listed in Table 2, are considered to be at high risk for CA-MRSA.

4.5 Transmission

The spread of CA-MRSA, like *S aureus* in general, occurs through direct contact between an infected person and an uninfected person, or by indirect contact through touching contaminated objects or surfaces that are part of the infected person's environment. Zoonotic transmission (from animals to humans) has also been documented (91,93,95,96,98-103).

5.0 MICROBIOLOGY

5.1 *S aureus* and MRSA

S aureus is a Gram-positive coccus that tends to form clusters. Resistance to methicillin and the entire class of beta-lactam antibiotics in *S aureus* is determined by altered penicillin binding protein 2a. This enzyme is encoded by the gene *mecA*, which is located within a larger mobile genetic element called the staphylococcal chromosomal cassette *mec* (SCC*mec*). Currently, there are five types of SCC*mec* distinguished by their genetic sequence, labelled SCC*mec* I to SCC*mec* V. CA-MRSA strains usually contain SCC*mec* IV or V, whereas HA-MRSA strains usually contain SCC*mec* I, II or III (104).

5.2 Virulence factors

Factors produced by *S aureus* that may play a role in virulence are shown in Table 3. The role of each of these factors in clinical disease is not clear, although considerable attention has been focused on the Panton-Valentine leukocidin (PVL) (104). The PVL is an extracellular product of *S aureus* that is encoded by the genes *lukS*-PV and *lukF*-PV (104). This factor, by its cytolytic pore-forming activity, damages the cell membranes of neutrophils, monocytes and macrophages (Figure 2). Infection caused by PVL-positive strains tends to occur in

TABLE 3
Virulence factors of *Staphylococcus aureus*

Category	Toxin
Cytolytic toxins	Panton-Valentine leukocidin S and F
	Fibronectin-binding proteins A and B
	Leukocidin R
Superantigenic toxins	Enterotoxins (A to J)
	Epidermolytic toxins
	Toxic shock syndrome toxin-1
Enhanced growth and survival	Arginine catabolic mobile element

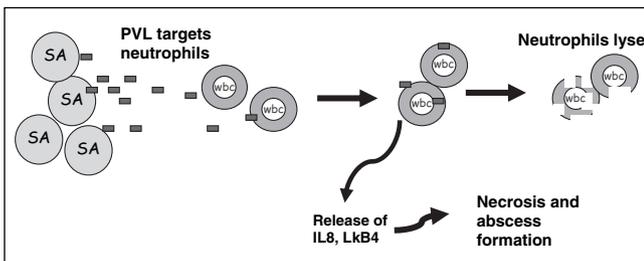


Figure 2) Mechanism of action of the Panton-Valentine leukocidin (PVL). PVL is a putative virulence factor associated with severe clinical disease. The toxin is released from *Staphylococcus aureus* (SA) and targets the cell membrane of neutrophils (wbc). This causes the release of cytokines, such as interleukin-8 (IL8) and leukotriene B4 (Lk_B4), which produce necrosis and abscess formation. The toxin also causes lysis of neutrophils such that infection with PVL-positive strains may be associated with neutropenia

children and young adults, and is associated with higher mortality (105,106). In patients with staphylococcal osteomyelitis, the presence of PVL-positive isolates is associated with a higher likelihood of complications (107,108).

5.3 Nomenclature of strains

Independent studies of the molecular epidemiology of MRSA have resulted in a confusing nomenclature of circulating strains (60). In Canada, based on *Sma*I macrorestriction patterns from pulsed-field gel electrophoresis, 10 major clusters have been labelled CMRSA-1 to CMRSA-10 (109). In the US, also using pulsed-field gel electrophoresis profiles, 11 major epidemic strains of MRSA, labelled USA100 to USA1100, have been described to date (110). The USA300 (equivalent to CMRSA-10) strain is the dominant circulating clone of CA-MRSA in North America (17,39,40,73,111,112). Another molecular method, multilocus sequence typing, has been used internationally to unambiguously categorize MRSA strains by using the sequence of internal fragments of seven chromosomal housekeeping genes (60). Table 4 shows the common circulating strains and the relationship among the different systems of nomenclature. Also provided are the associated SCCmec types and the presence or absence of PVL genes in the various strains.

5.4 Resistance to non-beta-lactam antibiotics

5.4.1 Clindamycin

While clindamycin resistance is common in HA-MRSA (observed in 79% of isolates) (38), CA-MRSA has a low

TABLE 4
Nomenclature of *Staphylococcus aureus* strains

US PFGE	CMRSA strain	MLST	SCCmec type	PVL presence
USA100	2	5	II	Negative
USA200	3,6	36	II	Negative
USA300	10	8	IVa	Positive
USA400	7	1	IVa	Positive
USA500	5,9	8	IV	Negative
USA600	1	45	II	Negative
USA700	–	72	IVa	Negative
USA800	2	5	IV	Negative
USA1000	–	59	IV	Positive
USA1100	–	30	IV	Positive

CMRSA Canadian methicillin-resistant *Staphylococcus aureus*; MLST Multilocus sequence typing; PFGE Pulsed-field gel electrophoresis; PVL Panton-Valentine leukocidin; SCCmec *Staphylococcal chromosomal cassette mec*; US United States

baseline resistance to clindamycin in some communities. Clindamycin resistance rates for CA-MRSA vary across the US, from 2% (Texas in 2001) to 17% (Minnesota in 2000) (61,113). In Canada, 49% of pediatric and 85% of adult MRSA isolates were resistant to clindamycin between 1995 and 2002 (62), but this reflects a preponderance of hospital strains within the Canadian Nosocomial Infection Surveillance Program.

Laboratory testing for clindamycin resistance should include the double disk diffusion test (D test) for inducible clindamycin resistance (114). A clindamycin disk is placed at a fixed distance from an erythromycin disk, and a D-shaped zone of inhibition around the clindamycin disk indicates that resistance has been induced by the diffusion of erythromycin (ie, MLS_B phenotype) (115). Clinical failures have been documented in CA-MRSA infection when clindamycin was used to treat strains with inducible clindamycin resistance (positive D test) (115,116). Therefore, laboratories should routinely test for inducible clindamycin resistance, and clindamycin should be avoided when inducible resistance is detected.

5.4.2 Erythromycin

Both HA-MRSA and CA-MRSA are frequently resistant to erythromycin. For example, resistance was detected in vitro in 91% and 56% of HA-MRSA and CA-MRSA isolates, respectively, in Minnesota in 2000 (61). A large, laboratory-based survey indicated that 93% of Canadian MRSA isolates demonstrated resistance to erythromycin (117).

5.4.3 Quinolones

Emergence of resistance during therapy leading to treatment failure may occur when quinolones are used for the treatment of *S aureus* infections, including CA-MRSA (118).

5.5 Differences between CA-MRSA and HA-MRSA

In summary, CA-MRSA strains are genetically and phenotypically distinct from HA-MRSA strains, as highlighted in Table 5.

