DRUG RESISTANT INFECTIONS IN THE COMMUNITY: CONSEQUENCES FOR PUBLIC HEALTH

HEARING

BEFORE THE

COMMITTEE ON OVERSIGHT AND GOVERNMENT REFORM

HOUSE OF REPRESENTATIVES

ONE HUNDRED TENTH CONGRESS

FIRST SESSION

NOVEMBER 7, 2007

Serial No. 110–65

Printed for the use of the Committee on Oversight and Government Reform

Available via the World Wide Web: http://www.gpoaccess.gov/congress/index.html
http://www.house.gov/reform

U.S. GOVERNMENT PRINTING OFFICE

43–600 PDF WASHINGTON : 2008

For sale by the Superintendent of Documents, U.S. Government Printing Office
Internet: bookstore.gpo.gov Phone: toll free (866) 512–1800; DC area (202) 512–1800
Fax: (202) 512–2104 Mail: Stop IDCC, Washington, DC 20402–0001

COMMITTEE ON OVERSIGHT AND GOVERNMENT REFORM

HENRY A. WAXMAN, California, *Chairman*

TOM LANTOS, California
EDOLPHUS TOWNS, New York
PAUL E. KANJORSKI, Pennsylvania
CAROLYN B. MALONEY, New York
ELIJAH E. CUMMINGS, Maryland
DENNIS J. KUCINICH, Ohio
DANNY K. DAVIS, Illinois
JOHN F. TIERNEY, Massachusetts
WM. LACY CLAY, Missouri
DIANE E. WATSON, California
STEPHEN F. LYNCH, Massachusetts
BRIAN HIGGINS, New York
JOHN A. YARMUTH, Kentucky
BRUCE L. BRALEY, Iowa
ELEANOR HOLMES NORTON, District of Columbia
BETTY McCOLLUM, Minnesota
JIM COOPER, Tennessee
CHRIS VAN HOLLEN, Maryland
PAUL W. HODES, New Hampshire
CHRISTOPHER S. MURPHY, Connecticut
JOHN P. SARBANES, Maryland
PETER WELCH, Vermont

TOM DAVIS, Virginia
DAN BURTON, Indiana
CHRISTOPHER SHAYS, Connecticut
JOHN M. McHUGH, New York
JOHN L. MICA, Florida
MARK E. SOUDER, Indiana
TODD RUSSELL PLATTS, Pennsylvania
CHRIS CANNON, Utah
JOHN J. DUNCAN, JR., Tennessee
MICHAEL R. TURNER, Ohio
DARRELL E. ISSA, California
KENNY MARCHANT, Texas
LYNN A. WESTMORELAND, Georgia
PATRICK T. McHENRY, North Carolina
VIRGINIA FOXX, North Carolina
BRIAN P. BILBRAY, California
BILL SALI, Idaho
JIM JORDAN, Ohio

PHIL SCHILIRO, *Chief of Staff*
PHIL BARNETT, *Staff Director*
EARLEY GREEN, *Chief Clerk*
DAVID MARIN, *Minority Staff Director*

CONTENTS

DRUG RESISTANT INFECTIONS IN THE COMMUNITY: CONSEQUENCES FOR PUBLIC HEALTH

WEDNESDAY, NOVEMBER 7, 2007

HOUSE OF REPRESENTATIVES,
COMMITTEE ON OVERSIGHT AND GOVERNMENT REFORM,
Washington, DC.

The committee met, pursuant to notice, at 9:20 a.m., in room 2154, Rayburn House Office Building, Hon. Henry A. Waxman (chairman of the committee) presiding.

Present: Representatives Waxman, Towns, Davis of Virginia, Duncan, Issa, Foxx, and Bilbray.

Also present: Representative Matheson.

Staff present: Phil Barnett, staff director and chief counsel; Kristin Amerling, general counsel; Karen Nelson, health policy director; Karen Lightfoot, communications director and senior policy advisor; Sarah Despres, senior health counsel; Steve Cha, professional staff member; Teresa Coufal, deputy clerk; Careen Auchman and Ella Hoffman, press assistants; Zhongrui Deng, chief information officer; Leneal Scott, information systems manager; Kerry Gutknecht, William Ragland, and Bret Schothorst, staff assistants; Earley Green, chief clerk; David Marin, minority staff director; Larry Halloran, minority deputy staff director; Jennifer Safavian, minority chief counsel for oversight and investigations; Ashley Callen, minority counsel; Patrick Lyden, minority parliamentarian and member services coordinator; Brian McNicoll, minority communications director; Benjamin Chance, minority clerk; Ali Ahmad, minority deputy press secretary; and Jill Schmalz, minority professional staff member.

Chairman WAXMAN. The meeting of the committee will please come to order. Today we will examine a growing threat to public health—the spread of drug resistant infections. In particular, we'll hear about a bacteria called methicillin-resistant staphylococcus aureus [MRSA]. At the outset I want to commend Ranking Member Tom Davis for his interest and leadership on this issue.

In fact, Mr. Davis was the person who first suggested holding this hearing. Under Mr. Davis' leadership, the committee held multiple hearings on public health preparedness, and we're working together to continue active oversight in this crucial area.

MRSA infections can occur anywhere. Traditionally, we have thought of them as confined to hospitals, nursing homes and other health care settings. But now we're learning that drug resistant staph infections can be contracted at schools and other places

where people congregate. This has alarmed parents across the Nation.

In October, researchers at CDC published a major study in JAMA, the Journal of the American Medical Association. The study estimated that there are about 94,000 cases of serious MRSA infections every year in this country and nearly 14 percent of these infections are due to exposures in the community. The researchers also estimated that over 18,000 deaths each year are due to MRSA in both the community and healthcare segments. That's far more deaths than previously believed.

In fact, it is more deaths each year than caused by AIDS, though it is about half of the number of deaths from influenza. At the same time, we've heard about personal tragedies with MRSA. In the last month alone, two otherwise healthy young people died from MRSA, a 17-year old boy in Virginia and a 12-year old boy in Brooklyn. In response to the reports of deaths associated with MRSA infection, many schools have begun to look for cases and to take steps to try to clean their facilities.

Since there are 94,000 MRSA infections each year it is not surprising that school districts across the country have found cases. Parents and the public are rightfully concerned about community-associated MRSA. Mr. Davis and I and other members of the committee share this concern, which is why we are holding this hearing today. We want to understand how to prevent the transmission of drug resistant staph infections in the community. What steps should schools, gyms and households be taking to reduce the risk of MRSA infection? Does it actually make sense to try to disinfect entire school districts? We will also examine what the Federal Government and State and local health officials can do to combat MRSA. We'll hear two messages from our expert witnesses; one reassuring and one worrisome. The reassuring message is that there are simple steps that we can take to protect ourselves and our children from this infection. We can limit the spread of MRSA with basic measures like frequent hand washing and keeping wounds covered.

Also reassuring is the fact that doctors already have drugs that can treat MRSA and more are in development. The worrisome message is that MRSA is a symptom of a larger problem of drug resistant infectious disease. This is not a new problem. But in recent years, antibiotic use has increased, which has led to more drug resistant bacteria. According to the Centers for Disease Control antibiotic resistance has been called one of the world's most pressing public health problems. Antibiotic use is no longer limited to the appropriate use of fighting antibiotic sensitive bacterial infections. Unfortunately antibiotics are inappropriately prescribed for a host of ailments that antibiotics can't actually treat. These include certain ear infections, the common cold, and flu. Antibiotics have also made it into our food supply and experts have raised the concern that this too could be increasing resistance. While this hearing will focus on MRSA, and in particular, on MRSA infections in the community, future hearings will examine other aspects of the growing threat posed by growing resistant infectious disease. In the spring, the committee will hold a hearing on infections in hospitals where drug resistance is particularly widespread. We will also have to

look at the root causes of antibiotic resistance and consider what we can do to curb the burgeoning overuse of antibiotics.

Today we're fortunate to have some of the Nation's top experts on MRSA to help us understand the risks of community-based infections. We'll first hear from Dr. Julie Gerberding, the Director of the Centers for Disease Control and Prevention about Federal efforts to address community associated MRSA.

Our second panel we will hear from Dr. Jim Burns, the deputy health commissioner of Virginia about Virginia's recent experience with MRSA. We'll also hear from Steven Walts, the superintendent of Prince William County schools about efforts being taken by school districts to reduce the risk of MRSA infection and to educate parents about MRSA. And from my own district of Los Angeles, Dr. Elizabeth Bancroft, an epidemiologist with the Los Angeles County Health Department who will talk about the public health implications of community associated MRSA.

We'll hear from Dr. Eric Gayle, a family practitioner at a community health center in the Bronx. And finally, we will hear from Dr. Robert Daum, a leading expert in community-associated MRSA, and a pediatrician who treats children who have become sick from MRSA infections. I hope that the experts before the committee today can help us understand the type of threat we are facing, what steps families, communities and government should be taking to minimize the risks. I thank all of our witnesses for being here today and I want to recognize the ranking member of the committee Congressman Tom Davis for his opening statement.

[The prepared statement of Chairman Henry A. Waxman follows:]

Opening Statement of Rep. Henry A. Waxman
Chairman, Committee on Oversight and Government Reform
Hearing on Drug-Resistant Infections in the Community:
Consequences for Public Health
November 7, 2007

Today we will examine a growing threat to public health: the spread of drug-resistant infections. In particular, we'll hear about bacteria called methicillin-resistant staphylococcus aureus. Some call it MRSA (mur-sa) for short.

At the outset, I want to commend Ranking Member Tom Davis for his interest and leadership on this issue. In fact, Mr. Davis was the person who first suggested holding this hearing. Under Mr. Davis's leadership, the Committee held multiple hearings on public health preparedness. We are working together to continue active oversight in this crucial area.

MRSA infections can occur anywhere. Traditionally, we have thought of them as confined to hospitals, nursing homes, and other healthcare settings. But now we are learning that drug-resistant staph infections can be contracted at schools and other places where people congregate. This has alarmed parents across the nation.

In October, researchers at CDC published a major study in JAMA. The study estimated that there are about 94,000 cases of serious MRSA infections every year in this country, and nearly 14% of these infections are due to exposures in the community. The researchers also estimated that over 18,000 deaths each year are due to MRSA in both the community and healthcare settings.

That's far more deaths than previously believed. In fact, it is more deaths each year than caused by AIDS, though it is about half of the number of deaths from influenza.

At the same time, we've heard about personal tragedies with MRSA. In the last month alone, two otherwise healthy young people died from MRSA — a 17-year-old boy in Virginia and a 12-year-old boy in Brooklyn.

In response to the reports of deaths associated with MRSA infection, many schools have begun to look for cases and to take steps to try to clean their facilities. Since there are 94,000 MRSA infections each year, it is not surprising that school districts across the country have found cases. Parents and the public are rightfully concerned about community-associated MRSA.

Mr. Davis and I — and other members of the Committee — share this concern, which is why we're holding this hearing.

We want to understand how to prevent the transmission of drug-resistant staph infections in the community. What steps should schools, gyms, and households be taking to reduce the risk of a MRSA infection? Does it actually make sense to try to disinfect entire school districts?

We will also examine what the federal government and state and local health officials can do to combat MRSA.

We will hear two messages from our expert witnesses: one reassuring and one worrisome.

The reassuring message is that there are simple steps that we can take to protect ourselves and our children from MRSA infections. We can limit the spread of MRSA with basic measures like frequent handwashing and keeping wounds covered. Also reassuring is the fact that doctors already have drugs that can treat MRSA, and more are in development.

The worrisome message is that MRSA is a symptom of a larger problem of drug-resistant infectious disease. This is not a new problem. But in recent years, antibiotic use has increased, which has led to more drug resistant bacteria. According to the CDC "antibiotic resistance has been called one of the world's most pressing public health problems."

Antibiotic use is no longer limited to the appropriate use of fighting antibiotic sensitive bacterial infections. Unfortunately, antibiotics are inappropriately prescribed for a host of ailments that antibiotics can't actually treat. These include certain ear infections and the common cold and flu. Antibiotics have also made it into our food supply and experts have raised the concern that this too could be increasing resistance.

This hearing will focus on MRSA — and in particular, on MRSA infections in the community.

Future hearings will examine other aspects of the growing threat posed by drug-resistant infectious diseases. In the spring, the Committee will hold a hearing on infections in hospitals, where drug resistance is particularly widespread. And we also have to look at the root causes of antibiotic resistance and consider what we can do to curb the burgeoning overuse of antibiotics.

Today we are fortunate to have some of the nation's top experts on MRSA to help us understand the risks of community-based infections.

We will first hear from Dr. Julie Gerberding, the Director of the Centers for Disease Control and Prevention, about federal efforts to address community associated MRSA.

On our second panel we will hear from Dr. Jim Burns, the Deputy Health Commissioner of Virginia, about Virginia's recent experience with MRSA. We will also hear from Steven Walts, the Superintendent of Prince William County Schools, about efforts being taken by school districts to reduce the risk of MRSA infection and to educate parents about MRSA. From my own district of Los Angeles, Dr. Elizabeth Bancroft, an epidemiologist with the Los Angeles County Health Department, will talk about the public health implications of community-associated MRSA. We'll also hear from Dr. Eric Gayle, a family practitioner at a community health center in the Bronx. And finally, we will hear from Dr. Robert Daum, a leading expert in community-associated MRSA and a pediatrician who treats children who have become sick from MRSA infection.

I hope that the experts before the Committee today can help us understand the type of threat we are facing and what steps families, communities, and government should be taking to minimize the risks.

Mr. DAVIS OF VIRGINIA. Thank you, Mr. Chairman. Thank you very much for holding the hearing on the alarming emergence of antibiotic resistant staph infections in new settings. Long recognized in health care facilities, where virulent drug resistant germs can thrive, invasive MRSA infections have recently been detected in unexpected places and in growing numbers. We requested this hearing to explore the causes, the implications and appropriate responses to this festering threat, and we appreciate the committee's timely attention to an important public health concern.

According to published comments by one of today's witnesses, old diseases have learned new tricks with hard-to-treat infectious strains penetrating local schools, athletic venues, prisons and community centers. The so-called superbug outbreak dominated local news and brought unwelcome but needed attention to the dangers of a microbe that is all around us.

In my district in Northern Virginia, at least 20 MRSA cases have been identified in Prince William County. Dr. William Walts, the superintendent of schools there, has been battling the problem aggressively, monitoring student and faculty health in helping translate obscure medical jargon to an understandably anxious community. He's here to share his firsthand experience with the committee today, and we welcome his testimony. When it comes to assigning blame for the spread of MRSA infections, almost no one comes to the argument with literally clean hands. Overuse of the antibiotics and spotty environmental sanitation health care facilities allow superbugs to walk out the door.

Once in the community, carriers spread the infection through poor surgical wound care, sharing personal items like razors, and inadequate personal hygiene. But there's some good news. In the battle against nature's resilience and guile in spawning drug resistant germs, we have two disarmingly simple and effective weapons; soap and water. Thorough hand-washing and disinfecting commonly used surface areas can be very efficient in limiting the spread of infection. Since the primary route of transmission is direct person-to-person contact a little caution about crowding, skin contact, covering cuts, washing contaminated equipment and keeping yourself clean all go a long way in fighting MRSA in our midst.

This is not the last antibiotic resistant organism we'll confront, and the emergence of MRSA raises important questions about the reach and sensitivity of disease surveillance and reporting systems. In response to the recent outbreak, the State of Virginia issued an emergency regulation requiring laboratories to report cases of MRSA. Twenty-two other States require MRSA cases to be reported to their public health authorities. But this drug resistant staph infection is not currently included on the list of nationally reportable diseases. We look to the Centers for Disease Control and Prevention for analysis of the net benefits and cost of expanding that and other Sentinel regimes.

Protecting the public health requires vigilance and common sense. Whether the rate of community acquired MRSA infections is growing or we're simply getting better at diagnosing existing disease rates, a robust response to the spread of MRSA will help reassure a nervous public and better prepare us for the next superbug. Until a vaccine can provide what public health officials call herd

immunity against drug resistant germs, information, or heard, H-E-A-R-D, immunity can be a powerful antibiotic. Every citizen can help fight the MRSA invasion by spreading the word about consistent application of routine personal and institutional hygiene practices.

We'll hear from the CDC director and a second panel of distinguished experts this morning. We become their testimony and look forward for a frank but hopefully not too clinical discussion of a community-based response to a community health problem. Thank you Mr. Chairman.

Chairman WAXMAN. Thank you, Mr. Davis.

[The prepared statement of Hon. Tom Davis follows:]

HENRY A. WAXMAN, CALIFORNIA
CHAIRMAN

TOM DAVIS, VIRGINIA
RANKING MINORITY MEMBER

ONE HUNDRED TENTH CONGRESS

Congress of the United States

House of Representatives

COMMITTEE ON OVERSIGHT AND GOVERNMENT REFORM

2157 RAYBURN HOUSE OFFICE BUILDING

WASHINGTON, DC 20515–6143

Majority (202) 225-5051
Minority (202) 225-5074

Statement of Rep. Tom Davis
Ranking Republican Member
Committee on Oversight and Government Reform
"Drug Resistant Infections in the Community:
Consequences for Public Health"
November 7, 2007

I want to thank Chairman Waxman for agreeing to hold this hearing on the alarming emergence of antibiotic resistant *Staph* infections in new settings. Long recognized in health care facilities, where virulent drug resistant germs can thrive, invasive MRSA infections have recently been detected in unexpected places and in growing numbers. We requested this hearing to explore the causes, implications and appropriate responses to this festering threat, and we appreciate the Committee's timely attention to an important public health concern.

According to published comments by one of today's witnesses, "Old diseases have learned new tricks" with hard-to-treat infectious strains penetrating local schools, athletic venues, prisons, and community centers. The so-called "Superbug" outbreak dominated local news and brought unwelcome, but needed, attention to the dangers of a microbe that is all around us. In my district in Northern Virginia, at least 20 MRSA cases have been identified in Prince William County. Dr. William Walts, Superintendent of Schools there, has been battling the problem aggressively, monitoring student and faculty health and helping translate obscure medical jargon to an understandably anxious community. He is here to share his first hand experience with the Committee today, and we welcome his testimony.

When it comes to assigning blame for the spread of MRSA infections, almost no one comes to the argument with clean hands. Overuse of antibiotics and spotty environmental sanitation at health care facilities allow Superbugs to walk out the door. Once in the community, carriers spread the infection through poor surgical wound care, sharing personal items like razors, and inadequate personal hygiene.

But there's some good news. In the battle against nature's resilience and guile in spawning drug resistant germs, we have two disarmingly simple and effective weapons: soap and water. Thorough hand-washing and disinfecting commonly used surface areas can be very efficient in limiting the spread of infection. Since the primary route of transmission is direct person-to-person contact, a little caution about crowding, skin contact, covering cuts, washing contaminated equipment and keeping yourself clean all go a long way in fighting MRSA in our midst.

This is not the last antibiotic resistant organism we'll confront, and the emergence of MRSA raises important questions about the reach and sensitivity of disease surveillance and reporting systems. In response to the recent outbreak, the State of Virginia issued an emergency regulation requiring laboratories to report cases of MRSA. Twenty-two other states require MRSA cases to be reported to their public health authorities. But this drug resistant *Staph* infection is not currently included on the list of nationally reportable diseases. We look to the Centers for Disease Control and Prevention for an analysis of the net benefits and costs of expanding that sentinel regime.

Protecting the public health requires vigilance and common sense. Whether the rate of community acquired MRSA infections is growing, or we're simply getting better at diagnosing existing disease rates, a robust response to the spread of MRSA will help reassure a nervous public and better prepare us for the next Superbug. Until a vaccine can provide what public health officials call "herd immunity" against drug resistant germs, information – or "heard immunity" - can be a powerful antibiotic. Every citizen can help fight the MRSA invasion by spreading the word and demanding consistent application of routine personal and institutional hygiene practices.

We will hear from the CDC Director and a second panel of distinguished experts this morning. We welcome their testimony and look forward to a frank – but hopefully not too clinical – discussion of a community-based response to a community health problem.

Chairman WAXMAN. We're going to limit the opening statements to just the two of us because of time constraints. But without objection, all Members will be given an opportunity to insert an opening statement in the record. Representative Matheson, who has been a very important leader in this whole effort, but is not a member of our committee, will be participating in the hearing, and I would like to ask unanimous consent that he be permitted to do so.

Our first witness today is the distinguished head of the Centers for Disease Control and Prevention, Dr. Julie Gerberding. Dr. Gerberding, we want to welcome you to our hearing today. While it seems awkward to put you under oath, it is the practice of this committee that all witnesses that testify before us testify under oath. So thank you for rising.

[Witness sworn.]

Chairman WAXMAN. The record will indicate that you answered in the affirmative. Your prepared statement will be made part of the record in its entirety, and we want to recognize you to make your opening oral presentation.

STATEMENT OF JULIE GERBERDING, M.D., M.P.H., DIRECTOR OF THE CENTERS FOR DISEASE CONTROL AND PREVENTION

Dr. GERBERDING. I am very happy to provide a chance to provide a CDC perspective on this really important health problem. Preventable infectious diseases are always an issue. Preventable drug resistant infections are an even more critical public health issue. And this particular problem with methicillin-resistant staph aureus [MRSA], in both hospitals and communities, is a problem that deserves our full attention. It is always tragic when young healthy people acquire any preventable disease and it upsets the community and the schools, and people really do get alert to a problem.

In this case, this problem is not as new as it seems from the news. It is a problem that actually has been going on for more than a decade. But we are grateful for the chance to shine this bright light on it and hopefully think through what else we can do to help prevent such tragic deaths. If I can have my first graphic, I would like to just make a couple of really important framing points. I started my training at San Francisco General Hospital in the laboratory with one of the world's experts on staph aureus, Dr. Henry Chambers. So I worked with this organism from the very first days of my infectious disease training. And I know this organism. It is a bad bug. I like to think of it as the cockroach of bacteria because staph aureus are everywhere, they're survivors, they last a long time on surfaces and it is just about impossible to get rid of them.

Staph infections generically are a very important cause of both health care and community-acquired blood infections. And when it enters the blood, it causes a high mortality. It is also, by far, the most common cause of skin and soft tissue infections, the kind of ordinary things that we grew up with and that people get whenever they have a skin wound. Antibiotic resistance and staph aureus emerged from the very beginning of the penicillin era.

In the late 1950's, early 1960's, our Nation was mesmerized by the problem of penicillin resistant staph aureus in nurseries and spread into the community. These organisms evolve resistance much faster than we can evolve immunity or evolve new drugs and

vaccines to combat them. So they will always be one step ahead of our drug store. And that is fundamentally the challenge.

If we use the antibiotics, we eventually lose their effectiveness. And so the overarching lesson here is that we've got to learn to be much more prudent in our use of antibiotics and only use them when they're absolutely essential. On the next graphic, I'm illustrating another very important point about staph aureus. And that is that it is everywhere. On this graph, we have gone across the United States and screened people's noses for staph in their nose. And what you can see is that about a third of the people in our country at any given time have staph aureus in their nose.

So if you look to the right of you and look to the left of you, one of the three of you has a good chance of being a carrier of staph aureus, at least at this moment in time. So it is an everywhere organism. And it isn't the kind of thing that we're going to be able to completely eliminate. But very subtly, this graphic also shows that in 2001/2002, only a small proportion of our population was carrying the methicillin-resistant staph. And it has only gone up to be about 1½ percent. But that is an increase, and it is a statistically important increase, and it represents more than a million people. So we do have this organism colonizing people's noses everywhere around our country every day. And that means that we have to look at that as the generic issue.

On the next graphic, I am showing a report from CDC's MMWR, which we have used to constantly and continuously update people on the problem of staph aureus. But this is really the first report that identified fatal infections among children who had inquired this community methicillin-resistant staph aureus. And when this report came out, I think a lot of people were skeptical. They thought oh, no, no, no, these kids must have had some connection with the hospital because that's where most of these drug resistant organisms are.

But in this case, there was no association with the hospital. And it was the Sentinel that told us that this bad bug was circulating in the community, and although rare could certainly, on occasion, cause very serious and fatal diseases in kids. So on the next slide, we had to change our vocabulary. We had to distinguish from the location where bacteria are acquired; i.e., some bacteria are acquired in hospitals, some bacteria are acquired in communities from the places where infections actually develop.

So some infections occur in the hospital, but that bacteria might have been obtained in the community. Some infections occur when people are in the community, but they might have actually picked the bacteria up during their last hospitalization. So it has gotten very complicated to sort out where are they being acquired versus where does the infection actually manifest itself. And part of that is because you can acquire it and carry it for a long period of time before you actually develop the disease. One of the helpful things that by chance has aided our understanding of how these organisms spread is that most of them that are causing this community problem that is the focus of our attention today belong to a particular family. And they have a unique fingerprint. And so we can track them by their fingerprint. It is called the USA300 strain. But

we can track them because they are different from the vast majority of staph that occur in the hospitals.

So we are able, in our special laboratories, to say this particular staph probably arose from the kind that we would see affecting patients in hospitals and long-term care settings versus this one over here is the pattern that we generally see in the community.

Now, of course, they still mix up because people in the community end up going to the hospital and then that organism can secondarily spread. But we know a lot about these community staph aureus because we can track their fingerprints. And what we have learned about them so far on the next slide is that they are a very common cause of garden variety minor skin and soft tissue infection, which usually doesn't require any treatment at all; just simply cleaning the wound with soap and water or draining it if there's a boil or an abscess.

Serious invasive disease like we're hearing about in the news this week is fortunately extremely rare, but it is tragic and it is preventable, and when you look at it over time it does represent a serious threat. Generally, these community infections occur in healthy people. You don't have to be debilitated or have a chronic disease. They tend to sometimes occur in outbreaks like athletes that share athletic equipment, are injured with turf burns or have the kinds of cuts and scrapes that linemen get on the football team. They occur in clusters of Native Americans, native Alaskans and aboriginal Australians.

We don't know exactly why that is, but some of it has to do with shared personal items. In one of the native Alaskan outbreaks it was related to sweathouses where the staff were colonizing the benches that people sat in when they were in their communal sweathouses, and so there may have been a tendency to move the staph from one person to the other that way. And there have been some very serious outbreaks in prisons where people are crowded together. They share toiletries, razors, towels, and, in some cases, they don't actually have soap.

So hygiene in those environments is a very key factor in preventing or promoting transmission. I think the bottom line here is that not all staph are alike. Some of them tend to cause worst disease than others. Some are adapted to hospitals, some are adapted to the community. But all of them can be prevented. And that's what I wanted to emphasize in my last graphic. CDC has aggressive programs in the health care environment for preventing infections of all types. And we have proven beyond a shadow of a doubt that you can drive staph infections down to a minimum, particularly the invasive ones caused by catheters that infect the bloodstream.

But we also believe that in the community, there's a lot we can do. And I have a number of the educational materials and posters that we've been using for schools and coaches and athletes. There's great material on the Web. This is out also on the Education Department Web sites disseminated to schools around the country. Just trying to send the message that we have to get back to basics. As you said, Mr. Chairman, in your opening statement, it is hand hygiene, it is not sharing personal materials that could be contaminated with someone's staph, it is taking care of wounds and keeping them covered, it is noticing when a wound looks angry and

purulent and then seeking medical attention to be sure that it doesn't require treatment.

For doctors it means when you are going to use an antibiotic for a wound like this you probably need to culture it so that we know what the organism is and whether it is in the resistant family. And I think one macro point to make in the context of these children who have been affected and the concern about the schools is that we need school nurses. In our country today, only about a third of schools have a full-time school nurse.

We in the government are depending on schools to be involved in nutrition and fitness, in safety, in hygiene as it pertains to these kinds of problems, in pandemic preparedness, in immunization programs. And our schools just simply don't have access to the health professionals that they need to recognize the prevention tools and to take the steps necessary to protect our children from this and any other health threat that could be emerging among our school children. So that is something I wanted to draw your attention to, because it hasn't been part of the conversation so far, and I think it is very, very important for a broad set of health issues and particularly this one. So thank you for allowing me to have a chance to frame the issues and I look forward to answering your questions.

Chairman WAXMAN. Thank you very much for that excellent presentation.

[The prepared statement of Dr. Gerberding follows:]

Testimony
Before the House Oversight and Government Reform Committee
United States House of Representatives

"Methicillin-Resistant *Staphylococcus aureus* Infections in the Community: Consequences for Public Health"

Statement of
Julie Louise Gerberding, M.D., M.P.H.
Director, Centers for Disease Control and Prevention
Administrator, Agency for Toxic Substances and Disease Registry
U.S. Department of Health and Human Services

CDC
SAFER • HEALTHIER • PEOPLE™

For Release on Delivery
Expected at 9:15am
November 7, 2007

Good morning Chairman Waxman, Ranking Member Davis, and other distinguished Members of the Committee. I am Dr. Julie Louise Gerberding, and it is my pleasure to be here today in my capacity as Director of the Centers for Disease Control and Prevention (CDC) to discuss with you the issues of infections caused by methicillin-resistant *Staphylococcus aureus* (MRSA), the occurrence of these infections among persons not exposed in healthcare settings (termed community-associated methicillin resistant *Staphylococcus aureus, or* CA-MRSA), as well as CDC's work in tracking trends in these infections and preventing their spread.

As you know, CDC recently released a report in the Journal of the American Medical Association (JAMA) that provided new information on the scope and nature of MRSA infections in the United States. Coincidentally, we learned of the tragic deaths of two young men in Virginia and New York due to MRSA. For the past few weeks, MRSA infections have received much media attention, which has in some cases provided useful information for parents and individuals and in others compounded confusion.

Today, I would like to discuss with you the growing problem of antimicrobial-resistant infections, provide some insights regarding MRSA, and update you on CDC's current and planned activities to address MRSA.

ANTIMICROBIAL RESISTANCE

Bacteria that are resistant to antimicrobial agents have been developing and spreading in both humans and animals for decades. As early as the 1950s, scientists had recognized strains of bacteria that were resistant to multiple antimicrobial agents, although these strains primarily caused community-associated infections such as *Shigella* dysentery. More recently, organisms resistant to multiple drugs, including strains of *Pseudomonas aeruginosa* and *Acinetobacter* species resistant to all available antimicrobial agents, have been recognized as sources of infection in U.S. hospitals and other healthcare settings around the world.

STAPHYLOCOCCUS AUREUS

Staphylococcus aureus is a bacterial species, first named in 1882, that is commonly carried on the skin or in the nasal passages of 25% to 30% of healthy people in the United States. Colonization by *Staphylococcus aureus* bacteria at these sites is often, but not always, a precursor to staphylococcal infections. While *S. aureus* has been one of the most common causes of skin infections in the United States, most of these infections are minor (such as boils and simple abscesses). Many can be treated by lancing the wound and draining the infection without the need for antimicrobial agents; others may require antibiotic therapy, most often administered orally as outpatient therapy using one of several very commonly used and very effective antibiotic agents. However, *S.*

aureus also can cause serious infections including surgical wound infections, bloodstream infections, endocarditis, toxic shock syndrome, and pneumonia.

ANTIMICROBIAL RESISTANCE AND *S. AUREUS*

The first strain of *S. aureus* found to be resistant to penicillin was identified in 1944. Today, >90% of *S. aureus* isolates are resistant to penicillin and a large percentage are resistant to other antimicrobials including macrolides (e.g., erythromycin), lincosamides (e.g., clindamycin), tetracyclines, or other anti-staphylococcal agents. Methicillin and other semi-synthetic beta-lactam drugs were developed in the late 1950s to treat penicillin-resistant strains of *S. aureus*, yet strains resistant to these drugs emerged very quickly, becoming recognized by 1961. Such strains are called methicillin-resistant *S. aureus* or more simply MRSA. In the 1980s, MRSA strains were identified in hospitals with increasing frequency, often becoming resistant to multiple antimicrobial agents. Treatment of invasive disease caused by multidrug-resistant MRSA is limited to relatively few antimicrobial agents.

COMMUNITY-ASSOCIATED METHICILLIN RESISTANT *S. AUREUS* (CA-MRSA)

While MRSA has typically been considered a healthcare-associated infection (termed healthcare-associated MRSA, or HA-MRSA), strains of MRSA causing infections in persons with no links to healthcare systems have been occurring with increasing frequency in the United Sates and elsewhere around the globe. In

the United States, CA-MRSA first emerged in Detroit in the early 1980s among intravenous drug users. In 1997-1999, four children from Minnesota and North Dakota died of MRSA infections, despite being treated, seemingly appropriately, with first-generation cephalosporins for staphylococcal infections. Those infections met the epidemiologic definition of CA-MRSA infection, and were found to be caused by a new strain-type unlike MRSA strains causing infections in hospitals. Within the next few years, similar CA-MRSA strains with the same properties and antimicrobial susceptibility patterns were reported to have caused infections among Native Americans in several states and among inmates at correctional facilities. These strains had a new resistance gene complex as well as a new virulence gene, making them ideal for causing infections in community settings. These new strains colonized easily, grew more rapidly in vitro compared to HA-MRSA isolates, and were resistant to the antimicrobial agents often chosen as first-line agents for treating community *S. aureus* infections, i.e., beta-lactams and macrolides. While some indirect evidence suggests that this strain may be more likely to cause serious infections, the overwhelming majority of CA-MRSA infections continue to be uncomplicated skin and soft tissue infections (SSTIs). While the CA-MRSA strains are resistant to beta-lactams and macrolides, these strains can be treated using other commonly available antimicrobial agents, in contrast to HA-MRSA which has fewer treatment options.

In 2000, CDC began investigating outbreaks of staphylococcal infections among inmates at correctional facilities in Mississippi, Georgia, and Texas. Remarkably,

among the MRSA isolates recovered from all three correctional facilities, a new pulse-field gel electrophoresis (PFGE) pattern was found, indicating that the same strain was causing infection in all three facilities. This strain type, called USA300, was subsequently isolated from children in Tennessee and Texas, sports participants, military recruits, and men who have sex with men. This strain type was very different from the one that typically causes HA-MRSA infections: it was not multidrug- resistant and had very different virulence factors. The USA300 strain represented a shift in lineages in MRSA isolates in the United States.