6.0 MANAGEMENT

6.1 Diagnostic evaluation

At the initial clinical presentation, CA-MRSA may not be easily distinguished from HA-MRSA, MSSA or streptococci

TABLE 5
Contrasting community-associated methicillin-resistant
***Staphylococcus aureus* (CA-MRSA) and hospital-**
associated (HA) MRSA

	CA-MRSA	HA-MRSA
Typical demographic characteristics	Younger Minority population	Older Nursing home resident
Common SCCmec type	IV	II
PVL virulence factor	Common	Unusual
Predominant strains	USA300 (CMRSA-10) USA400 (CMRSA-7)	USA100 (CMRSA-1) USA200 (CMRSA-3,6)
Multidrug resistance (other than beta-lactam)	Rare	Common

CMRSA Canadian MRSA; PVL Panton-Valentine leukocidin; SCCmec Staphylococcal chromosomal cassette mec; USA United States

as the agent of infection. Epidemiological risk factors (Table 2) should heighten suspicion of CA-MRSA. Furthermore, microbiological diagnosis can be helpful in guiding management and may prove helpful in monitoring local rates of CA-MRSA as this pathogen emerges in the community. The following principles of management are intended to assist the clinician faced with a possible or proven case of CA-MRSA infection and address clinical presentations that are potentially consistent with *S aureus* infection.

6.1.1 When to suspect CA-MRSA

Recommendations

- In areas where approximately 10% to 15% of community isolates of *S aureus* are methicillin resistant, CA-MRSA should be suspected in any patient who presents with an SSTI. (BIII)
- Suspect CA-MRSA in severe infections compatible with *S aureus* (eg, sepsis [39], necrotizing fasciitis [40], necrotizing pneumonia [44,45] and empyema [46,47]). (AIII)
- Suspect CA-MRSA when risk factors for CA-MRSA are present (Table 2). (AIII)
- Suspect CA-MRSA when there is a poor response to beta-lactam therapy in individuals with presumed staphylococcal infection. (AIII)

6.1.2 When to obtain cultures

Recommendations

- Cultures should be obtained from SSTIs, as well as other sites where *S aureus* infection is suspected, that have not responded to initial therapy. (AIII)
- Culture recurrent furuncles or abscesses (two or more in six months). (AIII)
- Obtain cultures in any severe presentation of the disease (should include blood cultures). (AIII)
- Obtain cultures when an outbreak is suspected in consultation with public health. (AIII)
- Consider an attempt to obtain material for culture from areas of cellulitis by aspiration of the area, with or

without preceding saline injection, particularly for patients who are going to be admitted for inpatient therapy or whose cellulitis progresses on treatment. (BIII)

- Specimens for culture of SSTIs should not be routinely obtained for all individuals presenting with minor skin infections and without previous CA-MRSA infection. (AIII)

6.2 Treatment

Studies have demonstrated that antibiotics may not be necessary in patients with minor SSTIs due to CA-MRSA (119). When systemic antimicrobial therapy is indicated for an infection consistent with *S aureus*, clinicians should bear in mind the possibility of methicillin resistance. The prevalence of CA-MRSA in the community is an important factor in guiding empirical antibiotic choice, but is unknown in most areas in Canada. The rate of methicillin resistance among community strains of *S aureus* is assumed to be low at the present time because of the relatively few cases of antibiotic failures reported to date, but may rise in the near future, as has occurred in many US cities. The threshold of resistance that should prompt a change in empirical therapy is thought to be approximately 10% to 15% (113). However, even in communities in which the rate is lower than 10% to 15%, clinicians may wish to include antimicrobial coverage for CA-MRSA in cases in which the infection is severe or life-threatening. In the absence of data to suggest a high prevalence of methicillin resistance in Canada, no change in empirical therapy of presumed *S aureus* infections is advocated at the present time. As resistance rates become better defined, recommendations for empirical therapy may change.

Table 6 summarizes the treatment principles and antimicrobial options for various presentations of CA-MRSA infection. Further details of the antimicrobial agents useful in the treatment of CA-MRSA are presented in Table 7. The following recommendations are categorized according to empirical therapy for suspected CA-MRSA infection versus therapy for confirmed infection, and according to severity and location of infection.

6.2.1 Minor SSTIs (folliculitis, furuncles and small abscesses without cellulitis)

Recommendations

- One or more of the following measures may be used:
 1. local therapy using hot soaks and elevation; (AIII)
 2. incision and drainage without antimicrobial therapy (119); (AII)
 3. topical mupirocin or bacitracin; (AIII) and/or
 4. topical antiseptics. (BIII)
- For young infants and for the immunocompromised host, antimicrobial therapy is recommended in addition to local measures, incision and drainage. (BIII)
- In follow-up, routine screening for colonization of the nares or other body sites is not recommended. (AIII)

TABLE 6
Guidelines for the management of infections due to community-associated methicillin-resistant *Staphylococcus aureus* (MRSA)

Clinical disease	Key features	Management principles	Antimicrobial choices*
Skin and soft tissue infection (SSTI)			
Mild	Localized disease	Culture selectively†	Generally not indicated
	Infected scratches	No antibiotic therapy recommended except for young or immunocompromised host	Topical antiseptic or antibacterial (eg, bacitracin) therapy may be considered.
	Insect bites	Cover draining lesions	Systemic antimicrobial therapy may be considered in the young infant or immunocompromised host.
	Furuncles	Emphasize personal hygiene	
	Small abscesses	Close follow-up	
Moderate	Absence of systemic illness	Return if worsening	
	Cellulitis	Culture (blood if febrile, site if purulent)	ET includes clindamycin 150 mg to 450 mg every 6 h po and ped dose of 30 mg/kg/day ÷ every 6 h to 8 h po, or TMP-SMX one double-strength tablet or two regular-strength tablets every 12 h po and ped dose of 8 mg/kg/day to 12 mg/kg/day (based on TMP component) ÷ every 12 h po/IV plus coverage for group A streptococcus, or doxycycline‡ 100 mg every 12 h po. If parenteral therapy is necessary, see choices for severe SSTI.
	Moderate abscesses	Drainage of abscess or needle aspiration	
	Minimal or no associated systemic features	Oral therapy in older child or adult	
		Consider parenteral therapy for young or immunocompromised host	
Severe		Appropriate infection control measures	Treat proven MRSA as above, based on sensitivity testing. If parenteral therapy is necessary, see choices for severe SSTI.
		Imaging for extent and complications (case by case)	
		Close follow-up	
		Return if worsening	
		Culture (blood if febrile, site if purulent)	ET includes vancomycin 1 g every 12 h IV and ped dose of 40 mg/kg/day to 60 mg/kg/day ÷ every 6 h IV. Some experts recommend adding cloxacillin or a first-generation cephalosporin while awaiting culture and sensitivity results (superior for MSSA). Clindamycin may be added in cases of toxin-mediated syndrome.
	Large or multiple abscesses	Drainage of abscess	Treatment for proven MRSA includes vancomycin 1 g every 12 h IV and ped dose of 40 mg/kg/day to 60 mg/kg/day ÷ every 6 h IV. Alternatives include clindamycin 600 mg to 900 mg every 8 h IV/IM (if sensitive) and ped dose of 30 mg/kg/day to 40 mg/kg/day ÷ every 6 h to 8 h IV or TMP-SMX* 8 mg/kg/day to 10 mg/kg/day (based on TMP component) ÷ every 12 h IV (if sensitive) and ped dose of 8 mg/kg/day to 12 mg/kg/day (based on TMP component) ÷ every 6 h IV. Clindamycin is bacteriostatic and should not be used alone if a bactericidal drug is required.
	Associated systemic features	Hospitalize	
		Parenteral therapy	
		Appropriate infection control measures	
		Infectious disease consultation	
		Imaging for extent and complications	
Musculoskeletal infection (MSI)			
Osteomyelitis	Preceding trauma	Cultures (blood, bone and tissue)	ET includes vancomycin 1 g every 12 h IV and ped dose of 40 mg/kg/day to 60 mg/kg/day ÷ every 6 h IV, or clindamycin 600 mg to 900 mg every 8 h IV/IM/po and ped dose of 30 mg/kg/day to 40 mg/kg/day ÷ every 6 h to 8 h IV or po, or TMP-SMX 8 mg/kg/day to 10 mg/kg/day (based on TMP component) ÷ every 12 h IV and ped dose of 8 mg/kg/day to 12 mg/kg/day (based on TMP component) ÷ every 6 h IV.
	Tendency for multifocal lesions	Involve surgical team (early debridement and drainage)	Treat proven MRSA as above, based on sensitivity testing.
	Disease in adjacent muscle not uncommon	Infectious disease consultation	Addition of rifampin may be considered for osteomyelitis.
	Progression to chronic osteomyelitis possible	Parenteral therapy	Treat similar to osteomyelitis.
	May be complicated by DVT	Consider combination therapy for severe cases or if slow to respond	
Pyomyositis		Infection control measures	
		Look for other infected sites (imaging)	
	May be extensive	Cultures (blood, tissue)	
	Tendency for multifocal involvement	Surgical drainage	
		Infectious disease consultation	
Necrotizing fasciitis		Parenteral therapy	
	Clinically indistinguishable from GAS disease	Infection control measures	
	Toxic	Imaging	
	High complication rate	Cultures (blood and tissue)	ET includes vancomycin 1 g every 12 h IV and ped dose of 40 mg/kg/day to 60 mg/kg/day ÷ every 6 h IV. Some experts recommend adding cloxacillin or a first-generation cephalosporin while awaiting culture and sensitivity results (superior for MSSA). Clindamycin may be added in case of toxin-mediated syndrome. Adjuncts such as IVIG should be considered on a case-by-case basis in conjunction with ID specialist.
		Surgical debridement	Treat proven MRSA as above, based on sensitivity testing.
	Infectious disease consultation		
	Parenteral therapy		
	Infection control measures		
	Imaging		

Continued on next page

TABLE 6 – CONTINUED

Guidelines for the management of infections due to community-associated methicillin-resistant *Staphylococcus aureus* (MRSA)

Clinical disease	Key features	Management principles	Antimicrobial choices*
Respiratory tract infection (RTI)			
Necrotizing pneumonia	Influenza-like prodrome, hemoptysis, fever, shock, leukopenia, pneumatoceles, abscesses, consolidation Respiratory failure High mortality	Cultures (blood, pleural fluid and sputum) ID consultation Intensive care unit care Infection control measures Combination parenteral therapy Chest drainage if empyema	ET includes vancomycin 1 g every 12 h IV and ped dose of 40 mg/kg/day to 60 mg/kg/day + every 6 h IV. Treat proven MRSA as above, based on sensitivity testing. Consider linezolid (superior for hospital-associated MRSA pneumonia [123,124]), as guided by ID opinion.
Other			
Sepsis syndrome	Shock Multiorgan failure May have purpura fulminans Associated SSTI, MSI, RTI May be complicated by Waterhouse-Friedrichsen syndrome High mortality	Blood cultures Culture any pus or fluid collection Look for primary or secondary focus ID consultation Intensive care unit care Imaging: look for occult abscesses, bone infection or endocarditis Involve surgery and other specialists as needed Infection control measures Parenteral, multidrug therapy Prolonged therapy for endovascular infections	ET includes vancomycin 1 g every 12 h IV and ped dose of 40 mg/kg/day to 60 mg/kg/day + every 6 h IV. Some experts recommend adding cloxacillin or a first-generation cephalosporin while awaiting culture and sensitivity results (superior for MSSA). Clindamycin may be added in case of toxin-mediated syndrome. Adjuncts such as IVIG should be considered on a case-by-case basis in conjunction with ID specialist Proven MRSA treatment includes vancomycin 1 g every 12 h IV and ped dose of 40 mg/kg/day to 60 mg/kg/day + every 6 h IV. Alternatives include clindamycin 600 mg to 900 mg every 8 h IV/IM (if sensitive) and a ped dose of 30 mg/kg/day to 40 mg/kg/day + every 6 h to 8 h IV or TMP-SMX 8 mg/kg/day to 10 mg/kg/day (based on TMP component) + every 12 h IV (if sensitive) and ped dose of 8 mg/kg/day to 12 mg/kg/day (based on TMP component) + every 6h IV. Clindamycin is bacteriostatic and should not be used alone if a bactericidal drug is required.
Septic thrombophlebitis, DVT	Complicates musculoskeletal infection	Management as for sepsis syndrome, plus Doppler ultrasound, often found on magnetic resonance imaging Anticoagulation, under direction of hematology (159)	Treat as above For endovascular infections, combination antimicrobial therapy is recommended (ie, vancomycin plus either gentamicin or rifampin) Prolonged therapy is required for endovascular infection, and expert advice from an ID specialist should be considered.
Endocarditis	Suspect if persistent bacteremia Pre-existing valvular heart disease may not be present	Management as for sepsis syndrome, plus Echocardiogram Cardiology consultation ID consultation Parenteral therapy Monitor for complications (embolic phenomena and hemodynamic instability)	

*Choice of antimicrobial therapy depends on local susceptibility patterns; [†]Patients with risk factors, as a part of an outbreak investigation, and patients with slowly responding or recurrent lesions; [‡]Not recommended for pediatric patients younger than eight years or during pregnancy. (AIII) Further information on antibiotic dosages and adverse effects can be found in Table 7. DVT Deep vein thrombosis; ET Empirical therapy; GAS Group A streptococcal; ID Infectious disease; IM Intramuscularly; IV Intravenously; IVIG Intravenous immunoglobulin; MSSA Methicillin-sensitive *Staphylococcus aureus*; ped Pediatric; po Orally; TMP-SMX Trimethoprim-sulfamethoxazole