Today, for descriptive purposes, these CA-MRSA infections are defined as MRSA infections occurring in persons who have no close linkages with recent healthcare delivery exposures (i.e., history of hospitalizations or surgery, permanent indwelling catheters or percutaneous medical devices, residence in a long-term care facility, or dialysis treatment within the year prior to the MRSA culture date).[1]

The most common clinical manifestations of CA-MRSA infections are those that are common to *S. aureus* infections. SSTIs, specifically abscesses or "boils" and infected hair follicles, are the most frequently reported symptoms. Results from a CDC-funded study conducted in 2004 showed that the USA300 MRSA strain was the most common cause of skin infections among patients treated at 11

[1] CDC Website: http://www.cdc.gov/ncidod/dhqp/ar_mrsa_ca_clinicians.html#6

emergency departments located across the United States, suggesting that this strain had already become an important cause of skin infection in the United States. The USA300 strain has been found to cause infections in professional football players, military recruits in boot camp, children in daycare, and in crystal methamphetamine users.

CA-MRSA skin infections are known to spread in crowded settings; in situations where there is close skin-to-skin contact; during participation in activities that result in abraded or compromised skin surfaces; when potentially contaminated personal items such as towels, sporting equipment, and razors are shared; when the ability to maintain personal hygiene is compromised; and when access to healthcare is limited. Frequent antibiotic use also may facilitate acquisition of CA-MRSA. In addition to the affected populations noted above, CA-MRSA has recently emerged as a cause of pneumonia among previously healthy young adults after suffering influenza or an influenza-like-illness. While post-influenza illnesses with staphylococci have historically been well recognized, the emergence of CA-MRSA presents a new treatment challenge for these potentially fatal infections.

Population-based surveillance for CA-MRSA has been conducted through CDC's Emerging Infections Program (EIP), a network of state health departments and their collaborators at selected U.S. sites. Information from these activities has been used to define the epidemiology and microbiology of MRSA in both

healthcare and community settings. In 2001-02, surveillance was conducted at three of these sites to determine the incidence of MRSA and the proportion that was healthcare- vs. community-associated to confirm that infections identified as CA-MRSA were independent of healthcare, and to characterize the epidemiology of MRSA in the community including identifying populations at risk, the clinical disease spectrum, and outcomes. These findings were the first comprehensive data showing that most MRSA infections are healthcare-associated, that CA-MRSA was distinct from healthcare, and that most CA-MRSA infections were SSTIs. To focus on the most severe of these infections, CDC has been monitoring invasive MRSA infections since 2004 in nine U.S. sites currently participating in the EIP's Active Bacterial Core Surveillance Program (ABC) on MRSA, which represents a population of about 16.3 million persons. Findings from this surveillance, recently reported in JAMA as described above, showed that the number of people developing serious MRSA infections (i.e., invasive) in 2005 was about 94,360--only 15% of which were due to the CA-MRSA. Approximately 85% of these MRSA infections were associated with healthcare; moreover, among the more than 18,000 persons who died from invasive MRSA, 92% had HA-MRSA.

In addition to active surveillance to define the problem, data analyses have been conducted from currently available data collected by CDC and AHRQ. Data collected through CDC's ambulatory medical care surveys (NAMCS/NHMACS) demonstrated that each year from 2001 through 2003 an estimated 12 million

outpatient (i.e., physician offices, emergency and outpatient department) healthcare visits for suspected *S. aureus* SSTIs occurred in the United States. Compared to 1992-1994, rates of visits to outpatient and emergency departments for suspected SSTIs increased by 59% and 31%, respectively, possibly reflecting the emergence of CA-MRSA infections. Furthermore, data from AHRQ's Health Care Utilization Project (HCUP) have shown a 25% increase in outpatient visits for skin infections from 2001 to 2005 and a 25% increase in hospitalizations for *S. aureus* infections from 1998 to 2003. Although MRSA may be a driver of these increases, the surveys do not provide such information.

HEALTHCARE-ASSOCIATED METHICILLIN RESISTANT *STAPHYLOCOCCUS AUREUS* (HA-MRSA)

Despite the increase in the number of CA-MRSA cases, most serious MRSA infections continue to occur in healthcare settings. HA-MRSA commonly causes serious and potentially life threatening infections, such as bloodstream infections, surgical site infections, or pneumonia. Of the healthcare-associated infections (HAIs) reported to CDC's National Healthcare Safety Network (NHSN), 8% are caused by MRSA; however, because of its virulence and resistance characteristics, these infections may account for a disproportionate amount of illness and death among patients receiving healthcare. Patients in healthcare settings are most vulnerable to colonization and infection with the bacteria because of severe disease, compromised host defenses from underlying medical

conditions, recent surgery, or the presence of indwelling medical devices such as urinary catheters or endotracheal tubes. Hospitalized patients, especially those in intensive care units (ICU), tend to have more risk factors for these infections compared with non-hospitalized patients and have the highest infection rates. Most HA-MRSA infections are also resistant to several other categories of antimicrobials (including macrolides, fluoroquinolones, clindamycin, and trimethoprim/sulfamethoxazole), leaving limited treatment options.

There is ample epidemiologic evidence to suggest that MRSA and other multidrug- resistant organisms are carried from one person to another via the hands of healthcare personnel. Hands are easily contaminated during the process of caregiving or from contact with environmental surfaces in close proximity to the patient. Thus, strategies to increase and monitor adherence to hand hygiene and correct glove use are important components of prevention programs. Implementation of prevention strategies recommended by CDC and the Healthcare Infection Control Practices Advisory Committee (HICPAC) have led to reductions in MRSA rates in U.S. hospitals.

WHAT IS CDC DOING TO PREVENT CA-MRSA?

CDC conducts surveillance and epidemiologic and laboratory research to guide and inform prevention efforts. CDC also leads national outbreak investigations on staphylococcal disease in collaboration with state and local health departments. In recent years, CDC has assisted state and local health departments in

investigating emerging CA-MRSA infections in several populations and settings shown to be at increased risk including athletes and military personnel, correctional facilities, schools, normal newborn nurseries, and tattoo parlors. These investigations have identified risk factors for the outbreaks and measures for their control. CDC also provides assistance to state public health laboratories by performing confirmatory testing for antimicrobial susceptibility, toxin characterization, and molecular typing for antimicrobial-resistant pathogens including MRSA.

CDC also monitors national trends and patterns of emerging CA-MRSA by collaborating with external partners including both academic and public health partners. As described earlier, CDC's EIP network conducts national surveillance for the most severe (i.e., invasive) cases of MRSA infections and has provided valuable insight into populations at risk and burden of disease in the U.S., as described in the recently published JAMA article. Such a system can also assess the impact of prevention efforts and detect emerging patterns of resistance.

Although other types of MRSA disease are not tracked by the EIP system, assessments are made through additional survey mechanisms, such as CDC's National Hospital Discharge Survey (NHDS) and AHRQ's HCUP, which are useful in following burden of disease for common occurrences,. CDC has also collaborated with *EMERGE*ncy ID Net, a network of 12 emergency departments

across the country, to determine the prevalence of MRSA as a cause of purulent skin infections and severe community-acquired pneumonia among adult patients at emergency departments.

To specifically address CA-MRSA infections, CDC has developed and published guidance for the management and prevention of MRSA in the community based on review of available information and input from clinical and public health experts. Major prevention messages include:

- keeping hands clean by washing thoroughly with (plain) soap and water or using an alcohol-based hand sanitizer;
- cleaning cuts and scrapes and keeping them covered with a bandage until healed;
- avoiding contact with other people's wounds or bandages;
- avoiding sharing personal items such as towels or razors; and
- for persons unable to maintain routine hygiene and keep wounds covered, not participating in activities such as athletic events or childcare until their wounds are healed or can be contained to prevent transmission.

CDC has also developed targeted materials for a variety of audiences, including clinicians, the general public, athletic directors, prison officials, and school nurses, and has promoted these messages through the CDC website, responses to public inquiries, interviews, presentations at local and national meetings, and work with national and state organizations. To reach both the clinical and

general community quickly with new information that could impact prevention and treatment of these infections, CDC has published at least one report a year on CA-MRSA in the Morbidity and Mortality Weekly Report (MMWR), CDC's high profile weekly publication spotlighting the latest disease trends for clinicians, public health professionals, and the media. CDC has collaborated with state and local health departments to develop physician and patient guidance and education materials for MRSA and has performed needs and knowledge assessments with public health partners, at-risk groups, and the general public to target further development of guidance and education. In addition to collaborations with health departments, CDC has worked with professional societies such as the American Medical Association, Infectious Disease Society of America, and others to develop guidelines for prevention and treatment of infections, including management of SSTIs and community-acquired pneumonia. Other efforts have focused on prevention messages for specific at-risk groups and have involved collaborations with organizations such as the National Collegiate Athletic Association (NCAA), National Federation of High School Associations, National Athletic Trainers' Association (NATA), and others to develop informational materials and educate athletes and trainers about CA-MRSA and its prevention. CDC has also collaborated closely with other federal agencies including the Federal Bureau of Prisons to develop guidelines for correctional facilities, the Department of Defense to provide guidance for preventing MRSA infections among military recruits, and the National Institutes of

Health by providing staphylococcal isolates to the Network for Antimicrobial Resistance for *S. aureus* (NARSA).

CDC has also supported numerous extramural grants for research on CA-MRSA. Specific objectives for these collaborations included the characterization of the epidemiology and microbiology of CA-MRSA, the development of novel methods for controlling the transmission of antimicrobial-resistant pathogens including CA-MRSA, and evaluation of strategies to prevent recurrent CA-MRSA infections. By characterizing these CA-MRSA strains, we can improve our understanding of the infection and enhance national and local prevention and control efforts.

CDC ACTIVITIES FOR PREVENTION OF HA-MRSA

In addition to strategies to detect and prevent CA-MRSA infections, CDC leads several activities to monitor and prevent HA-MRSA. The National Healthcare Safety Network (NHSN), formerly the Nosocomial Infection Surveillance (NNIS) System, is a surveillance tool for hospitals and state health departments to measure HAIs including those caused by MRSA. This system has many options available to hospitals and local health authorities, and provides hospitals with an accurate measure of infections attributable to a patient's hospital stay as well as information to drive infection prevention efforts at the hospital level. Additional options available to facilities and States participating in NHSN include the system's ability to measure MRSA among both inpatients and outpatients to help the facility prioritize staffing and prevention efforts. CDC's surveillance systems,

including NHSN, provide the means for building the infrastructure to capture data from electronic sources in an automated fashion, providing accurate, timely measures of MRSA at a healthcare facility to direct local prevention efforts and track the effectiveness of prevention programs.

Participation in NHSN has increased in the past few years and the Network is expected to continue to expand in order to accommodate local, state, and federal reporting initiatives for HAIs. CDC is currently providing support to 13 states that are using NHSN to fulfill state reporting requirements for HAIs, including MRSA infections.

CDC activities to prevent HA-MRSA include developing national infection control guidelines, conducting research activities, and working with partners to translate success with local prevention demonstration projects into national efforts to prevent MRSA infections. In 2006, CDC and HICPAC published evidence-based infection control guidelines to prevent the emergence of antimicrobial resistance and stop transmission of MRSA and other antimicrobial resistant pathogens in healthcare settings (Healthcare Infection Control Practices Advisory Committee (HICPAC)). The recommendations from CDC's HICPAC guidelines have been used in several successful local, regional, and national initiatives to prevent MRSA in healthcare settings.

CDC has also funded Prevention Epicenters (Prevention Epicenter Program), a network of academic centers to identify novel, or determine the effectiveness of existing, HAI prevention strategies, including the prevention of MRSA and other resistant organisms.

CDC has provided direct support, through in-kind technical assistance and extramural funds, as well as assistance to external partners involved in MRSA prevention initiatives to translate local success strategies into national efforts. These partners include the Veterans Health Administration of the Department of Veterans Affairs, Institute for Healthcare Improvement, state and regional initiatives, and other multi-center prevention collaboratives. CDC funded and collaborated with the Pittsburgh VA Medical Center to prevent MRSA infections using several CDC recommendations; these efforts led to reductions in MRSA rates of more than 60% in the hospital. Influenced by their success, other hospitals in southwestern Pennsylvania are now collaborating on a regional MRSA prevention initiative, and the Veterans Health Administration has launched a national MRSA prevention initiative involving every Veterans Health Administration hospital in the country. The prevention successes demonstrated in southwestern Pennsylvania have also served as the model for other national and regional initiatives such as Southeastern Pennsylvania, a statewide initiative coordinated by the Maryland Patient Safety Center; a group of hospitals funded by the Robert Woods Johnson Foundation to prevent MRSA infection in

participating hospitals in Pennsylvania, Maryland, Montana, and Kentucky; and a national initiative by the Voluntary Hospital Association (VHA) members.

Additionally, CDC launched a national evidence-based educational Campaign to Prevent Antimicrobial Resistance in Healthcare Settings that targets healthcare providers. The Campaign focuses on preventing antimicrobial resistance in healthcare settings by promoting four strategies targeting various patient populations including: hospitalized adults, dialysis patients, surgical patients, hospitalized children, and long-term care residents.

IN SUMMARY

Community- and healthcare-associated infections caused by antimicrobial-resistant pathogens such as MRSA are critical public health concerns, as made evident by the emergence of CA-MRSA. CDC continues to invest in the detection, control, and prevention of MRSA, working toward the goal of eliminating life-threatening infections caused by this and other healthcare-associated pathogens. The distinction between community- and healthcare-acquired infections will continue to decrease as we rely more and more on ambulatory surgical centers, home-care, infusion clinics, and other non-hospital-based types of care. To successfully prevent these infections among patients and the public, we must maximize the accurate and timely monitoring of MRSA and related infections, determine which hospitals are successfully preventing these infections and disseminate their experiences and strategies, and prevent spread in our communities by providing important information and promoting

necessary hygiene measures. Whether at home or in schools, athletic facilities, or other places similarly prone to spreading skin infections, individuals must remain alert for signs of potentially serious infections and know the importance of promptly seeking medical care if these signs occur. Basic hygiene including hand washing and wound covering can efficiently prevent the spread of these infections in community settings.

We can eliminate these infections; but only by maintaining basic hygiene in our communities, while ensuring 100% adherence to the guidelines and best-practices for prevention of infection in healthcare settings, recognizing excellence in healthcare, and informing our communities and providing data for local action.

Thank you for the opportunity to testify today; I am happy to take any questions you may have.

Chairman WAXMAN. Let me start off the questioning by asking you how worried should parents be, how worried should people be about getting these infections that are resistant to antibiotics? Is there a range of infection and are there some that we need to worry more about than others? If you could put it in perspective. Is MRSA the tip of the iceberg of more problematic infections and what would you advise parents to do.

Dr. GERBERDING. It is hard to put this into perspective, even with us with our expertise. But I think it is important that parents recognize that kids get scrapes and cuts and minor wound infections all the time. And the vast majority of these are the same that we grew up with and are not a cause for alarm or concern. They need to be handled with common sense; keep the wound clean, keep it covered and seek help if it looks bad or gets pussy. But I also recognize that when something like this tragedy occurs in your community, it does raise everybody's sensitivity and concern.

And we want to assure parents that schools are taking the steps to protect them. But protection also has to occur in the home. There are the same issues around hygiene and hand-washing and wound care in our households that we are concerned about in the schools. So the common sense back to basics are the way to manage the threat. And just to not wait if a child has a wound that looks particularly bad, but to get it checked out.

Chairman WAXMAN. So MRSA sounds like it is more a skin problem than any other kind of infection, is that what we're concerned about?

Dr. GERBERDING. These community MRSA are almost entirely skin and soft tissue. They tend to stay on the surface of the skin. There's some biological reasons for it. The bacteria probably has adapted some characteristics along with its resistance that allow it to be particularly good at infecting skin and relatively efficient at being transmitted from one skin problem to another.

So the bacteria itself is designed to do this very well. But sometimes it does have the trick, the unfortunate trick of being able to invade more deeply and cause very severe ugly skin infections very quickly or it can enter the bloodstream and cause infection of the whole blood system called blood poisoning if you will, and that, of course, is a very, very serious disease and very difficult to treat.

Chairman WAXMAN. Is it also very rare?

Dr. GERBERDING. It is fortunately very, very rare. We don't have complete data for the United States, but we estimate that about 200 children will get a serious MRSA infection, and even of those 200 people who get the bloodstream form of this the vast majority of them will be treated and survive.

So we're not talking about thousands and thousands of kids, but we're talking about some children. And we have to take each one of these children to heart and try to do the prevention steps that will help.

Chairman WAXMAN. Now, I cited earlier a recent Center for Disease Control paper that was published in the Journal of American Medical Association that found there are 94,000 serious MRSA infections each year, and there are 18,000 deaths from MRSA, more than from AIDS. Now, when you hear a figure like that, that

sounds pretty serious. That's not the kind of thing you're describing as being routine.