6.2.2 Empirical therapy of non-life-threatening infections other than minor skin infections, potentially due to CA-MRSA Recommendations

- Antibiotic choice should be based on the severity of illness at presentation, clinical judgment and regional susceptibilities of strains. Antibiotic chosen should include an agent effective against group A streptococcus. (AIII)
- At present, cloxacillin or cefazolin remain appropriate empirical antibiotic choices for moderate infections (serious enough to require systemic antibiotics but not considered life threatening), consistent with *S aureus*. (AIII)

6.2.3 Empirical therapy of life-threatening infections potentially due to CA-MRSA Recommendations

- Include MRSA coverage, regardless of prevalence rates of CA-MRSA in the community. (AIII)

- Include an effective anti-MSSA agent until susceptibility results become available (cloxacillin is superior to vancomycin against MSSA) (120,121). (BIII)

6.2.4 Confirmed non-life-threatening CA-MRSA infections other than minor skin infections Recommendations

- For patients older than eight years, first-line oral agents include clindamycin, trimethoprim-sulfamethoxazole (TMP-SMX) or doxycycline. Fusidic acid in combination with another agent may also be considered. (AIII)
- Treatment should be guided by the susceptibility pattern. Clindamycin should only be considered an appropriate choice if susceptibility is confirmed using the D test. (AIII)

TABLE 7
Recommended antibiotics and doses

Drug	Dose (adult)	Dose (pediatric)*	Adverse reaction	Notes
Oral options for mild to moderate SSTI with no systemic features				
Clindamycin	150 mg to 450 mg every 6 h po	30 mg/kg/day + every 6 h to 8 h po	Pseudomembranous colitis	Resistance may occur Check susceptibility with D test
TMP-SMX	1 DS or 2 RS tabs (160 mg TMP/800 mg SMX) every 12 h po	8 mg/kg/day to 12 mg/kg/day (based on TMP component) + every 12 h po	Allergy (skin rash) Bone marrow suppression	Not recommended for group A streptococcus
Doxycycline	100 mg every 12 h po	2 mg/kg/day to 4 mg/kg/day + every 12 h to maximum 100 mg every 12 h po Not for children younger than eight years	Photosensitivity Erosive esophagitis Teeth staining	Not for children younger than eight years Not for use in pregnancy
Linezolid	400 mg every 12 h po	20 mg/kg/day + every 12 h po (160)	Dose-dependent bone marrow suppression Peripheral neuropathy Optic neuritis (rare)	Selected cases only Expensive ID consultation recommended
Parenteral therapy for systemic and severe infections				
Vancomycin	1 g every 12 h IV	40 mg/kg/day to 60 mg/kg/day + every 6 h to a maximum 4 g/day IV	Renal toxicity	Lower efficacy in pneumonia Monitor levels
Clindamycin	600 mg to 900 mg every 8 h IV/IM	30 mg/kg/day to 40 mg/kg/day + every 6 h to 8 h IV	Pseudomembranous colitis	Resistance may occur Check susceptibility with D test Bacteriostatic
TMP-SMX	8 mg/kg/day to 10 mg/kg/day + every 12 h IV	8 mg/kg/day to 12 mg/kg/day (based on TMP component) + every 12 h IV	Allergy (skin rash) Bone marrow suppression	Not recommended for group A streptococcus
Linezolid	600 mg every 12 h IV/po	Children younger than 12 years: 30 mg/kg/day + every 8 h IV (160) Children older than 12 years: 20 mg/kg/day + every 12 h IV	Dose-dependent bone marrow suppression Peripheral neuropathy Optic neuritis (rare)	Selected cases only Expensive ID consultation recommended Bacteriostatic
Adjunctive therapy				
Rifampin	600 mg po qd	10 mg/kg/day to 20 mg/kg/day + every 12 h to 24 h po/IV	Hepatotoxicity Rash Discoloured urine Stains soft contact lenses	Consider in high bacterial burden Never use alone Potential for drug interactions
Fusidic acid	500 mg tid po/IV	No data for children	Skin rash Jaundice	No cerebrospinal fluid penetration Not excreted in urine Never use alone (161) Bacteriostatic

*Doses in the neonate may be different. DS Double strength; D test Double disk diffusion test; ID Infectious disease; IM Intramuscularly; IV Intravenously; po Orally; qd Once daily; RS Regular strength; SSTI Skin and soft tissue infection; tid Three times daily; TMP-SMX Trimethoprim-sulfamethoxazole

- For children younger than eight years, first-line oral agents include clindamycin and TMP-SMX. Doxycycline is contraindicated in children younger than eight years, as are all tetracyclines, and there are limited data regarding the use of fusidic acid in children (122). (AIII)
- Do not use doxycycline in pregnancy. (AIII)
- Patients should be followed, and the antimicrobial therapy should be reconsidered if there is evidence of treatment failure. (CIII)
- In follow-up, routine screening for colonization of the nares or other body sites is not recommended. (AIII)

6.2.5 Confirmed CA-MRSA life-threatening infections Recommendations

- Treatment options include parenteral vancomycin, clindamycin (provided susceptibility confirmed with D test) and TMP-SMX. (AIII)
- Some experts recommend against the use of bacteriostatic agents such as clindamycin alone for the treatment of life-threatening infections. (CIII) Fusidic acid and rifampin should not be used alone because of rapid emergence of resistance. (AIII)
- Newer drug therapies, such as linezolid, tigecycline or quinupristin-dalfopristin, should be guided by an infectious disease specialist. In particular, drugs such as

quinupristin-dalfopristin and daptomycin should be used with caution in pediatric populations in which there are limited data for their use. (CIII)

- Linezolid is preferred over vancomycin for the treatment of MRSA pneumonia because of its superiority in clinical trials for adults with HA-MRSA pneumonia (123), possibly explained by better penetration into the lung parenchyma (124). (BII)
- In follow-up, routine screening for colonization of the nares or other body sites is not recommended. (AIII)

6.2.6 Adjunctive therapy

Recommendations

- Combination of first-line drugs with rifampin or gentamicin to enhance killing in serious invasive disease should be decided on a case-by-case basis in discussion with an infectious disease specialist (125). (BIII)
- Other adjunctive therapy, such as intravenous immunoglobulin, may play a role in neutralizing toxin-mediated effects and may be considered for selected patients with severe disease as guided by an infectious disease or critical care specialist (126). (CIII)

7.0 SCREENING AND DECOLONIZATION

7.1 Screening for CA-MRSA

S aureus may asymptomatically colonize body surfaces, particularly the nares. Rates of colonization in a recent US population-based survey (127) were 31.6% for *S aureus* and 0.84% for MRSA. These asymptomatic carriers may act as a reservoir for infection; therefore, identifying *S aureus* carriers and eradicating the carriage state may theoretically prevent recurrent *S aureus* infections or person-to-person spread. However, at present, there is insufficient evidence to support the use of eradication regimens; thus, there is no clear role for screening (128).

Recommendations

- In the nonoutbreak setting, routinely screening individuals infected with CA-MRSA or their contacts for colonization of nares or other sites is not recommended. (AIII)
- In selected circumstances, following consultation with public health or an infectious disease consultant, nasal and/or additional site screening may be considered. These selected circumstances include the following:
 1. Individuals with recurrent *S aureus* skin infections (two or more in six months), in whom eradication therapy is being considered; (BIII)
 2. In a family setting, where recurrent skin infections continue despite repeated review and reinforcement of hygiene measures, and there is not known to be a high prevalence of CA-MRSA in the community; (BIII) and
 3. To investigate an outbreak in a closed population with continuing new infections despite repeated

reinforcement of hygiene practices. (BIII) When a colonization survey is performed as part of an outbreak investigation, assessing carriage sites other than the nares may be considered, in consultation with public health officials and/or other experts (51). (BIII)

7.2 Decolonization

Decolonization refers to the process of eradicating or reducing carriage of a particular organism from the skin, nose or other mucosal surfaces. In the case of staphylococcal carriage, decolonization has been attempted using topical or systemic (usually oral) therapy. The available systemic options include rifampin plus another antistaphylococcal antibiotic, such as TMP-SMX, clindamycin, fusidic acid, doxycycline or minocycline. Eradication from the skin can be attempted using topical agents, such as chlorhexidine or triclosan, whereas nasal decolonization usually requires intranasal mupirocin. Eradication from sites other than the nose usually requires systemic and topical therapy in addition to intranasal therapy. However, decolonization regimens have met with limited success. A systematic review (128) of the literature published in 2003 concluded that there is insufficient evidence to support the use of topical or systemic antimicrobial therapy for eradicating nasal or extranasal MRSA. Experience in hospitals indicates that recolonization is frequent (129,130). In the community setting, decolonization has been attempted with mixed success. Decolonization was successful in eradicating CA-MRSA carriage in a daycare facility (51); however, recurrent infection occurred despite decolonization attempts in two CA-MRSA outbreaks involving football teams (73,74).

One disadvantage of attempted decolonization is the development of resistance to the agents used. Mupirocin resistance has been documented in several studies (131-134), usually associated with prolonged use or repeated courses of mupirocin. In Canada, Mulvey et al (109) have reported mupirocin resistance rates of up to 50% in community isolates on the prairies. Limiting its use to a maximum course of five to 10 days and ensuring a minimum time period of one month between recurrent use are strategies that have been found to be effective in preventing the emergence of mupirocin resistance (133,134).

Recommendations

- Decolonization is not recommended for usual management of individual CA-MRSA infections, endemic infection or outbreaks (128,131,135-138). (AI)
- Decolonization should be considered only in exceptional circumstances, which may include the following:
 1. recurrent CA-MRSA skin infections (two or more in six months) with no evidence of repeated re-exposures when hygiene measures have been reinforced and after discussion with an infectious disease expert; and (BIII)
 2. as a public health strategy for ongoing transmission despite repeated review and reinforcement of appropriate hygiene interventions in outbreaks in selected closed settings. (BIII)

7.3 Guidelines for the use of decolonization regimens

In exceptional situations in which decolonization regimens are used, several options are available: intranasal mupirocin ointment, topical antiseptics applied to the skin and systemic antibiotics active against the colonizing strain, particularly those that achieve high levels in body secretions, such as rifampin and clindamycin. Some experts favour a combined approach (including intranasal mupirocin, topical antiseptics and two systemic agents) for maximum possible effect in the rare circumstances when decolonization is indicated. Other experts offer only intranasal mupirocin to patients with isolated nasal carriage of *S aureus* (139).

Recommendations

- Decolonization regimens should be administered only to individual patients or well-defined closed cohorts, and only over a limited time interval to minimize the potential for resistance to develop. (BIII)
- Selection of a decolonization regimen should take into consideration the sensitivities of the organism isolated as well as the sites colonized, and infectious disease consultation should be sought. (BIII)
- The recommended regimen for nasal decolonization for mupirocin-susceptible isolates is mupirocin ointment to the nares twice daily for five to 10 days (133,134,140). (BII)
- When mupirocin is used to eradicate carriage, isolate susceptibility to mupirocin should be tested. (BIII)
- No recommendations can be made at this time for the use of other topical intranasal agents for decolonization. (CIII)
- There is insufficient evidence to make a recommendation for or against the use of topical antiseptics for cleaning or cutaneous decolonization. (CIII)
- A combined strategy of intranasal mupirocin, topical antiseptics and systemic antibiotics (active against the colonizing strain and achieving high levels in body secretions [eg, rifampin or clindamycin]) may be considered (140). (BIII)

8.0 POPULATION SURVEILLANCE

8.1 Population surveillance program for CA-MRSA

The Working Group meeting identified several possible purposes of a population surveillance program: to document the emergence of resistance to methicillin among community isolates of *S aureus* to inform empirical therapy; to describe the occurrence and impact of severe *S aureus* disease in a community, irrespective of resistance pattern; and to facilitate timely identification of potential outbreaks.

Recommendations

- Surveillance for methicillin resistance among CA strains of *S aureus* should be considered. (CIII)
- Population-based surveillance for severe CA *S aureus* infections (including severe SSTIs, osteomyelitis, pyomyositis, necrotizing fasciitis, sepsis and endocarditis

[Table 6]), irrespective of susceptibility, should be considered. (CIII)

- Intermittent or targeted surveillance of all purulent skin lesions in patients presenting to primary care may be considered to support timely identification of outbreaks, and to recognize emergence and spread of new strains in the community. (CIII)
- Populations recognized to be at increased risk (eg, sports teams and Aboriginal communities) should be included in the development of a surveillance program. (BIII)

8.2 Laboratory support

Monitoring CA-MRSA in the community requires collaboration among the clinician managing individual patients, the microbiology laboratory and public health departments.

Recommendations

- Clinicians and public health personnel in a given region should develop, together with microbiological laboratories, a method for rapid dissemination and timely feedback of susceptibility profiles for CA-MRSA in the region. (AIII)
- Clinical microbiology laboratories should follow the current guidelines laid out by the Clinical and Laboratory Standards Institute (USA) when testing erythromycin-resistant strains of CA-MRSA for inducible clindamycin resistance (ie, D testing). (AIII)
- Antimicrobials that are tested and reported back to practitioners should reflect the usual standard of care for CA-MRSA (eg, fluoroquinolone susceptibilities should not be provided). (AIII)

9.0 PREVENTION

9.1 Prevention of transmission of CA-MRSA

The goal of community control of CA-MRSA is to prevent spread of the bacteria from an infected or colonized individual to other persons in the family and the community. This requires individuals to take a proactive role to limit transmission. As a general rule, the prevention of CA-MRSA and infections with other common skin pathogens requires consistent application and reinforcement of good hygienic practices with emphasis on handwashing, not sharing potentially contaminated personal articles, and covering of draining skin lesions to prevent direct or indirect contact with infected secretions of another person. These measures are not specific to CA-MRSA, and apply to draining lesions, wounds or potentially infected sites caused by any microorganism.