Dr. GERBERDING. The paper is a very important first study of the problem. But there is a little bit of apples and oranges mixed in there, because it is describing both the community MRSA that's our focus today, as well as the MRSA that occur in the hospital. So we are adding them all together to get the 94,000 figure. That is a high number and we can bring that number down. In fact, we have some evidence that probably the number of these infections in hospitals is going down because of the emphasis on improving safety in hospitals and preventing some of the underlying causes of these infections.

So this study has sent an alarm that is a big problem that we need to address it aggressively. But the piece of it that is the discussion we're having today is a small proportion of that 94,000.

Chairman WAXMAN. When we hear about antibiotic resistant infections and people dying from those infections should parents think that's what's going to happen to their children if they have some contact with a bug?

Dr. GERBERDING. Absolutely not. As I mentioned, about a third of the people in this room have staph. And even the nonresistant staph can still cause very, very serious disease. And the vast majority of us will never have a staph infection because we don't have the predisposing conditions or because our immune system is able to protect us. So they're everywhere if you look, but they don't cause disease very often, and when they do they generally cause this very minor form of disease.

Chairman WAXMAN. Thank you very much. Mr. Davis.

Mr. DAVIS OF VIRGINIA. Could you explain the difference between the community-based MRSA we're talking about and the hospital? Are they transferrable? Are they mutations of the same? Are they just germs that act the same?

Dr. GERBERDING. This is a fascinating perspective and there are some controversies in here, so I'm going to share with you my understanding based on my previous work and what I've been able to accumulate from experts. But there are people who see this a little bit differently. In the hospital, the staph aureus have been transmitted there for a long time. And they're resistant to many things besides methicillin. Most of them are resistant to anything we have in the hospital, except one or two drugs. So they're highly resistant.

Mr. DAVIS OF VIRGINIA. They're just mutations that have survived; everything else is killed off along the way?

Dr. GERBERDING. Exactly. Because we use so many powerful antibiotics in the hospital that only the survivors persist. I like to think of them as somewhat weak staph in the sense that they probably aren't as capable of causing disease in healthy people as their sensitive cousins because they've had all this evolutionary pressure to evolve and adapt. And they pay a price for having all this resistance. They're not in their native staph. Don't get me wrong, they can still cause very important infections. But they tend to evolve infections in people who have catheters, which allow the staph to crawl into the bloodstream, or people who have to be injected with needles or on dialysis for their diabetes, or just people who are generally weakened and quite ill.

They're vulnerable because they're sick, but they're also in an environment where they have lots of catheters that create an independent way for the staff to gain entry. And they're surrounded by an ecology of staph in the hospital where those hospital strains live.

Now, in the community, you don't have those factors. I mean, we're talking about healthy children here. And the community staph are resistant to penicillin and their resistant methicillin, but fortunately, they're usually very easily treated with other inexpensive garden variety antibiotics. So they haven't had this tremendous pressure to change that we're seeing in the hospital environment. Perhaps they're a little bit fitter, meaning they are more robust and they can be more easily transmitted to one healthy person to another.

Mr. DAVIS OF VIRGINIA. And can be more virulent as a result?

Dr. GERBERDING. Well, the virulence is tricky, but they do tend to have a particular toxin. It's called the PVL toxin. You'll probably hear from an expert about this, Dr. Daum. But most people believe that this toxin probably does increase the ability of this, at least USA300 community strain to cause more skin disease. What it does is it basically explodes your white blood cells that surround the infection, and that sets off a cascade of inflammation and pus and the kinds of things that you would associate with a more severe skin infection. Whether that's the only explanation or not, we're still learning.

Mr. DAVIS OF VIRGINIA. About 22 States require that MRSA cases be reported, but it is not a nation-wide reporting requirement. I understand that the CDC doctors get data from the States on a voluntary basis, is that correct?

Dr. GERBERDING. There are several ways that we get data. But the information we published was from a set of States that we pay to do very thorough and intensive surveillance. That's why we have such confidence that in those areas we have a complete picture on this invasive staph aureus. Part of the reason that we did that was to find out what value there would be in making staphylococcal infections reportable.

I have a bias from a CDC perspective that if you measure things they tend to improve. So I'm always going to lean in the direction of measurement. But the question is not should we measure and report, the question is what should we measure and report. We can't report everybody who's got staph in their nose because that would be a third of our Nation. We can't report every skin infection that comes in because we would just have nothing but reams of paper coming in. But we probably could take a look at the value of reporting the invasive infections, the ones that enter the bloodstream or those that cause fatalities.

Part of the reason for doing that is that it is an indicator we need to look at where that infection was acquired. Maybe there is a problem with the disinfection of athletic equipment, or maybe that's the tip of the iceberg of a cluster that we need to engage in so that we can protect other people in the short-run and learn things that we can adapt in other similar environments. So the purpose of reporting is mostly to try to intervene in a way that protects other people from infection.

Mr. DAVIS OF VIRGINIA. Are you satisfied with the reporting requirements that—not requirements—I'd say that the lists that you're getting are accurate?

Dr. GERBERDING. The Sentinel study that we published, I have a great deal of confidence in those data. And the people who did that study are looking at, OK, we know we can't afford to do this kind of intensive assessment everywhere. That would not be a good use of taxpayers' dollars. So what can we do that is feasible? And we move into this era of electronic laboratory reporting and electronic health records, reporting will get much easier, much less burdensome. CDC has actually demonstrated that the tool that we were using for biosense for surveillance for terrorism attacks is easily adapted to look at methicillin-resistant staph infections.

So when you make reporting inexpensive and automatic and not detracting from health care providers' time, then we'll be able to, I think, have a conversation about a very robust system that makes sense.

Mr. DAVIS OF VIRGINIA. The schools are using bleach-based cleansers. Are there other effective cleansers that can be used?

Dr. GERBERDING. There are a number of surface disinfectants that are approved by the Environmental Protection Agency for disinfection, and it is written on the bottle so it is easy for someone who has that responsibility to know whether it is an improved germicide and for what use.

Mr. DAVIS OF VIRGINIA. That's why school nurses——

Dr. GERBERDING. Exactly, where you need that kind of expertise.

Chairman WAXMAN. Thank you, Mr. Davis.

Mr. Towns.

Mr. TOWNS. Thank you very much, Mr. Chairman. Let me thank you so much for coming and sharing, and I respect the fact that you've been involved in this for so many years. What can you tell us about what causes antibiotic resistance like MRSA? How does this develop in the community?

Dr. GERBERDING. Bacteria multiply very fast, so they go 2, 4, 8, 16, 32, 64. They're just constantly growing. That's their business. And every time they divide, there's a chance that they could make a genetic mistake despite a random chance. Sometimes those genetic mistakes cause them to die. They're lethal. But sometimes those genetic mistakes give them an advantage if they happen to be exposed to an antibiotic. So mutations occur frequently because they're always growing. And if you have one resistant bacteria in your body, that bacteria probably will eventually just go away on its own. But if we gave you an antibiotic, that bacteria would survive and the rest would be killed and then that bacteria would take over and grow 2, 4, 8, 16, 32 and become the dominant bacteria.

So it is a practice of survival of the fittest. And over time, this happens enough in a population of patients or in a community where there's antibiotic use that you end up switching from most people having the sensitive bacteria to most people having the resistant bacteria. Now, staph also have another trick, because once they figured out how to do this, you know, to get the genes to create the resistance, that gene doesn't stay put.

And they have developed a very clever strategy for moving that gene in a little piece of DNA called a cassette. And they can trans-

fer it to other staph bacteria that aren't already resistant. So those bacteria don't have to go through the process of evolution, they can just pick up this new piece of genetic material because it gives them a selection advantage when they're exposed to antibiotics as well. So one part of it is just evolution of bacteria, but the big piece is that we expose these bacteria to drugs, and the survivors are the ones that have the preexisting capacity to be drug resistant.

Mr. TOWNS. I'm concerned about coaches, for instance, in these little leagues that just sort of really have no idea what's going on. And when you say that, well, it was posted on the Web site, these are people that don't have computers. What can we do to be able to get information out? I'm concerned about the fact that——

Dr. GERBERDING. These are the kinds of things that we're sending out to schools through the athletic associations. We're working in partnership with organizations that support coaches and trainers and athletes, little leagues, those sorts of things. So we're trying to get the information out. And individual schools are picking these things up and also getting them out to the school system. I'm not satisfied that we've gotten this information everywhere that it needs to be. And not to harp on the issue of school nurses, but I think in a school environment, you need somebody who is really thinking about the health aspects of the athletic program or the health aspects of the classroom. And that is a really important resource for making sure that the school is doing the right thing for athletes or for any other potential hazard.

Mr. TOWNS. Do you feel that we need a national registry? I'm sort of thinking, now that we're focusing on this, and I really appreciate the fact, Mr. Chairman, that you and the ranking member are having this hearing, because I think it provides us an opportunity to really focus on this. Because I'm wondering, this has been going on for a long time and now we're beginning to sort of focus on it more. Because I can think on my own in terms of situations of strange deaths with people back over through the years. And I just sort of wondered, and now wondering, did it have anything to do with—and I'm sort of saying, if we don't have a central kind of registry, we don't really know in terms of how much is going on. And does that bother you that we don't have a central registry?

Dr. GERBERDING. Well, separate the community from the health care environment. Because in the health care environment, CDC has a registry. We have a system to allow us to track infections that occur among patients in hospitals. And several States now are reporting all of their hospital infection data to CDC using this kind of tool. And we hope that soon they'll be reporting it publicly so that if we see the results, people will be more motivated to do the things necessary to improve.

But in the community it is harder. We have some diseases that are nationally reportable. But I think we're going to be able to do a lot better with that. Again, when our laboratories are connected electronically, this will become something that can be generated automatically and doesn't require someone to fill out a report every time they see a patient with an infection.

So we're just on the brink of being able to do this in a much more efficient way so that people in the local health department can

know there's a problem in their community as it is emerging. They don't have to wait until, in retrospect, we figure it out.

Mr. TOWNS. Mr. Chairman, I see my time has expired. But I still feel that we need to have a central person that's going to be responsible for this. I notice the State of New Jersey has moved forward with legislation. And of course, I think that's really—I'm sure they're doing it out of frustration, but I think it should be done at the Federal level.

Dr. GERBERDING. I don't disagree with you. I think it should be done at all levels. The school needs to know what's going on in the school. The local health department needs to understand the community. The State has great responsibility for prioritizing things in the State. But we do, too, at CDC. And we fund and support and we create national and international guidelines. And yes, we would very much like to be able to have a comprehensive picture of the whole problem, not just the MRSA problem, the whole problem of preventable infectious diseases. Again, if we measure it, I know we will be able to fix it. But if we don't know the scope and magnitude it is very difficult to guess where we should put our effort.

Chairman WAXMAN. Thank you, Mr. Towns. You said you appreciated our holding this hearing. As I mentioned earlier, this was at the suggestion of Representative Tom Davis. But I do want to indicate that the idea was staff driven. Mr. Issa.

Mr. ISSA. Thank you Mr. Chairman. Thank you for holding this hearing, regardless at whose insistence it was at. I would like to characterize, not just your testimony, but sort of the picture that you laid out. Because I think, hopefully, as the "Committee on Government Oversight and the Reforms Necessary," perhaps should be our name, it will lead to something positive. This is a 50-year old problem that the finest minds, our physicians and health care professionals, have either been unable to successfully end, they've only coped with, and in some cases, since you're still printing the plastic card today that says get the catheters out, they've been a participant in the delivery of that.

Because a catheter, for example, is not just about—it is a pathway, it is a pathway where fingers touch. And in fact, the person putting it in or adjusting it or taping and retaping may be part of the process too that helps get it there. So our hospitals, even though you want to separate these, and I think it is appropriate to separate, it has a number 300, does that mean that there's a 299, a 298 and so on?

Dr. GERBERDING. There's 100, 200, 300, 400, 500.

Mr. ISSA. And then there's subgroups?

Dr. GERBERDING. Yes.

Mr. ISSA. There's a lot of these?

Dr. GERBERDING. Yes.

Mr. ISSA. Basically staph kills more people in America than AIDS, all staph, including all the hospital staphs. More people die in which that's the primary cause leading to their death. So this is not an insignificant problem as a whole. You've been dealing with it for 50 years and you haven't vaccinated and you haven't successfully killed staph. Nor from your testimony do I think you're going to, is that fair to say?

Dr. GERBERDING. I think it is very unlikely we're going to eliminate staph aureus has a human pathogen. But I do believe that we can have a tremendous impact on the infections that it causes, particularly, those infections in health care environments.

Mr. ISSA. I'm viewing the less sanitary world outside the hospital and saying, OK, we failed in the hospital where essentially ever since we got the curtains out of the operating room, we've been cognizant of these things and trying to fight them.

So as much as I would like to believe that every gym locker room is going to get cleaned based on public awareness, I'm not buying it. What I am concerned about are what we should be funding your organization or you as an umbrella organization should be working with other organizations to do in the way of vaccine development. Particularly, I would like you to comment on the impact this could have on the military because they don't have any of the luxuries of really good hygiene at certain times in a war effort.

They certainly don't have the ability to spread out and isolate each other at will. And if, in fact, somebody were to use the ugliest of staph infection ever found, could they potentially weaponize it. So looking at it from a standpoint of where we put our funding into vaccines, into reserve antibiotics that would be used, only in a case of an outbreak, or only when we see something where nothing else is working and we want to stop an epidemic, if you will.

So I've given you a lot of questions, but I would like you to characterize it. What my concern is we have the 50-year problem that we haven't been able to do anything but work with. It is now out in the community in a less-informed and harder to inform, and even if informed and even if they did everything that a doctor would do or his health care professional team would do in a hospital, you wouldn't do any better than you would in a hospital which is, in some ways, a miserable failure since that's where you go to get staph infections that can really be nasty. Can you put it in that light so that we get some inkling not what you are doing, which is important, but of what we should be empowering you to do beyond that?

Dr. GERBERDING. I would like to start with the perspective of the hospital or the health care environment. Because one thing that's changed in about the last 5 years is that this is becoming unacceptable to have one of these infections in the hospital. And that simple change in attitude is resulting in some phenomenal changes in infection rates. We have in our reporting system half of some of our intensive care units have had no staphylococcal infections in the last year, so they truly are eliminating the problem.

Mr. ISSA. So it is like the curtains out of the operating room?

Dr. GERBERDING. So you can do something about it? So I don't want to lose sight of that, because the key to that is the commitment and the believe that you should not have staph infections when patients come to the hospital. But I think your broader question is really important. Our vaccine story for staph is not robust. There was a vaccine that went into clinical trial in a very hard to vaccinate population of people, dialysis patients. And unfortunately the vaccine did not prove to be effective at preventing staph infections in that group.

Not many vaccines are effective in people that ill. But we have some prototype work underway, not CDC, but many people have prototype work under way for second generation vaccines. But they're not getting the boost that I would like to see them have. They're not getting the focused attention. And there's actually a very tight coupling here between pandemic influenza and staphylococcus. Because one of the things that we have observed is that when children get influenza, they're prone to get complicated bacterial infections.

When adults get influenza, they're prone to get complicated pneumonias. Very often, it is a staphylococcus pneumonia. So as we're preparing for pandemics and stockpiling antivirals, we've got to think about stockpiling drugs to treat the complicating bacterial infections, including MRSA, since that's likely to be a big killer in the context of any serious outbreak. So the antibiotic pipeline is not robust. It is not robust for anything right now. But it is certainly not robust in this direction.

So we need to look at our vaccine pipeline, both in the research that NIH is doing, as well as the work that goes on in the private sector. We need to look at the drug development pipeline. And then I think we've got to think about new approaches. Traditionally, the approach to a bacterial problem was to kill the bacteria. And unfortunately, as I've already said, that results in replacement with a resistant form, or substitution with a different player, not necessarily a better one. There are novel approaches in investigation right now that don't concentrate on trying to kill the bacteria. They actually concentrate on trying to prevent it from doing damage. And so they're like lasers going in to destroy certain parts of the bacteria as opposed to a bomb that blows the whole thing up. And I think those novel, you know, next generation strategies are not proven yet, but really something that needs a lot more attention and focus. And it is exciting to me what I've learned so far, but the pipeline is long and it is not very wide.

Mr. ISSA. Thank you. Thank you Mr. Chairman. This was very informative.

Chairman WAXMAN. Thank you, Mr. Issa.

Mr. Cummings.

Mr. CUMMINGS. Yes. Thank you, Doctor, for your testimony. I just want to—this whole thing of hospitals and infections should concern all of us. A person goes in the hospital trying to say, for example, address a hernia, and the next thing, you know, they are sicker than they would have been if they had not gone into the hospital. And you've said something just a moment ago that I just want to know the extent of it. You said operating rooms have become better at dealing with staph infection. Is that what you said?

Dr. GERBERDING. I said intensive care units.

Mr. CUMMINGS. Intensive care units. And what is your measuring tool? No. 1. And are there best practices? Johns Hopkins is located smack dab in the middle of my district, and I know they had some kind of campaign trying to get doctors to do more with regard to washing their hands and things of that nature. But I think we need—I mean, that's very significant, because you've got healthy people who are literally going in, and I'm not just talking about Johns Hopkins, of course. But I'm just saying what have you all

learned from that, that intensive care less staph infections, what have we learned that we can put out there to transfer to other hospitals?

Dr. GERBERDING. We've learned a lot. And that little card you have in front of you is a summary of some of the science that we have accumulated that defines certain best practices that we believe are really critical. So we've learned, first of all, that the most important step is to commit to the concept that it is not OK to have these infections that you've got to do something about and you've got to drive the infection rate down.

The second very important factor is that you can't just do one thing. You have to take a comprehensive approach and not think that there's a magic bullet. Oh, we'll all wash our hands more or we'll all screen patients. Those things are not magic bullets. You've got to systematically exhibit the best practices across the board. You've got to control antibiotic use. You've got to get the catheters out of patients because they're the biggest risk factor. And very often patients have catheters for convenience, not because they actually require them medically for as long as they're left in. But the science that supports these recommendations has been codified in a document called the Infection Control Precautions For Multi-Drug Resistant Organisms. And we have put out the recommendations of what the best practices are. But we've also said in your hospital you must measure these things. And if you find that your infection rates are not going down, then you need to do the next generation of interventions, which are even more important.

Mr. CUMMINGS. Is that information out to the public? Because one of the things that I've noticed just from living is that people seem to be driven by money. So if a hospital has a record of infecting its patients, and the patients know about it and the patients have choices, and in Baltimore, you've got 50 million advertisements for hospitals and so apparently somebody is competing for patients, it seems as if that would be not only—cause them to say, wait a minute, we're going to lose business, we're going to have some problems if we don't address it. So is there some data base that a patient could go to? And if there's not would that be a good idea?

Dr. GERBERDING. It is coming. More and more States are requiring that this information be reported. And some States are requiring that it be made public right away. CDC is facilitating that with our tools because we do know how to make these measurements accurate and reliable. But I also want to just read you a headline from something that came out in August 2007, because the headline is: New Medicare Regulations Are Adopted to Reduce Hospital Infections and Medical Errors. Medicare will withhold payments to hospitals for failing to keep patients safe. So what CMS is preparing to do, at Secretary Leavitt's insistence, is not paying for things that are avoidable applications of care.

Mr. CUMMINGS. I see my time is running out, but let me ask you this: Should we in the Congress back that up? Because you have Secretary Leavitt, now you're going to have another Secretary in a year and a half. Do you understand what I'm saying.

Dr. GERBERDING. I believe I do.

Mr. CUMMINGS. Are those things that we ought to be doing? Because this goes to the health of our people. And I'm just wondering what you think.

Dr. GERBERDING. First of all, these are regulations and they last for a long time once they're enacted. But I think I would like to have a conversation. We would really like to sit down and think, OK, we've done this so far, what else could we do to really make this a permanent part of hospital culture, and, for that matter, any health care setting. So that we are not only relying on best practices in kind of a proactive way, but there's also an incentive in that we're aligning the payments that we make for care with the quality and safety of the care that's provided.

Right now, perversely, if someone has a surgical procedure, they may be reimbursed at a certain rate. If that procedure is complicated by an infection, more money is paid. Well, that's perverse. It doesn't result in a strong incentive to solve the problem.

Mr. CUMMINGS. Thank you very much, Mr. Chairman.

Chairman WAXMAN. Thank you, Mr. Cummings.

The Congressman from Tennessee, Mr. Duncan.

Mr. DUNCAN. Thank you, Mr. Chairman.

And I am sorry I didn't get here in time to hear your testimony. But there was a Washington Post story from October 19th that said these MRSA staph infections are reaching epidemic levels. And just trying to skim through your testimony, I see that you have a sentence in here that says, in 2005, there were 94,360 serious MRSA infections. Maybe you have covered this already when I wasn't here, but has this reached epidemic levels? And I think I did hear you say just a minute ago something about some progress or good efforts that were being made. But is this 94,000 number, would that be higher today, and is this going up fast or——

Dr. GERBERDING. Short answer, sir, is I don't know because that was the first time we ever took a look that way, and we have to repeat it to know whether it is going up or down. But we can make some inferences: 85 percent of those patients in that study were people who acquired their infection in the hospital. And we have, from other kinds of information sources, the suggestion that hospital infections are going down and that the proportion of them related to this particular bacteria may be going down as well. Right now, about 8 percent of all preventable infections in hospitals are associated with this bug.

But on the community side, I believe we would guess that the infections are increasing. I am saying that because AHRQ has data showing there are more visits for skin and soft tissue infections generically over time, and the small proportion of those that actually get swabbed and cultured so we know what the bacteria is, the proportion that are caused by MRSA is increasing. So we suspect there are more skin infections in some communities and that a greater proportion of those may be caused by this organism. But we don't have quite the solid evidence for that. There is a bit of extrapolation in that statement, and we need to do more studies to verify that as a broad issue. Certainly true in certain communities, but we don't know nationally whether that is the case.

Mr. DUNCAN. Even as we speak, just this past weekend a member of my staff here came down with a staph infection, but they

told her that this is not a MRSA staph infection, and they have told my other staff members that they don't need to do anything or don't need to be worried. Are there many, many different kinds of staph infections?

Dr. GERBERDING. Yes. There are many different kinds. And that is one of the fascinating things about this bacteria. They are not all alike. We lump them together when we talk about them, but they are independent families of staph, and they behave in different ways. So when we have the specialized laboratory resources, we can predict certain things about a particular strain of staph. For example, if your colleague had a methicillin-sensitive staph, it is unlikely to be related to this problem we are talking about today with these serious infections in healthy kids. But there is not always a way to know that up front. And I think the most important message is, again, kind of back to basics that you should respect skin and soft tissue infections, take care of them, keep them covered, try not to touch them, and if you do, be sure you clean your own hands and don't pass your staph onto somebody else. But more importantly, especially in communities where this problem has emerged, to make sure that if you see a wound that is getting angry or filling with pus or the surrounding area is getting redder and redder or the person has a fever, then not to wait and to get to the doctor.

Mr. DUNCAN. Well, I first heard about this just a few years ago in a meeting with some Members of Congress. And one former Member from Missouri told us that a 57-year-old county executive or county mayor of a suburban county to St. Louis had gone into the hospital for some minor surgery and had gotten a staph infection. And 3 weeks later, he died. And since then, I have heard and read a lot of things about this, and it is getting kind of—there is a lot of concern about this. And so I am glad we are holding this hearing. But I will tell you, maybe this is a little impolite or unpleasant to bring up, to bring up at this time, but I remember 5 or 6 years ago, Dateline had a hidden camera in a men's rest room at one of the major airports, and they obscured everybody's faces, but they showed that something like two-thirds of the men were leaving the rest room without washing their hands. And everything I read and hear, hand washing is about the best thing that you can do to try to hold this down.

Dr. GERBERDING. I couldn't agree with you more. I think soap and water is, you know, the cheapest intervention that we have and extremely effective. Hand hygiene of any kind, the alcohol preps, I think you have one sitting up there, that is a very important part of just constantly disinfecting your hands. What happens is, especially in hospitals, if you touch something that is carrying one of these staph, it is sitting on your fingers. You may not end up carrying it yourself, but you can pick it up and move it someplace else. And that is where the hand washing just becomes so important, because you eliminate that transfer. If you are a carrier of staph, you protect others. And if you happen to be in an environment where someone else has been present with the staph, then you won't pass it onto yourself or someone else.

I also want to emphasize, however, that this isn't something that is just floating around in the air or that we need to exaggerate the

way it is spread. It is spread by very close personal contact. And primarily the major force of transmission outside the hospital are skin wounds.

Mr. DUNCAN. Well, I think it is important that we call more attention to this.

And thank you, Mr. Chairman.

Chairman WAXMAN. Thank you very much, Mr. Duncan.

Ms. Watson.

Ms. WATSON. I want to thank you, Mr. Chairman, and ranking member for having this hearing today. We have all been following the stories in the local area about schools closing down. And I just want you to clarify for us, we see those beautiful, colorful posters that you hope to get out. When should a school close down and disinfect? What are the signs? Not all schools, you have already made that point, have the health care personnel there. And I don't think they are going to have them in anytime soon. We found on our desk these cards. Would it be a good thing to send these cards out to every school? Should the school personnel carry these cards? Should we send them home when we find one case of staph? Should we close down the whole school and disinfect? Can you clarify the procedures for us?

Dr. GERBERDING. Thank you. You know, we have a lot to learn about this, so I am going to tell you our best perspective right now, and we will learn more as we investigate behind the scenes. In general, when there is a case of this kind of staph infection in a school, it is linked to something like the athletic program or to some potential environmental exposure. And it is a signal for schools to take a look at their general housekeeping and particularly the housekeeping in the gymnasium or the locker rooms or areas where kids who have skin wounds might come in contact with each other. I mean, the wrestling room is a great example of that. The wrestling mat, for example, needs to be properly disinfected at periodic intervals. So this is a point where the school should review their procedures for environmental hygiene. There is generally no need to go in and disinfect the whole school, because that isn't how this organism is transmitted. From a public health perspective——

Ms. WATSON. Let me just query that a bit. We don't know how it is transmitted. And I was going to ask you about soaps and disinfectants.

Dr. GERBERDING. The local health officers who are involved——

Ms. WATSON. Let me just say this, so you can give me a more comprehensive answer. We are talking about schools where children come from all kinds of environments and they are there. It could be spread through athletic activities, it could be brought from home and so on.

Dr. GERBERDING. Exactly.

Ms. WATSON. What guidance do you give the school personnel, since we have had two incidents in the surrounding areas? And I am just wondering, and you mentioned prisons before, too, and the fact that some of them don't even have soap. Are there some guidelines that we could send out to our schools? Maybe this ought to be distributed. So can you be a little clearer as to how we can protect, prevent in our schools?

Dr. GERBERDING. The card that you have is targeted for hospitals. But it would be very easy for us to make a tool like that for schools. And I think that is a great idea, and we will look around and see how we can afford that. But I think we can figure out a way to get something like that accessible to teachers and trainers and coaches and anybody else who has a stake in keeping the school a safe and hygienic place. You asked me the question about closing schools. And I don't want the impression to be that, if there is a case of this infection, that it is necessary to close the school. Sometimes a decision is made to close the school because you do need to pause and buy some time to go in and inspect and understand what happened and also to reassure parents that you are taking every step. So I would never say it is wrong to close a school for a variety of reasons. But it is not necessary, generally speaking, from an infection prevention perspective, to do that. It is necessary to assure that the school has a proper hygienic environment, using common sense principles of hygiene. And many have presented those. And I have, you know, these examples of various posters that you will find in a lot of schools already. They are made in collaboration, this one, for example, is with the Massachusetts Department of Public Health, the CDC and HSS, and this is for athletics on a football team. And these kinds of things are in the locker rooms and reminders of avoiding skin, keep your hands clean, shower after you play a sport, use a clean towel, keep your cuts and scrapes clean. So we are using a multimedia effort to inform students as well as schools, but I think we can do a lot more, and I want to be able to do that. So this is an opportunity for us to really have a broad campaign around preventing infections in schools and homes. And MRSA is a good hook for getting that message across.

Ms. WATSON. My time is almost up. And I just want to say this, as a former teacher and school psychologist and administrator, I know that current budgets—I am from the State of California—current budgets don't allow auxiliary personnel, because our constitution in our States only require two people in a classroom, the student and the teacher. So the first to go are the school nurses and other auxiliary personnel. Is it possible that CDC can put out some guidelines to the public health departments in counties throughout the country or to States so that they then will take some action to prevent this? It is awful frightening, with the news coverage that we have today, to know that young people are contacting the staph aureus, and they are dying. And I think we can prevent it. And I think, you know, you go into some schools, the toilets are dysfunctional, they don't have soap in them. So it might be, you know, we can require—of course, we can't do it federally, but they certainly could do it statewide—require that there is disinfectant soap in every single rest room. We have to do something so these new growths of pathogens don't take a foothold and spread across this country in an epidemic fashion, which can happen very easily in schools. And thank you so very much.

Dr. GERBERDING. Thank you. My mom was a teacher, and most of the members of my family were teachers. And I know exactly what you are talking about in terms of school budgets and the priorities that have to occur there. And I was impressed when I was

learning about the school interface with this problem how much guidance and evidence has been produced by CDC and Department of Education and many State health departments. But I don't think that we have systematically assured it has gotten to all the places, to the PTAs, to the parents' groups. And this is a really good reminder for us we have to market more effectively what we have and fill in the gaps that we are missing. Thank you.

Chairman WAXMAN. Thank you, Ms. Watson.

Mr. Lynch.

Mr. LYNCH. Thank you, Mr. Chairman. I also want to thank the ranking member for his work on this. And thank you, Dr. Gerberding. I want to sort of turn the question around a little bit. If these infections were indeed treatable, if these infections were not drug-resistant, we wouldn't be here today. And there seems to be a real history of inaction on the FDA's part to incentivize the development of vaccines and other antibiotics that would be able to treat these new infections. Now the fact of the matter is there are some countries, Mexico, countries in Central America, South America, where you can actually buy antibiotics over the counter like we do aspirins. And so what is happening in those countries is there is a breeding ground, basically, for super bugs, because they evolve over time and become resistant to those antibiotics. But there are some things that we are doing in our own country that I think are problematic as well. And I wanted to talk to you this morning about some of these antimicrobial soaps. I have one here. It is a hand sanitizer. This one is Avant, I guess; it uses ethanol. It has alcohol in it. And it physically disrupts the bacteria on the skin. There is another one out there, Purell, that is similar to this. And that is fine; it doesn't use antibiotics. But there is another one here; this is antibacterial soft soap. And what is happening is, commercially, some of these producers, manufacturers are actually capitalizing on the fear that is out there. And this one has triclosan in it. And that is an antibiotic that doesn't need to be in this. But what we are fearful of is that this is contributing to the problem, and that the more products that are out there that have antibiotics in them and don't need to, it is creating, more resistance out there in the pathogens that we see. So what I want to know is what are we doing about this? Here we are allowing producers, manufacturers in this country to put out stuff that has, you know, antibiotics in it, creating more of a problem. And there are obviously some very—this one has ethanol in it, you know, it is a green product, where it is doing the job. I mean, can we ask these people to take this stuff off the market? And what is the efficacy of those efforts, if any?

Dr. GERBERDING. Let me first say that you are bringing up a dimension of this that is very sophisticated, it is the dimension of the balance between pretending that we could possibly live in a sterile environment and common sense that would dictate, let us do the sensible things that we learned in kindergarten to try to protect ourselves and others from infections. And I do agree with you from a societal perspective, we are enjoying the marketing of the fear for any number of health hazards that is feeding a lot of unnecessary motivation to use many of these types of products. And right now, we don't have any evidence of resistance emerging to the com-

pounds that are in these products. For example, alcohol, it would be almost impossible for a bacteria to develop resistance to alcohol just by the mechanism of how it works. So they are relatively unlikely. Although with triclosan, there has been some very preliminary worrisome suggestion that certain bacteria are developing the ability to exude it from the cells, and they could become resistant. It is not a problem, and we have been using these drugs for a long time, these compounds. So I am not going to say, it won't happen. But that is not my major concern with them right now. My concern is that we are creating an environment where people are misunderstanding the hazards that actually exist, and they are misapplying this kind of technology and these kinds of products in ways that actually don't result in better health and, in some cases, might make matters worse. I mean, just an extreme example of that, if your hands are filthy and you rub some alcohol on it, you are really not cleaning your hands. You may be removing some things but are actually not able to disinfect your hands properly. So you need soap and water to be able to accomplish that. So I recognize that we are delivering a message that says hand hygiene is important, soap and water, and there is a role for these products.

We know from science in hospitals, where we have looked at their use and what happens to infections when they are used properly, that they can really be an important contributor to patient safety. But their overuse in other environments is not necessarily constructive and really diverts people from important steps.

Mr. LYNCH. Thank you. I have limited time, so let me just ask you the other side of this, the first question I mentioned. What are we doing? I am working with a group called the Alliance for the Prudent Use of Antibiotics. And they are concerned that there aren't enough manufacturers out there that are trying to develop new antibiotics. They say we have a small family of tools in our toolbox, and we need more. What are we doing to help that effort to have drug manufacturers look at some of this stuff? It may not be the most lucrative stuff, but government does have an ability to incentivize research and development in certain areas. And if you would, would you share with us any thoughts on that? Are we doing anything in that direction? Thank you.

Dr. GERBERDING. I would just say that Dr. Levy from the Alliance is a good friend of mine. And so I am well aware of the work that is going on with the Alliance. And there is some very important steps that are being taken there. The pipeline for antibiotics is attenuated for a lot of reasons. In part, the reasons have to do with the complexities of drug development and the fact that there aren't very many blockbuster ideas around anymore. They have sort of run out of new approaches to defeating these bacteria. And so the great ideas seem to be drying up. I don't believe that is the end story here, but I think there has been a dramatic attenuation of what is in the pipeline to try to solve these problems. And part of the recognition is that these drugs have a shorter and shorter life span of utility because the bacteria are so quickly able to develop resistance. And it is so expensive and so legally expensive to try to bring a drug to market that it gets very complicated. I think we can do more. And as I mentioned, the investments that NIH and the private sector are making in completely different ap-

proaches that are much more laser in orientation as opposed to blasting the bacteria in orientation, there are some very exciting and innovative strategies. I personally think for staph aureus we need a vaccine. There are people we know are at risk for this infection. And if we can develop a vaccine that prevents invasive disease and reduces the infection rate we will really save lives. And I think we need a concerted and very aggressive effort in that regard.