9.1.1 Role of the individual

Recommendations

- Individuals should follow basic practices for good hygiene at all times and in all settings. These include, but are not limited to the following:
 1. regular hand hygiene to limit personal contamination and transmission; and (AIII)
 2. regular bathing with soap and water. (AIII)

- If skin lesions are present:
 1. cover lesions with appropriate dressings to contain drainage or exudate, and ensure that appropriate medical care has been received; (AIII)
 2. do not share creams, lotions, soaps, cosmetics and other personal products that are in contact with the skin; (AIII)
 3. do not share unwashed towels; (AIII)
 4. do not share personal items that come in contact with the skin lesions – such as razors, toothbrushes, towels, nail files, combs and brushes – without cleaning; (AIII)
 5. discard contaminated waste, including used dressings, in a safe and timely manner to avoid exposure to other individuals; (AIII) and
 6. wash hands with soap and water after touching any skin lesions and potentially infected materials, such as soiled dressings. (AIII)

9.1.2 Role of health care practitioners

Recommendations

- Practitioners should use antibiotics judiciously (141). (AIII)
 1. Treatment of viral infections with antimicrobials should be avoided; and
 2. Patients should be encouraged to complete all courses of antibiotics as prescribed.
- Public health officials should be notified if spread occurs beyond a family unit to a localized community group, such as a school or sports team (ie, if an outbreak of the disease is suspected). (AIII)
- Educate patients about appropriate hygiene practices, as outlined in section 9.1.1. (AIII)

9.1.3 Role of health authorities

Recommendations

- Communication strategies that inform the general public, as well as high-risk groups, about CA-MRSA and practices to limit infection need to be developed, implemented and evaluated. (AIII)
- Strategies for ensuring early diagnosis and appropriate treatment of skin infections should target physicians, and should include education about risk factors, clinical features and expected treatment response time. (AIII)
- Regional and local programs to review antibiotic use and resistance should be developed. (BIII)
- Education programs should be developed to educate the public on the proper use of antibiotics in the community. (AIII)

9.2 Prevention in specific settings

9.2.1 Households with CA-MRSA infection

In addition to the general measures outlined in section 9.1, specific measures can be recommended within households in which one or more members have a CA-MRSA infection.

Recommendations

- The household environment should be regularly cleaned with a standard household detergent. (AIII)
- Clothes and linens from individuals who are MRSA-positive or have other skin lesions can be included in the regular household laundry. Usual laundry washing and drying destroys most potentially pathogenic bacteria. (AIII)
- Cutlery and dishes may be washed in the usual manner with other household utensils using soap and hot water, or a dishwasher. (AIII)
- Individuals who are MRSA-positive, or their family members, should be advised to notify at the time of contact with the health care system that they are either MRSA-positive or living in a household with someone who is MRSA-positive. (BIII)

9.2.2 Daycare centres and schools

Isolation of children with CA-MRSA in childcare settings or schools is not a practical solution and impacts negatively on the child's well-being. The emphasis must be placed on the consistent application of hygienic measures within the daycare or school setting to reduce the risk of transmission. In addition to the general measures outlined in section 9.1, specific measures are recommended to prevent transmission in schools and daycare centres.

Recommendations

- Educate providers, teachers, children and families on general hygiene practices (eg, hand hygiene, respiratory etiquette and staying home if ill). (AIII)
- Ensure availability of products to allow hand hygiene to be performed. This includes access to liquid soap in pump dispensers, running water and paper towels to dry hands. Alcohol-based, waterless hand sanitizers can be used as an alternative as long as hands are not visibly soiled. (AIII)
- Structure activities to include opportunities for hand hygiene to be practised (before eating, after outdoor play and after using the washroom). (BIII)
- In situations in which open lesions cannot be kept covered, consider temporary exclusion from the daycare or school setting until the wound has healed or drainage can be contained. (BIII)
- Ensure that frequently touched surfaces (eg, counters, desks and toys) are cleaned at least daily with a disinfectant solution. (AIII)
- Items soiled with body fluids should be cleaned and disinfected as soon as possible and before use by another child. (AIII)

9.2.3 Sports settings

CA-MRSA transmission has been documented in several reports among athletes and contact sports participants (70-74). In addition to the general measures outlined in section 9.1, the following recommendations address infection prevention and control in this high-risk group.

Recommendations

At all times:

- Use alcohol-based hand antiseptic rinse or gel when handwashing facilities are not available. (AIII)
- Individuals participating in sports should shower with soap and water after every practice or tournament. (AIII)
- Do not share hygiene items, such as bar soap or towels (73). (AIII)
- Ensure regular cleaning of communal bathing facilities and frequently touched surfaces. (AIII)
- Personal items, such as towels and supporters, should be laundered or cleaned after each use. (AIII)
- Clean or launder shared athletic equipment, such as pads or helmets, at least once a week, but ideally after each use. Establish a routine cleaning schedule for nonpersonal devices, such as sensor wires used in fencing. (AIII)

Individuals with skin lesions:

- Provide both verbal and written instructions describing management of skin lesions infected with CA-MRSA or other potential pathogens to coaches and/or participants. (BIII)
- Individuals who have open lesions that cannot be kept covered should not participate in contact sports until the wound has healed or drainage can be contained. (AIII)
- Individuals who have open skin lesions should be excluded from common whirlpools or saunas. (AIII)
- Persons with skin lesions should not share athletic equipment that is in contact with the skin. (AIII)

9.2.4 Pets and other animals

Recurrent MRSA infections in household contacts of colonized companion animals (pets) have been described (91,96,102,103). Given the evidence of transmission of MRSA between humans and animals, there is concern that pets may serve as a reservoir for MRSA in the community (96). In addition to the general measures outlined in section 9.1, the following recommendations are made for owners of pets infected or colonized with MRSA.

Recommendations

- Pet ownership and contact information may identify risk and should be queried as part of the standard history for any patient. Known MRSA status of pets or owners, when available, should be documented. (AIII)
- Pet screening should only be considered when recurrent infections are occurring within an isolated group exposed to the pet and despite repeated reinforcement of hygiene practices. Consultation with a veterinarian, as well as a public health or infectious disease expert, is recommended. (BIII)
- Treatment of colonized pets is not indicated because there is little evidence that antimicrobial-based

eradication therapy is effective in colonized pets, and colonization tends to be short term. (BIII)

- In exceptional circumstances, when a colonized pet is implicated as a source of infection and the infection is serious and recurrent, temporary removal of the pet from the household may be considered. While there is the potential for pets to be involved in dissemination of MRSA in the community, the beneficial effects of pet contact should be considered in any discussion about removal of the pet from the household. (BIII)
- There should be increased awareness in the veterinary community about MRSA infection and colonization in pets, interspecies transmission of MRSA, appropriate testing, management of infected and colonized pets, and relevant infection control measures. (BIII)

9.2.5 Correctional facilities or shelters

Outbreaks of CA-MRSA have been documented in incarcerated populations in the US, Australia and Canada (82-84,86,87,142). In addition to the general measures outlined in section 9.1, the following recommendations address this high-risk group.