Mr. LYNCH. Thank you. I yield back.

Chairman WAXMAN. Ms. McCollum.

Ms. MCCOLLUM. Thank you.

Thank you, Dr. Gerberding. I want to just followup on two issues about how we go about identifying this type of staph that we are talking about today. One of the things that some States have been doing, Minnesota has been doing, and I quote from a Pioneer Press article, one of our newspapers, proposed State guidelines would require hospitals to test all high-risk patients for MRSA, isolate those with positive tests, and encourage all workers and visitors to stop the spread of disease by washing their hands. It goes on to cite one hospital, Southdale has cut its hospital-acquired infections this year partly because it screens all patients in the intensive care for the presence of this before it becomes a problem. All caregivers are paying more attention to infection control. And I am assuming by caregivers they are even including those who will be giving care possibly at home further instruction on hand washing and that as well. But then it goes on to say that the strains of this in hospitals are somewhat wimpy compared to the strains circulating in the community. And that is what has everybody I think really, you know, with heightened awareness with these unfortunate two deaths. But community cases often surface as skin infections in healthy people. Hospital cases often attack patients already weakened by surgery or other illnesses. So I am just wondering, just to make sure that—because we go out and talk to people in the community—just so that we are clear, the hospitals, what is the testing? I saw something just for a few seconds on television, it was a nose swab. What is the CDC talking to hospitals about doing? To followup on another Congress Member's suggestion, what should we be doing to work with either with the Governors Association, State boards of health or with you so that there is a unified message going out? We don't have so many things tripping over themselves that nothing happens. And then here again even with the schools, school nurses are something that I am very upset that we have seen disappear in our schools for a whole host of reasons, this being one of them. But maybe you could speak to that and what the CDC might want Congress to do or not to do to be helpful here again with schools, school nursing, school administrators, coaches' renewal, coaches' certificates which States certify and offer. What can we do to be helpful? And what are the types of things that you would want a Member of Congress, if a mom came up to me worried about their child in school, if a person came up to me worried about a loved one in a hospital, what do I need to know so that either I point them in the right direction and so that I don't give out misinformation?

Dr. GERBERDING. Let me start with prevention in the hospital and other health care settings. What CDC has done is to bring the

best experts together and to really look at the science and the best practices and try to draw conclusions about, what do we know is at least the basic set, we call them the tier one recommendations, that everybody should do? And we have published those, like we do our other infection control guidelines, and they are picked up by infection control professionals, which we do have in hospitals, thankfully, to implement them. What those recommendations say are basically you need to measure your problem and you need to reduce it. And if you are not reducing it with the basic recommendations that we have offered, you have to move to a much more aggressive and expensive set of interventions, which include aggressive screening, aggressive isolation, and a variety of other steps.

Now you might ask, why wouldn't we screen and isolate everyone up front? And there are several reasons for that. First of all, the evidence indicates that is not necessary to drive your infection rates down. There are many hospitals that have seen 60-plus percent reduction without taking that particular approach. But more importantly, in hospitals where this has happened, they have been able to show that patients in isolation get less care. And what happens is the doctor doesn't go in as much. The nurses don't go in as much. The bed sores go up. The other infection and safety problems increase. And so there is a ying and a yang. If you are going to isolate someone, you have to commit to making sure that you provide the same attention and care that you would be able to provide them if they weren't in a room that was filled with barriers that you had to change your clothes to go in and out of and so forth. So there are aspects of this from a comprehensive approach to patients that I worry about. I was a hospital epidemiologist. It was my job to execute these kinds of programs at San Francisco General Hospital. And one of the things that I am aware of is that about 8 percent of the problem is staph, but there are a whole lot of other bacteria that also cause deadly infections in hospital patients. And you have to have a program that deals with infections, not just with this particular bacteria, if you really want to improve the safety of your patient care. So the problem is much bigger than what we are addressing today. And it takes a comprehensive and a generic solution. But it can be done. And our whole point is, do it. And let us measure and report that you are successful while you are at it.

Chairman WAXMAN. Thank you, Ms. McCollum.

Mr. Sarbanes.

Mr. SARBANES. Thank you, Mr. Chairman.

Thank you for your testimony. I became aware of MRSA when I was first elected last year. A lawyer who was in my law firm gave me a 10-page handwritten discussion of this and sort of handed it to me and said, nobody's talking about this; you need to know about it. And so when the hearing was called, I was very anxious to come and understand more about the issue. We have had some questions about how the various practices that are out there that are increasing the resistance to antibiotics are something that we need to be concerned about. I want to just focus a little bit on what is being done with respect to animal feed and the introduction of fairly heavy antibiotic use in animal feed within that industry, and

whether that is contributing to this kind of resistance. Maybe you could just speak to that generally. And then I have a specific question on that.

Dr. GERBERDING. This has been a subject of a great deal of scientific scrutiny from people in the agriculture side of the House as well as on the public health side of the House. And I think particularly deep analysis has been done in some European countries. I believe the evidence strongly indicates that the use of certain antibiotics in animal feed were a major driver for one of our most feared drug-resistant organisms, vancomycin-resistant enterococci, but that there is also an association with drug use in animal feed with the emergence of resistance in some more common enteric pathogens like salmonella. And so just as what happens in people is, if you have an infection and you treat it, eventually the bacteria will learn to be resistant to it. Of course, the same thing happens in the intestinal track of animals. Over time, they become resistant to these antibiotics. And the problem is, they are not over there, and they are over here. We are all mixed together. They are in our food supply. We work with them on farms. We have very intimate contact. That is why most of the new infectious diseases people have developed in the last 20 years have come from animals. So, of course, our drug-resistant infections could emerge from animals, or the genes that cause that resistance could move from an animal bacteria to a human bacteria. So it is an important issue.

And I think, in Europe, where they have tackled it in a very systemic way, they have been able to show that you still get good yields from your chicken production or your pork production, and that it actually doesn't interfere with the livelihood and productivity of your industry if you do this in a sensible and prudent way. Beyond that, what I can say about the United States and the current status of our own regulations around certain antibiotics and animal feed, I am not up to date on that, so I would have to get back with you on the current status, but I know we have taken similar steps in the United States.

Mr. SARBANES. I appreciate that. I guess there is an antibiotic that treats meningitis called Ceftriaxone, and there is a very close drug to that which is being used in animal feed called cefquinome. And I mean, meningitis is something that causes, obviously, high anxiety in the public. And right now, we are in a position to treat it with this one particular antibiotic, or at least it is a key antibiotic in the treatment regimen to combat meningitis. Are you concerned that the FDA allowing the use of this cefquinome in animal feed could create a problem with the treatment of meningitis?

Dr. GERBERDING. I am not properly briefed on that, so I would need to get back to you for the record on this particular issue. I will just say, generically speaking, wholesale use of antimicrobials drives drug resistance, and if we are creating a ecology of resistance that is relevant to human health, then it is a concern to me.

Mr. SARBANES. Is the FDA, as it is regulating the use of antibiotics in animal feed, are they working into that analysis the effect it could have on the antibiotics that are being used to treat human conditions?

Dr. GERBERDING. There are several organizations that have a stake in this; FDA, USDA, CDC among them. But about 5 years

ago, people came together—actually a little bit longer than that now—and developed a comprehensive plan for dealing with antimicrobial resistance, which really should be revisited because it was a fantastic, comprehensive approach to systematically addressing the problem on a national and international scale. And this was one of the main issues in that report. And there were 10 Federal agencies that contributed to it. It is quite good, and I would be happy to make it available to you.

Mr. SARBANES. I appreciate that. I know the AMA and Infectious Disease Society have addressed this issue of cefquinome and their concerns about it, and they are hoping that the FDA will regulate against that usage. So I would be encouraged to hear more information about that.

Dr. GERBERDING. Thank you.

Mr. SARBANES. Thank you, Mr. Chairman.

Chairman WAXMAN. Thank you, Mr. Sarbanes.

As I indicated earlier, Mr. Matheson is joining our committee for this hearing. He is on the committee that has legislative jurisdiction over these issues and has been a leader with legislation to deal with resistant strains of antibiotics.

Mr. Matheson, I want to recognize you for questions.

Mr. MATHESON. Thank you, Mr. Chairman.

And thank you for the opportunity to participate on this hearing's committee today. Dr. Gerberding, I want to ask you about the Federal response to the problem of drug resistance. It is not a new problem. In 1995, a report from the Office of Technology Assessment said that drug resistance was a growing problem and we needed some basic, commonsense public health measures to address the issue. In 1998, the Institute of Medicine also put out a report on drug resistance and said some similar things to the OTA report. In 1999, the GAO reported that data on drug-resistant bacteria were limited and raised concern this problem might get worse. So, in 2000, Congress enacted a law that set up a task force to coordinate Federal programs on antimicrobial resistance. I understand that the CDC played an informal leadership role for this task force. The task force identified some top priority items, like creating a national surveillance program. And that was 7 years ago. I want to know, in your view, in the past 7 years, has the administration done a good job in addressing this problem and in implementing the recommendations of that task force that was set up?

Dr. GERBERDING. You know, I would have to go back and look one by one at the recommendations. And I didn't prepare that. I was part of that task force, so I am very familiar with the process. And you know, the experience of bringing 10 agencies together with the whole universe of stakeholders was something that I don't think had ever really been done before in government. And I do know that some aspects of the program were funded, and that my division, the division I initially directed when I came to CDC, was one of the beneficiaries of the investment in the antimicrobial resistance budget line for CDC. So, clearly, some things have happened. But CDC will be working with our other partners to reconvene that task force this winter. And we expect to go line item by line item through it and understand, OK, what did we do? What

remains to be done? And where do we go from here? What was resourced? What wasn't resourced? What are the gaps? And let us refresh this and get the show on the road.

Mr. MATHESON. I appreciate that. I will offer you a couple of gaps that were key recommendations that the task force made that haven't been implemented, such as a comprehensive national antibiotic resistance surveillance plan, and I think there is still a need to research the most effective infection control practices. And I am glad to hear the task force is going to be coming back together.

Dr. Gerberding, as you may know, I have introduced legislation, and Chairman Waxman has cosponsored as well, called the STAAR Act. And it is an effort to strengthen our response to antimicrobial resistance. I am just wondering if you have had a chance to review this legislation, and if so, what you think of the provisions related to surveillance, prevention, control and research.

Dr. GERBERDING. Yes, I did have a chance to review it, and thank you. I would say that there is one perspective that is good news and will make this a lot easier. And that is, we are in the process of switching from traditional approaches to surveillance to very contemporary approaches to surveillance, relying on electronic medical records and the connectivity that we have created. CDC is going to be funding eight enormous contracts with large States or health care organizations to be able to utilize anonymized data about various things, including infections and drug resistant infections that will allow local health officers and State health officers to have much quicker and much more efficient and much, I think, more robust information in a timely way about these problems as they emerge. So the technology now allows us to do something very inexpensively that before we would have had to invest a ton of money to even get off the ground. That is exciting, and we are doing it. The other provisions in the act I think also reflect a comprehensive approach. And it would be good to compare what is in the proposed legislation with what the task force thinks the priorities are so that we could refresh and stay in lockstep as that moves forward.

Mr. MATHESON. Sure. I certainly am open to any suggestions that you have for that legislation as we try to move it forward. So I make that just a general request of you and am interested in your input.

Dr. GERBERDING. Thank you. Thank you.

Mr. MATHESON. Again, Mr. Chairman, I thank you for the opportunity to participate in the hearing, and I yield back.

Chairman WAXMAN. Thank you very much, Mr. Matheson.

Mr. Bilbray.

Mr. BILBRAY. Thank you, Mr. Chairman.

Doctor, as the chairman well knows, in my previous life, before coming here, I supervised the health program for 3 million people in San Diego County. And obviously, my information is very dated, so I would ask you to sort of update me on the latest. One of the issues that we were addressing was the creation of these resistant strains through incomplete treatment, antibiotic treatment. Is that still a concern out there about the fact that a patient's ceasing treatment after the symptoms have left but not completing the entire treatment?

Dr. GERBERDING. That certainly is one of the factors that promotes resistance, incomplete killing of the organism and leaving some of the stragglers around to benefit from their reduced susceptibility and emerge. That probably has not been an important issue for staph infections, but it probably is an important contributor to some streptococcal infections and some other common community problems. So when people are prescribed an antibiotic, they must take it for the duration that the doctor prescribes it.

Mr. BILBRAY. OK. I want to say this, because I think it is important that the chairman and the committee keep it in mind when we talk about other things, one of the big concerns we had, Mr. Chairman, was that, especially in the population of the homeless community, where you had mental illness, substance abuse and basically a feeling of not wanting to be under the jurisdiction of anybody, we had a real problem with trying to maintain a lot of people in the homeless community to finish their treatment. And our health department was always concerned about that. And we were sort of caught in between the ability to protect the public health but not wanting to step on the civil liberties of the homeless. And I think that we almost err so far over to one side, because the public's perception of civil liberties was so that it doesn't affect us if somebody doesn't finish their treatment. And I think that we need to talk about this openly that, yes, it does. And just as we require people to be vaccinated if they are going to go to school and expose other people's children, we need to be a little more outspoken about the fact that, even if it means requiring people to finish treatment, we need to be a little more forceful on that than we have in the past. Is that still a legitimate concern?

Dr. GERBERDING. I like to answer questions like this with science. And I can certainly say the quintessential example of a scientific yes is in the case of tuberculosis. You have to finish your tuberculosis treatment in order to be protected from TB and prevent the emergence of drug resistance. And it is important for the individual, but it is of essential importance to public health as well. So to the extent that the science would support aggressive interventions, we would certainly—we would want to go in that direction.

Mr. BILBRAY. I appreciate that, and I think you have given us sort of a guidance there in that we need to make sure that our civil law and our criminal law and our resources for treating are reflected by good science and that we make sure that we move into those areas of requiring people to finish treatment when and where it is only proven to be needed for the public health, as opposed to doing it universally or to ignore the problem universally, which is to a large degree, none of us have wanted to take on that tough public relations problem, explaining to the media why this person had to be put into custody because they were chronic violators of the, you know, the finish-the-treatment argument. And that has been a concern in that population. And it is one that I think we just need to be frank and brave enough to raise.

Dr. GERBERDING. You are raising an issue that I think is very important for the committee to understand. And that is the kind of research that you are describing is very practical research. This isn't the kind of thing that excites people to write RO1 NIH grants,

but this is such important knowledge. And we need mechanisms to be able to ask and answer these very, very down-to-earth, in-the-trenches kind of questions about what is working, what isn't working. It is the application of all this biomedical knowledge in the communities and in the streets, in your case, that we just need to take our science that last step so that we can answer these questions. We call it learn-as-you-go research. But it is kind of the evaluation and the applied evidence to answer the question, well, what is the best way to do this? Or what is the harm from taking that step? Or what does it cost? Or what is the best method for getting things disseminated? And we have some real gaps across the board in all of these issues related to preventable infections and drug resistance, whether it is what works in the hospital or what works in the community or what works in the school. We need to get answers so that we are able to provide something other than it is common sense when so much is at stake.

Mr. BILBRAY. Thank you, Doctor. And I will just say that one of the great privileges I had as chairman of the county was to go and work 1 day in a certain department. And when going out into the community with the health expert to triage and, you know, make contact with the homeless community specifically for health reasons, that is only through their practical knowledge and their practical application was I able to learn that. So I hope to be able to bring that to the forum. Thank you very much.

And thank you, Mr. Chairman, and I yield back.

Chairman WAXMAN. Thank you, Mr. Bilbray.

Dr. Gerberding, that completes the questions from the members of the committee. You have done an outstanding job and given us a better perspective of this issue. And I thank you so much for it.

Dr. GERBERDING. Thank you.

Chairman WAXMAN. We have a second panel that we are going to hear from and question, but we are going to break now and return at noon, or as soon thereafter as the Joint Session of the Congress has been completed. So we stand in recess until 12 noon.

[Recess.]

Mr. TOWNS [presiding]. I would like to welcome our second panel.

As with our first panel, it is our committee policy that all witnesses be sworn in. So please rise and raise your right hand.

[Witnesses sworn.]

Mr. TOWNS. Let the record show that each witness answered in the affirmative. I would briefly introduce each witness. Dr. James Burns is chief deputy commissioner for public health at the Virginia Department of Health.

Welcome.

Dr. Elizabeth Bancroft is a medical epidemiologist from Los Angeles County Department of Health Services.

Welcome.

Dr. Robert Daum is a professor of pediatrics at the University of Chicago.

Welcome.

Dr. DAUM. Thank you.

Mr. TOWNS. Dr. Eric Gayle is a family physician in New York City who practices at a community health center in the Bronx.

Dr. Steven Walts is Superintendent of Schools in Prince William County, VA. And of course, he is from the ranking member's district.

Let me begin with you, Dr. Burns.

Welcome all of you.

Dr. Burns.