Recommendations

- Educate correctional facility staff and inmates on transmission, prevention, treatment and containment of MRSA infections. (BIII)
- Restrict inmates who have uncovered draining skin lesions, as well as inmates with skin lesions and poor hygiene, to prevent exposure of other inmates. (BIII)
- Consider housing assignments based on the potential harm to individuals who could acquire infection. (BIII)

9.2.6 Newborn care facilities

Routine practices can be expected to limit the transmission of CA-MRSA within newborn care facilities and must be followed at all times (143).

Recommendations: Routine care

- Wash hands before and after contact with the newborn. (AIII)
- Use gloves until the newborn has been cleaned or bathed for the first time. (AIII)
- Clean and disinfect all used equipment before it is used with another infant (eg, thermometers, weigh scales, glucose meters and stethoscopes). (AIII)
- Staff should wear a gown when holding the infant against the body. (AIII)

There are several reports of outbreaks of CA-MRSA strains within the nursery setting (144-148). In the outbreak setting, strategies to interrupt transmission may be directed toward infants, health care workers or the nursery environment because all three elements play a role in the chain of transmission (Table 8).

When increased transmission of CA-MRSA is documented within the nursery, intensified infection control measures are necessary.

TABLE 8
Risk factors for neonatal infections and outbreaks

Risk category	Factors
Staff	Lack of compliance with routine practices, including hand hygiene Inadequate staff education Staff carriage of the outbreak strain Poor staff to patient ratios (90) Intensity of colonization (eg, chronic skin conditions and concurrent upper respiratory tract infections)
Neonate	Prematurity Prolonged neonatal intensive care unit stay Use of invasive medical devices Exposure intensity (eg, to carriers with chronic skin conditions or concurrent upper respiratory tract infections)
Environment	Poor cleaning of equipment and environment Patients residing in common areas (eg, large nurseries) Overcrowding and inadequate spacing of patients (90); nonadherence to facility guidelines Common newborn bath areas Lack of isolation areas during an outbreak

Recommendations: Outbreak setting

Measures directed at health care workers:

- Enhance hand hygiene. Consider the use of antiseptic handwashing agents, such as chlorhexidine gluconate or triclosan, before each contact with the newborn (143,149). (BIII)
- Reinforce infection prevention and control practices. (BIII)
 1. Provide staff education sessions; and
 2. Perform practice audits to document compliance.
- Staff screening may be considered in selected situations (eg, if cohorting and barriers are in place and the outbreak continues, or if a staff member is epidemiologically linked to cases). (AIII)
 1. Screen nares, examine hands for lesions, inquire about skin conditions on other areas of body (scalp and feet) and inquire about upper respiratory symptoms.
 2. For staff epidemiologically linked to cases, perform thorough full-body skin examinations and culture any lesions.
 3. Staff screening should be performed through the occupational health department, ensuring staff confidentiality, and education and counselling for staff should be provided.
 4. Decolonization may be attempted for the identified staff carriers with topical and/or systemic therapy (149,150).
 5. Exclusion of carriers from the area must be carefully considered, which depends on factors such as compliance with decolonization therapy,

compliance with hand hygiene and routine practices or additional precautions, severity of illness in cases, exposure intensity (eg, chronic skin conditions, concurrent upper respiratory tract infection or allergic rhinitis) and evidence of ongoing transmission.

- Cohort personnel who care for colonized and infected newborns. (BIII)
- Increase the nurse to patient ratio. (AIII)

Measures directed at neonates:

- There is insufficient evidence to make a recommendation for or against measures to decrease the burden of organisms through cord care, topical antiseptic baths or intranasal mupirocin (149-157). (CIII)
- Consider screening all patients for the epidemic strain. (AIII)
 1. Examine carefully for skin lesions and eye discharge and culture any lesions or pustules.
 2. Culture nares, perineum, umbilicus, device exit sites and open skin lesions.
 3. Continue weekly screening of entire cohort until the outbreak is over.

At the time of discharge:

- Communicate with family physicians and pediatricians receiving newborns from the facility, bringing to their attention the risk of colonization or infection with CA-MRSA in discharged neonates. (AIII)
- There is insufficient evidence to make a recommendation for or against routine screening at the time of discharge and periodically thereafter. Although colonization may not be detectable without repeated sampling, the value of screening at or after discharge is questionable if no intervention is planned for colonized infants, and this may increase parental anxiety (158). (CIII)
- Advise parents of discharged infants to watch carefully for skin lesions and to report immediately whether these occur, at which time the lesions should be cultured. If a baby sees a physician for an infection or is to be readmitted to the hospital, parents should inform the physician of possible MRSA exposure. (AIII)

Measures directed at the nursery environment:

- Institute contact precautions and cohorting for colonized and infected infants; avoid cohorting infants with CA-MRSA together with those with HA-MRSA. (BIII)
- Reduce overcrowding, strongly encourage rooming-in and correct spacing deficiencies (90). (AIII)
- Consider ward closure, balancing the risks and benefits of closure versus infection risk. (BIII)

Additional measures:

- Assign a dedicated additional infection control professional to the nursery during the outbreak. (BIII)
- Perform epidemiological typing of the strains. (BIII)
- Consider recall of discharged infants for screening. (BIII)
- Notify public health. (AIII)
- Consider a case-control study. (BIII)

10.0 DIRECTIONS FOR FUTURE RESEARCH

The Working Group meeting identified numerous areas in need of further research, classified here by category.

10.1 Epidemiology

- Establish the current incidence and prevalence of CA-MRSA disease in Canadian communities.
- Determine modifiable risk factors for CA-MRSA infection; in particular, better define any link with antibiotic use.
- Determine the impact of animals, especially household pets, on CA-MRSA infection.
- Determine the role that colonized persons play in the spread of CA-MRSA in the community.

10.2 Biology of CA-MRSA: Organism versus host

- Better define the virulence factors of CA-MRSA, including the role of virulence factors such as PVL and the use of immunotherapy to neutralize these virulence factors.
- Pursue vaccine development.
- Investigate host or pathogen factors that may be implicated in the particular virulence and rapid dissemination of CA-MRSA.
- Study the effect of the pneumococcal vaccine, now in widespread use, on colonization with CA-MRSA, particularly in children.
- Study the effect of influenza and influenza vaccination on CA-MRSA colonization and disease.