STATEMENTS OF JAMES BURNS, M.D., M.B.A., CHIEF DEPUTY COMMISSIONER FOR PUBLIC HEALTH, VIRGINIA DEPARTMENT OF HEALTH, RICHMOND, VA; ELIZABETH A. BANCROFT, M.D., S.M., MEDICAL EPIDEMIOLOGIST, LOS ANGELES COUNTY DEPARTMENT OF HEALTH SERVICES, LOS ANGELES, CA; ROBERT S. DAUM, M.D., PROFESSOR OF PEDIATRICS, UNIVERSITY OF CHICAGO, CHICAGO, IL; STEVEN L. WALTS, ED.D., SUPERINTENDENT OF SCHOOLS, PRINCE WILLIAM COUNTY SCHOOLS, MANASSAS, VA; AND ERIC GAYLE, M.D., BRONX REGIONAL MEDICAL DIRECTOR, INSTITUTE FOR FAMILY HEALTH, NEW YORK, NY

STATEMENT OF JAMES BURNS, M.D., M.B.A.

Dr. BURNS. Mr. Chairman, distinguished members of the committee, I am honored to be testifying before you today. And I would like to thank the chair and the committee members for convening this hearing on a very timely public health topic and for providing Virginia with the opportunity to discuss the public health impact of community acquired methicillin-resistant Staphylococcus aureus.

The recent death of a teenager in Virginia and the closing of several schools as a result attracted intense media interest in MRSA, the likes of which we have not seen in Virginia since we had three cases of inhalational anthrax in 2001. We were contacted by numerous local, State and national news organizations, and our central office staff and local health directors gave countless interviews. Conservatively, we spent more than 2,000 staff hours, over 2 weeks, on this issue.

Community concerns were not limited to parents and students. A local office of the Department of Motor Vehicles closed when an employee was reported to have a MRSA infection on her arm. The closure was despite the recommendation of her physician and the Health Department to not close the office.

In addition to many individual contacts with the media, citizens, local and State officials, and a statewide press briefing, the Health Department provided many online resources, worked with the Department of Education to draft guidance for local school divisions, which was transmitted to them, and worked with the State Human Resources Department to provide guidance to State agencies. And that is in addition to all the individual contacts that the local health departments had with those similar situations at the local level.

The messages we have emphasized in our communications are ones that we have heard here today; that, in spite of this unfortunate case, serious MRSA infections are generally associated with hospital patients receiving invasive procedures, and that skin and superficial MRSA infections are generally mild. Also, those wishing to decrease their relatively small chances of becoming sick from

MRSA should wash their hands frequently, cover cuts and scrapes until they are healed, avoid contact with other people's wounds and dressings, and to not share personal items, such as towels and razors. We emphasized that the spread of MRSA was mostly person to person, so general environmental cleaning is not generally indicated, though cleaning of certain kinds of exercise equipment between users and similar measures are reasonable.

Among the most frequently asked questions by the public and media was how many MRSA infections occurred in Virginia each year. MRSA was not a reportable disease, and we could not answer that question. There was intense interest at all levels of the government in introducing legislation to address the public's concern. Governor Kaine determined that the most appropriate and the most effective strategy was for the Health Commissioner to use his existing statutory authority to add MRSA to the list of diseases required to be reported by laboratories. An emergency regulation was issued by the Commissioner on October 24th to establish this goal.

Antibiotic resistance has been on our radar screen in Virginia for many years. Beginning in 2000, the Virginia Department of Health began working with the Centers for Disease Control and managed care providers in Virginia on an antibiotic resistance prevention program designed in two parts; a public education campaign and a health provider campaign. The public education campaign focused on convincing patients not to ask for antibiotics when they went to a doctor with respiratory infections, and emphasized the importance of finishing the entire course of antibiotics. We also evaluated physicians' prescribing patterns for pharyngitis, usually a viral infection not requiring antibiotics, and we were able to show a statistically significant decrease in those inappropriate prescriptions. The campaign received national recognition at the National Press Club in April 2001. We received grant funding from the CDC to support this effort. And our campaign continues today through a partnership with Anthem Foundation, that is the Blue Cross/Blue Shield company in Virginia, and the Medical Society of Virginia Foundation. We believe that such a campaign in every State would be useful in reversing, or at least slowing, the troubling trend toward increasing drug resistance.

I would be remiss without taking this opportunity to thank the many Health Department employees in our local offices, the Office of Epidemiology and the Office of Public Information, who worked so hard to determine that there was no increased risk to the public as a result of this unfortunate case, and to communicate accurate and timely information to all requesting it. I also deeply appreciate the support provided by the Association of State and Territorial Health Officials, and the great support provided by our colleagues at the Centers for Disease Control. Thank you.

[The prepared statement of Dr. Burns follows:]

Statement James E. Burns, MD, MBA

Chief Deputy Health Commissioner, Virginia Department of Health

Before the House Committee on Government Reform

November 07, 2007 at 10:00 A.M. in Room 2154 of the Rayburn House Office Building

Mr. Chairman and distinguished members of the House Oversight and Government Reform Committee, my name is Dr. James E. Burns. I am the Chief Deputy State Health Commissioner for the Virginia Department of Health, and I am honored to be testifying before you today. I would like to thank the Chair and the committee members for convening this hearing on a very timely public health topic – drug-resistant infections and for providing Virginia with the opportunity to discuss the public health impact of community acquired methicillin-resistant Staphylococcus aureus (MRSA).

I am here today testifying on behalf of Dr. Robert Stroube, Virginia's State Health Commissioner, who has appeared before this Committee on numerous occasions. Dr. Stroube asked me to express his regrets that family illness prevented him from being here today.

As Chief Deputy State Health Commissioner, I serve Commissioner Stroube who is the principal advisor to Virginia Governor Tim Kaine, Virginia Secretary of Health and Human Resources Marilyn Tavenner, and the Virginia General Assembly on a wide range of public health issues. During my 27 year career in the Virginia Department of Health, I have served in a variety of leadership roles including 15 years as a local health director in two health districts. I am board certified in pediatrics with advanced training in infectious diseases and earned a Master in Business Administration.

Introduction

The Virginia Department of Health celebrates its centennial in 2008. Virginia's local public health system was created 60 years ago and is one of the strongest in the nation. The Virginia Department of Health supervises our local health departments, except in Arlington and Fairfax where they are locally administered. Our 119 local health departments are combined into 35 health districts for management efficiencies. Our health districts are led by full-time physician

directors nearly all of whom have advanced training in public health. Our local health departments are jointly funded by our state general fund and local governments using a matching formula based on ability to pay. State and local funding, combined with earned revenue from issuing permits and vital records fees, now exceeds $180 million annually with a workforce of more than 2,800 FTEs. Federal grant funds play an important role in supporting these local agencies accounting for an additional $34 million. I mention how our system is organized and funded and the high quality of our workforce as a backdrop to my testimony today that will focus on discussing our recent experience with Methicillin-Resistant Staphylococcal Aureus (MRSA).

Bedford County Virginia

Bedford County is a largely rural county in the southwestern region of Virginia with a population of 65,000 residents. A teenager from Bedford County in Southwest Virginia was seen in the emergency department of a community hospital in Bedford on Sunday October 7. Based on staff's assessment, the patient was transferred to a tertiary care center approximately 30 miles away. Blood cultures were positive for MRSA and treatment was initiated. Despite aggressive treatment, the patient did not improve and died on October 15. Word of the teenager's death created fear and concern among parents and students at the public high school he attended. Students held protests outside the school and refused to enter the building. Local school officials received a high volume of calls from concerned parents and local and national media were providing extensive coverage of the death. On Tuesday, October 16, the local school superintendent, responding to intense pressure from parents, students, and staff, decided to close all of the schools in the county on Wednesday October 17 and to hire a contractor to perform disinfection. Unfortunately, he made this decision without consulting the local health director who learned about the school closing from media sources. After she learned about the closure, the local health director attempted to contact the local superintendent to offer assistance but he did not return her phone calls. We have subsequently addressed such interaction in cooperation with the Department of Education.

The timing of the child's death coincided with publication of the JAMA article which estimated that there were as many as 90,000 MRSA infections annually and put a face on this research. At roughly the same time, CDC released information about the importance of addressing the growing problem of antibiotic-resistant infections, including MRSA, citing the potential that this trend, unabated, could be as devastating as AIDS. The timing of these three events created widespread concern in communities throughout Virginia. This concern bordered on panic in some areas of the state where the mention of a possible MRSA case created pressure for local officials to close schools or cancel sporting events. As

a result, a number of schools and colleges were closed and events were postponed unnecessarily.

There was intense media interest in MRSA, the likes of we have not seen in Virginia since we had three cases of inhalational anthrax in 2001. We were contacted by numerous national news organizations and our central office staff and local health directors gave countless interviews. Conservatively, we spent more than 2,000 staff hours in a period of two weeks.

Community concerns were not limited to parents and students. A local office of Virginia's Department of Motor Vehicles closed when an employee was reported to have a MRSA infection on her arm – despite the advice of her physician and the health department.

Virginia's Response

After the local health department's investigation of the case, VDH staff rapidly reviewed the literature, CDC's website, and our Offices of Epidemiology and Public Information worked collaboratively to post educational materials and resources for the public and providers on our website. We also developed an intranet resource page for our local health directors. These materials were posted within 2 days and we continue to refine them as new information and links become available.

We knew that one of the keys for successfully addressing the concerns of communities and decision-makers was closer collaboration between local school divisions and local health departments. VDH staff worked with staff from the Department of Education and the State Superintendent of Public Instruction issued a "Superintendent's Memo" instructing local school divisions to work closely with local health directors in making decisions about how to respond to MRSA reports among students.

Among the most frequently-asked questions by the public and media was how many MRSA infections occurred in Virginia each year. MRSA was not a reportable disease and we were unable to provide this information. There was intense interest at all levels of government to introduce legislation to address the public's concern. Dr. Stroube made a recommendation concerning reporting to Governor Kaine. Dr. Stroube, the Superintendent of Public Instruction, met with Governor Kaine, members of his cabinet, and the Governor's staff on October 23 to discuss how best to respond to this question. Consensus was reached that the appropriate strategy was for the Commissioner to use his existing statutory authority to add MRSA to the list of diseases required to be reported by laboratories. An Emergency Regulation was issued on October 24 to accomplish this goal.

Subsequent to Dr. Stroube issuing the Emergency Regulation, VDH held a briefing for the press to explain the emergency regulation and to provide information on our recommendations about steps individuals could take to protect themselves and to reduce the transmission of the infection to others as well as appropriate actions schools or businesses could take to reduce the risk of transmission.

Throughout the last few weeks, our local health directors and their staffs and the staff in the Offices of Epidemiology and Public Information have done an outstanding job of working with local school officials, private health care providers, businesses, and members of their communities to address their concerns and to provide consistent and accurate formation and I appreciate the chance to recognize them here today.

One of the strengths of state health agencies is the network among state health officials working with the Association of State and Territorial Health Officials (ASTHO) to share best practices. Dr. Stroube received calls from other commissioners asking if they could have copies of the emergency regulation and permission to adapt materials VDH developed related to MRSA.

Virginia's Collaborative Efforts to Prevent Antibiotic Resistance

In closing Mr. Chairman, I'd like to mention that antibiotic resistance has been on our radar screen in Virginia for many years. Beginning in 2000, the Virginia Department of Health began working with the Centers for Disease Control and managed care providers on an antibiotic drug resistance prevention program designed in two parts – a public education campaign and a health provider campaign. The public education campaign focused on convincing patients not to ask for antibiotics whenever they went to the doctor with a respiratory infection and emphasizing the importance of finishing the entire course of antibiotics when they were prescribed. We evaluated physicians' prescriptions written for pharyngitis which doesn't normally require antibiotics. The campaign received national recognition at the National Press Club in April 2001. We receive grant funding from CDC to support this effort and our campaign continues today through a partnership with the Anthem Foundation and the Medical Society of Virginia Foundation. We believe that such a campaign in every state is needed to attempt to reverse a troubling trend toward more and more infectious agents that are drug resistant.

Thank you again for the opportunity to speak with you today. I would be pleased to answer any questions you may have.

Appendic :

Emergency Regulation issued by the Virginia State Health Commissioner on October 24, 2007 requiring laboratories to report MRSA infections.

Superintendent's Memo to local School Divisions encouraging collaboration with local health departments around public education and school closure decisions.

Department of Human Resource Management guidelines for state agencies regarding closure of offices based on the presence of a staff member or customer who may have a MRSA infection.

Virginia's Antibiotic Drug-Resistance Prevention Program Description.

VA.R Doc. No. R08-1024 - Emerg ncy/NOIRA

DEPARTMENT OF HEALTH

Emergency Regulations Requiring MRSA Reporting

12VAC5-90-80. Reportable disease list.

A. The board declares suspected or confirmed cases of the following named diseases, toxic effects, and conditions to be reportable by the persons enumerated in 12VAC5-90-90. Conditions identified by an asterisk (*) require rapid communication to the local health department within 24 hours of suspicion or confirmation, as defined in subsection C of this section. Other conditions should be reported within three days of suspected or confirmed diagnosis.

Acquired immunodeficiency syndrome (AIDS)
Amebiasis
*Anthrax
Arboviral infections (e.g., EEE, LAC, SLE, WNV)
*Botulism
*Brucellosis
Campylobacteriosis
Chancroid
Chickenpox (Varicella)
Chlamydia trachomatis infection
*Cholera
Creutzfeldt-Jakob disease if <55 years of age
Cryptosporidiosis
Cyclosporiasis
*Diphtheria
*Disease caused by an agent that may have been used as a weapon
Ehrlichiosis
Escherichia coli infection, Shiga toxin-producing
Giardiasis
Gonorrhea
Granuloma inguinale
*Haemophilus influenzae infection, invasive
Hantavirus pulmonary syndrome
Hemolytic uremic syndrome (HUS)
*Hepatitis A
Hepatitis B: (acute and chronic)
Hepatitis C (acute and chronic)
Hepatitis, other acute viral
Human immunodeficiency virus (HIV) infection
Influenza
*Influenza-associated deaths in children <18 years of age
Kawasaki syndrome
Lead-elevated blood levels

Legionellosis
Leprosy (Hansen's disease)
Listeriosis
Lyme disease
Lymphogranuloma venereum
Malaria
*Measles (Rubeola)
*Meningococcal disease
*Monkeypox
Mumps
Ophthalmia neonatorum
*Outbreaks, all (including but not limited to foodborne, nosocomial, occupational, toxic substance-related, and waterborne)
*Pertussis
*Plague
*Poliomyelitis
*Psittacosis
*Q fever
*Rabies, human and animal
Rabies treatment, post-exposure
Rocky Mountain spotted fever
*Rubella, including congenital rubella syndrome
Salmonellosis
*Severe acute respiratory syndrome (SARS)
Shigellosis
*Smallpox (Variola)
Streptococcal disease, Group A, invasive
Streptococcus pneumoniae infection, invasive, in children <5 years of age
Syphilis (report *primary and *secondary syphilis by rapid means)
Tetanus
Toxic shock syndrome
Toxic substance-related illness
Trichinosis (Trichinellosis)
*Tuberculosis, active disease
Tuberculosis infection in children <4 years of age
*Tularemia
*Typhoid fever
*Unusual occurrence of disease of public health concern
*Vaccinia, disease or adverse event
Vancomycin-intermediate or vancomycin-resistant Staphylococcus aureus infection
*Vibrio infection
*Viral hemorrhagic fever

*Yellow fever

Yersiniosis

B. Conditions reportable by directors of laboratories.

Conditions identified by an asterisk (*) require rapid communication to the local health department within 24 hours of suspicion or confirmation, as defined in subsection C of this section. Other conditions should be reported within three days of suspected or confirmed diagnosis.