10.3 Clinical outcomes and management

- Within the pediatric population, define the safety and efficacy of newer agents, such as daptomycin.
- Investigate the use of options other than antibiotic therapy, including anticytokines, immunomodulators or intravenous immunoglobulin.
- Study the effect of combination therapy (eg, addition of fusidic acid or rifampin to standard antibiotic regimens).
- Define the role of novel testing modalities (eg, polymerase chain reaction for rapid diagnosis).
- Define best practices in wound management that may have implications for minimizing antibiotic use.

10.4 Infection prevention and control

- Investigate primary prevention initiatives.
- Determine the effect of infection prevention and control practices in the community on rates of CA-MRSA and clinical outcomes.
- Define appropriate infection control practices for the purulent wound, particularly the challenges of wound management outside the hospital.
- Develop strategies for managing household clusters.
- Determine the psychosocial impact on individuals 'labelled' as MRSA-positive.
- Develop strategies for infection control in the physician's office.

10.5 Knowledge translation

- Determine which public health communication strategies should be used.
- Investigate factors that will result in 'cultural' change (eg, improving hygienic practices at a population level).
- Discover how target groups (eg, the community and sports teams) can be involved in the development of guidelines and best practices.

11.0 CONCLUSION

The epidemiology of MRSA is changing, as evidenced by the dramatic increase and stable high prevalence of CA-MRSA in several US communities. While the problem does not yet appear to be widespread in Canada, several early reports indicate that CA-MRSA is emerging as an important pathogen in Canada as well. Physicians and other health care providers should be aware of the increasing prevalence and potential severity of CA-MRSA infection because beta-lactam antibiotics, currently used for the treatment of presumed staphylococcal infections in the community, are ineffective. The management of presumed *S aureus* infection should include surgical drainage when appropriate, culture of significant draining lesions and abscess collections, and empirical antibiotic therapy, taking into account both the severity of the infection and the regional prevalence of CA-MRSA. Families, school and daycare centre personnel, and sports teams should be actively encouraged to practice meticulous handwashing, the most important measure to control or attenuate the community transmission of CA-MRSA.

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APPENDIX
**Useful resources for specific questions related
 to the management of health care facilities and
 health care workers**

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Appendix D

Glossary

active surveillance testing (or cultures): screening patients for an organism regardless of symptoms (e.g., culture all ICU admissions for MRSA).

antibiogram: overall profile of antimicrobial susceptibility results of a microbial species to a battery of antimicrobial agents or results of laboratory testing for susceptibility of a bacterial isolate to different antibiotics.

antimicrobial stewardship (judicious antibiotic use): programs and policies to improve appropriate use of antibiotics, with the goals of reducing antibiotic resistance and improving patient care.

APIC: Association for Professionals in Infection Control and Epidemiology. APIC's mission is to improve health and patient safety by reducing risks of infection and other adverse outcomes.

case definition: standard criteria used to report a case for surveillance purposes, which may differ from criteria used to diagnose and treat a patient.

CDC: Centers for Disease Control and Prevention, part of the United State Department of Health and Human Services.

colonization: proliferation of an organism on or in the body without causing symptoms of infection, cellular damage, or an immune reaction.

community onset: health care associated infection that starts outside a health care facility, for example MRSA infection shortly after hospital discharge.

community-associated: infection acquired by persons who have not recently (within one year) been hospitalized or had a medical procedure.

Contact Precautions: a group of infection prevention practices to prevent transmission of organisms from an infected or colonized patient or when there is an increased potential for extensive environmental contamination and risk of transmission such as with excessive wound drainage or fecal incontinence.

drug (or antibiotic) resistant: bacterial infection that is not is not treated by one or more classes of antibiotics intended to treat that infection.

drug (or antibiotic) sensitive: bacterial infection that can be treated by a class of antibiotics intended to treat that infection.

hand hygiene: protecting and cleansing hands at appropriate times using appropriate means; includes hand washing with plain or antiseptic soap, use of antiseptic alcohol products, and use of gloves followed by hand washing.

health care-associated: infections associated with health care in any setting during the preceding 12 months such as surgery, hospitalization, outpatient visit, presence of an invasive device, dialysis, or residence in a long-term care facility.

HICPAC: Health Care Infection Control Practices Advisory Committee, which advises the Department of Health and Human Services and Centers for Disease Control and Prevention regarding the practice of infection control and strategies for surveillance, prevention, and control of health care-associated infections, antimicrobial resistance and related events in settings where health care is provided, including hospitals, long-term care facilities, and home health agencies.

hospital onset: infection that was not present or incubating at the time of admission, usually starting more than 48 hours after hospital admission or within 48 hours of discharge.

IHI: Institute of Health Care Improvement (IHI) is a not-for-profit organization leading the improvement of health care throughout the world.

incidence: number of new cases of disease in a specific population during a time period (e.g., cases of botulism in Washington residents during 2006).

infection: entry and multiplication of an organism in the body causing symptoms of infection, cellular damage, or an immune reaction.

invasive infection: severe infection involving internal body parts or the bloodstream often defined as consistent symptoms and culturing the organism from a normally sterile body site (e.g., blood, cerebrospinal fluid, joint, internal organ).

methicillin: antibiotic in the penicillin class used in the past to treat infections such as with *S. aureus*.

MRSA (methicillin-resistant *Staphylococcus aureus*): *S. aureus* resistant to penicillin-type antibiotics used in the past to treat Staph infections.

MDROs (multidrug-resistant organisms): bacterial infection that is not treated by multiple classes of antibiotics intended to treat that infection.

nosocomial infection: infection acquired in the hospital.

oxacillin: antibiotic used to test for resistance to methicillin and related antibiotics.

performance bundle: collection (bundle) of evidence-based processes needed to prevent infections and effectively care for patients undergoing particular treatments.

point prevalence: total number of cases of a disease in a population at one specific time.

prevalence: total number of cases of a disease in a population during a period of time.

resistant (antibiotic or drug resistant): antibiotic intended to treat a specific bacterial infection is ineffective.

screening: testing people without symptoms for the presence of a disease or infection.

sentinel surveillance: disease surveillance conducted by selected health care facilities, laboratories, or health care providers in an area.

SHEA: Society for Health Care Epidemiology of America, which works to prevent and control infections in all health care settings.

skin and soft tissue infections: generally minor infections of the skin and underlying tissues, such as abscesses, boils, impetigo, or folliculitis.

standard precautions: a group of infection prevention practices (hand hygiene; use as needed gloves, gown, mask, eye protection, or face shield; safe injection practices; and appropriate handling of items that may have been contaminated with infectious body) that apply to all patients, regardless of suspected or confirmed infection status, in any setting in which health care is delivered.

S. (Staphylococcus) aureus: bacterial specie which can colonize or infect a person, with infections ranging from minor boils or abscesses to severe conditions such as pneumonia, meningitis, bone infection, or blood stream infection.

surveillance: systematic collection and analysis of information about a disease such as case reports or laboratory results.

Appendix E

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