Amebiasis—by microscopic examination, culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

*Anthrax—by culture, antigen detection or nucleic acid detection

Arboviral infection—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

*Botulism—by culture or identification of toxin in a clinical specimen

*Brucellosis—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

Campylobacteriosis—by culture

Chancroid—by culture, antigen detection, or nucleic acid detection

Chickenpox (varicella)—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

Chlamydia trachomatis infection—by culture, antigen detection, nucleic acid detection or, for lymphogranuloma venereum, serologic results consistent with recent infection

*Cholera—by culture or serologic results consistent with recent infection

Creutzfeldt-Jakob disease if <55 years of age—presumptive diagnosis—by histopathology in patients under the age of 55 years

Cryptosporidiosis—by microscopic examination, antigen detection, or nucleic acid detection

Cyclosporiasis—by microscopic examination or nucleic acid detection

*Diphtheria—by culture

Ehrlichiosis—by culture, nucleic acid detection, or serologic results consistent with recent infection

Escherichia coli infection, Shiga toxin-producing—by culture of E. coli O157 or other Shiga toxin-producing E. coli, Shiga toxin detection (e.g., by EIA), or nucleic acid detection

Giardiasis—by microscopic examination or antigen detection

Gonorrhea—by microscopic examination of a urethral smear specimen (males only), culture, antigen detection, or nucleic acid detection

*Haemophilus influenzae infection, invasive—by culture, antigen detection, or nucleic acid detection from a normally sterile site

Hantavirus pulmonary syndrome—by antigen detection (immunohistochemistry), nucleic acid detection, or serologic results consistent with recent infection

*Hepatitis A—by detection of IgM antibodies

Hepatitis B (acute and chronic)—by detection of HBsAg or IgM antibodies

Hepatitis C (acute and chronic)—by hepatitis C virus antibody (anti-HCV) screening test positive with a signal-to-cutoff ratio predictive of a true positive as determined for the particular assay as defined by CDC, HCV antibody positive by immunoblot (RIBA), or HCV RNA positive by nucleic acid test. For all hepatitis C patients, also report available results of serum alanine aminotransferase (ALT), anti-HAV IgM, anti-HBc IgM, and HBsAg

Human immunodeficiency virus infection—by culture, antigen detection, nucleic acid detection, or detection of antibody confirmed with a supplemental test. For HIV-infected patients, report all results of CD4 and HIV viral load tests

Influenza—by culture, antigen detection by direct fluorescent antibody (DFA) or nucleic acid detection

Lead-elevated blood levels—by blood lead level greater than or equal to 10 µg/dL in children ages 0-15 years, or greater than or equal to 25 µg/dL in persons older than 15 years of age

Legionellosis—by culture, antigen detection including urinary antigen), nucleic acid detection, or serologic results consistent with recent infection

Listeriosis—by culture

Malaria—by microscopic examination, antigen detection, or nucleic acid detection

*Measles (rubeola)—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

*Meningococcal disease—by culture or antigen detection from a normally sterile site

*Monkeypox—by culture nucleic acid detection

Mumps—by culture, nucleic acid detection, or serologic results consistent with recent infection

*Mycobacterial diseases—(See 12VAC5-90-225 B) Report any of the following:

1. Acid fast bacilli by microscopic examination;

2. Mycobacterial identification—preliminary and final identification by culture or nucleic acid detection;

3. Drug susceptibility test results for M. tuberculosis.

*Pertussis—by culture, antigen detection, or nucleic acid detection

*Plague—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

*Poliomyelitis—by culture

*Psittacosis—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

*Q fever—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

*Rabies, human and animal—by culture, antigen detection by direct fluorescent antibody test, nucleic acid detection, or, for humans only, serologic results consistent with recent infection

Rocky Mountain spotted fever—by culture, antigen detection (including immunohistochemical staining), nucleic acid detection, or serologic results consistent with recent infection

*Rubella—by culture, nucleic acid detection, or serologic results consistent with recent infection

Salmonellosis—by culture

*Severe acute respiratory syndrome—by culture, nucleic acid detection, or serologic results consistent with recent infection

Shigellosis—by culture

*Smallpox (variola)—by culture or nucleic acid detection

Staphylococcus aureus infection, resistant, as defined below:

1. Methicillin-resistant - by antimicrobial susceptibility testing of a Staphylococcus aureus isolate, with a susceptibility result indicating methicillin resistance, cultured from a normally sterile site;

2. Vancomycin-intermediate or vancomycin-resistant Staphylococcus aureus infection - by antimicrobial susceptibility testing of a Staphylococcus aureus isolate, with a vancomycin susceptibility result of intermediate or resistant, cultured from a clinical specimen.

Streptococcal disease, Group A, invasive—by culture from a normally sterile site

Streptococcus pneumoniae infection, invasive, in children <5 years of age—by culture from a normally sterile site in a child under the age of five years

*Syphilis—by microscopic examination (including dark field), antigen detection (including direct

fluorescent antibody), or serology by either treponemal or nontreponemal methods

Toxic substance-related illness—by blood or urine laboratory findings above the normal range, including but not limited to heavy metals, pesticides, and industrial-type solvents and gases

Trichinosis (trichinellosis)—by microscopic examination of a muscle biopsy or serologic results consistent with recent infection

*Tularemia—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

*Typhoid fever—by culture

*Vaccinia, disease or adverse event—by culture or nucleic acid detection

~~Vancomycin—intermediate or vancomycin-resistant Staphylococcus aureus infection—by antimicrobial susceptibility testing of a Staphylococcus aureus isolate, with a vancomycin susceptibility result of intermediate or resistant, cultured from a clinical specimen~~

*Vibrio infection—by culture

*Viral hemorrhagic fever—by culture, antigen detection (including immunohistochemical staining), nucleic acid detection, or serologic results consistent with recent infection

*Yellow fever—by culture, antigen detection, nucleic acid detection, or serologic results consistent with recent infection

Yersiniosis—by culture, nucleic acid detection, or serologic results consistent with recent infection

C. Reportable diseases requiring rapid communication. Certain of the diseases in the list of reportable diseases, because of their extremely contagious nature or their potential for greater harm, or both, require immediate identification and control. Reporting of persons confirmed or suspected of having these diseases, listed below, shall be made within 24 hours by the most rapid means available, preferably that of telecommunication (e.g., telephone, telephone transmitted facsimile, pagers, etc.) to the local health director or other professional employee of the department. (These same diseases are also identified by an asterisk (*) in subsection A and subsection B, where applicable, of this section.)

Anthrax

Botulism

Brucellosis

Cholera

Diphtheria

Disease caused by an agent that may have been used as a weapon

Haemophilus influenzae infection, invasive

Hepatitis A

Influenza deaths in children <18 years of age

Measles (Rubeola)

Meningococcal disease

Monkeypox

Outbreaks, all

Pertussis

Plague

Poliomyelitis

Psittacosis

Q fever

Rabies, human and animal

Rubella

Severe acute respiratory syndrome (SARS)
Smallpox (Variola)
Syphilis, primary and secondary
Tuberculosis, active disease
Tularemia
Typhoid fever
Unusual occurrence of disease of public health concern
Vaccinia, disease or adverse event
Vibrio infection
Viral hemorrhagic fever
Yellow Fever

D. Toxic substance-related illnesses. All toxic substance-related illnesses, including pesticide and heavy metal poisoning or illness resulting from exposure to an occupational dust or fiber or radioactive substance, shall be reported.

If such illness is verified or suspected and presents an emergency or a serious threat to public health or safety, the report of such illness shall be by rapid communication as in subsection C of this section.

E. Outbreaks. The occurrence of outbreaks or clusters of any illness which may represent a group expression of an illness which may be of public health concern shall be reported to the local health department by the most rapid means available.

F. Unusual or ill-defined diseases or emerging or reemerging pathogens. Unusual or emerging conditions of public health concern shall be reported to the local health department by the most rapid means available. In addition, the commissioner or his designee may establish surveillance systems for diseases or conditions that are not on the list of reportable diseases. Such surveillance may be established to identify cases (delineate the magnitude of the situation), to identify the mode of transmission and risk factors for the disease, and to identify and implement appropriate action to protect public health. Any person reporting information at the request of the department for special surveillance or other epidemiological studies shall be immune from liability as provided by §32.1-38 of the Code of Virginia.

Subject: MRSA
Date: Thu, 25 Oct 2007 17:40:14 -0400
From: Wilson, Sara R. <sara.wilson@DHRM.VIRGINIA.GOV>
Reply-To: Wilson, Sara R. <sara.wilson@DHRM.VIRGINIA.GOV>
To: ALL_HRDIRECTORS@LISTSERVER.DHRM.VIRGINIA.GOV

We have had several inquiries from state agencies concerning the appropriate response to cases of **MRSA** in the workplace. MRSA stands for methicillin-resistant *Staphylococcus aureus*, a form of staph infection that does not respond to routine treatment with some commonly used antibiotics, although other antibiotics are effective.

Attached are documents that provide information on MRSA, with special thanks to the Virginia Department of Health for their guidance and assistance.

1. **Overview** of MRSA and basic steps for its prevention ,
2. **MRSA Fact Sheet,**
3. **Questions and Answers** about MRSA ,
4. **Workers' Compensation** MRSA claims procedures,
5. **Cleaning products** effective against MRSA.

Please note that it is not necessary to close or disinfect businesses or offices because of a MRSA infection in an employee or customer. Because the bacteria live on the skin, they may be reintroduced back into any environment at any time. Therefore, hand washing and wound care are the primary means of preventing staph infections.

Please contact your assigned human resource consultant if you have any questions that are not covered in these materials.

Sara

Superintendent's E-mail Regarding Mandatory Reporting of MRSA Infections

Governor Timothy Kaine has signed emergency regulations prepared by the Virginia Department of Health requiring mandatory reporting of MRSA infections, as a systematic means of capturing data about incidents. The emergency regulatory action requires **laboratories** to report MRSA infections confirmed from normally sterile sites of the body. The Virginia Department of Health will use the data to compile reports on the occurrences of these infections in different localities and populations across Virginia.

This data will enhance the local health department's ability to advise schools regarding the prevalence of MRSA infections in their divisions. School division superintendents are being asked to continue to work with their health departments regarding MRSA outbreaks in schools. Superintendents are encouraged to consult with their local health directors if considering closing schools due to MRSA outbreaks.

The Virginia Administrative Code at 12VAC5-90-80(B) will be amended to include MRSA and may be accessed at:
http://leg1.state.va.us/cgi-bin/legp504.exe?000+reg+12VAC5-90-80

If you have any further questions regarding MRSA, please contact Tia Campbell, school health specialist, at the Virginia Department of Education at (804)786-8671, or e-mail at Tia.Campbell@doe.virginia.gov .

Virginia Department of Health, Office of Epidemiology
October 25, 2007

MRSA: Information for State Agencies

MRSA stands for methicillin-resistant *Staphylococcus aureus*, a form of staph infection that does not respond to routine treatment with some commonly used antibiotics, although other antibiotics are effective. MRSA is becoming increasingly prevalent in community settings. Public attention surrounding MRSA underscores the need for raising awareness and preventing infection, especially in community settings such as businesses and offices. Should employee concerns over MRSA occur the following guidance may be helpful (note: healthcare settings, such as physicians' offices, may have additional requirements). Employees may also contact their local health district for further guidance.

Background
Staph infections have been around for a long time, causing mild to severe illness. MRSA may be more difficult to treat but is otherwise generally the same as a "staph infection." Mild infections may look like a pimple or boil and can be red, swollen, painful, or have pus or other drainage. More serious infections may cause pneumonia, bloodstream infections, or surgical wound infections.

MRSA outbreaks in community settings do occur. However, outbreaks typically occur among those having poor hygiene, sharing contaminated personal items or athletic equipment (e.g., sports teams), with skin-to-skin contact (e.g., family members, sexual partners), or with cuts or breaks in the skin occur.

Colonization
While 25-30% of the population is colonized with staph, approximately 1% is colonized with MRSA. Colonization means the organism is carried on the body, either in the nose or on the skin, but is not causing any symptoms or infection. As a result, an employee or customer/client could be a carrier, but not be aware of it. These individuals may spread the organism to others who could go on to develop infections.

Conditions for the Spread of Bacteria
Staph, including MRSA, are spread by direct skin-to-skin contact or contact with a shared, contaminated item. In some settings, where individuals share towels, personal hygiene items, or athletic equipment, or where individuals are engaged in close-contact (e.g., sports teams) staph could be transmitted. Risk factors for transmission of MRSA include crowding, frequent skin-to-skin contact, cuts or breaks in the skin, contaminated surfaces and shared items, poor hygiene, immune system problems, and recent surgery or other invasive procedure.

Basic Steps for Prevention
- Practice good hand hygiene and encourage staff to routinely wash hands with soap and water.
    - Alcohol-based hand sanitizer (alcohol content ≥60%) is also effective at killing staph.

- Keep wounds or cuts covered with a clean, dry bandage until healed.
- Discourage sharing of personal items (e.g., razors, nail files, towels).
- Routine cleaning with detergent- or bleach-based cleaners is recommended for disinfection. It is important to read the instruction labels on all cleaners to make sure they are used safely and appropriately. It is NOT necessary to close or 'disinfect' facilities or offices because of a MRSA infection in an employee or customer/client. Because the bacteria live on the skin, they may be reintroduced back into any environment at any time. Therefore, hand washing and wound care remain the primary means of preventing staph infections.
- Individuals infected with MRSA should NOT report this to their supervisors, unless the condition interferes with job duties or wound drainage cannot be contained by a bandage. Policies should be developed to ensure the appropriate management of this information to adequately protect the privacy of employees.
- It is not necessary to inform other personnel regarding an employee with a MRSA infection.
- Follow your sick leave policy. Unless directed by a physician, individuals with MRSA infections do not need to be excluded from work, as long as wound drainage can be contained by a bandage. Exclusion may be considered for those with wound drainage that cannot be covered and contained with a clean, dry bandage and for those who cannot maintain good personal hygiene.

Public Health Reporting
Suspected outbreaks of staph infections should be reported to the local health department (see http://www.vdh.virginia.gov/lhd/). Health department staff may be able to provide additional guidance in identifying causes of transmission, and recommendations for reducing the risk to staff.

Resources
Further information about MRSA can be found on the website links listed below:

- Virginia Department of Health (http:/www.vdh.virginia.gov)
- MSRA fact sheet
- Centers for Disease Control and Prevention (http://www.cdc.gov)

Methicillin-Resistant *Staphylococcus aureus* (MRSA) November 2005

What is MRSA?
Staphylococcus aureus ("staph") is a common type of bacteria (germ) that is often found on the skin and in the nose of healthy people. It can also grow in wounds or other sites in the body, sometimes causing an infection. For example, staph is one of the most common causes of skin infections. Penicillin is a drug that was once commonly used to treat staph infections. However, over time many staph bacteria have become difficult to treat with penicillin and antibiotics related to penicillin. These new or resistant forms of *Staphylococcus aureus* are called methicillin-resistant *Staphylococcus aureus*, or MRSA. The illnesses they cause are the same as those caused by other staph; the difference is in how they are treated.

Who is at risk for getting these organisms?
Just like normal staph bacteria, MRSA normally does not cause disease unless it enters an opening in the skin. However, some people are at higher risk for carrying MRSA or becoming infected with this type of staph. MRSA more often occurs in people in hospitals and healthcare facilities. It can also occur outside the hospital in people who receive multiple antibiotics, as well as in people who have close contact with a person carrying the germ or by touching objects contaminated with MRSA (e.g., clothes, towels, bedding, athletic equipment, benches in saunas or hot tubs, bandages).

How are MRSA and other staph spread?
Staph bacteria (including MRSA) are most often spread by close contact with infected people or the things they touch. It is not spread through the air.

What are the symptoms of infection?
Many people carry staph bacteria on their skin without any symptoms. Symptoms of a MRSA or other staph infection depend on where the infection is located. Infections of the skin are the most common, and cause symptoms such as redness, warmth, pus and a wound that does not heal. Your doctor may refer to these infections as boils, furuncles, impetigo, or abscesses. Infections can also develop in the blood, bone, bladder, lungs, and other sites. Symptoms there will depend on the site of infection, but include fever and pain at the site.

What should I do if I think I have a MRSA or other staph infection?
See your healthcare provider.

Are MRSA and other staph infections treatable?
Yes. Some staph skin infections can be treated simply by draining the sore and keeping the wound clean. For more serious infections, antibiotics can be used to treat these infections. If antibiotics are prescribed by your healthcare provider, it is very important to finish taking all the pills and to call your doctor if the infection does not get better.

What can I do to prevent MRSA and other staph infections?

• Wash your hands often, especially when you're exposed to someone with an infection or when you touch objects that may be contaminated.
• Keep cuts and scrapes clean and covered.
• Avoid sharing personal items such as towels, sports equipment, razors, etc.
• If a sore or cut becomes red, oozes, causes pain or isn't healing, see a doctor.
• Don't insist on antibiotics for colds or other viruses.
• If prescribed antibiotics, take all the pills, even if you feel better before they are all gone.

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

INFORMATION FOR EMPLOYERS AND EMPLOYEES

Community Associated MRSA Information for the Public

Questions and Answers

Released: February 3, 2005

Source: Centers for Disease Control, retrieved 10/24/07 from http://www.cdc.gov/ncidod/dhqp/ar_mrsa_ca_public.html#3

What is *Staphylococcus aureus* (staph)?

Staphylococcus aureus, often referred to simply as "staph," are bacteria commonly carried on the skin or in the nose of healthy people. Approximately 25% to 30% of the population is colonized (when bacteria are present, but not causing an infection) in the nose with staph bacteria. Sometimes, staph can cause an infection. Staph bacteria are one of the most common causes of skin infections in the United States. Most of these skin infections are minor (such as pimples and boils) and can be treated without antibiotics (also known as antimicrobials or antibacterials). However, staph bacteria also can cause serious infections (such as surgical wound infections, bloodstream infections, and pneumonia).

What is MRSA (methicillin-resistant *Staphylococcus aureus*)?

Some staph bacteria are resistant to antibiotics. MRSA is a type of staph that is resistant to antibiotics called beta-lactams. Beta-lactam antibiotics include methicillin and other more common antibiotics such as oxacillin, penicillin and amoxicillin. While 25% to 30% of the population is colonized with staph, approximately 1% is colonized with MRSA.

Who gets staph or MRSA infections?

Staph infections, including MRSA, occur most frequently among persons in hospitals and healthcare facilities (such as nursing homes and dialysis centers) who have weakened immune systems. These healthcare-associated staph infections include surgical wound infections, urinary tract infections, bloodstream infections, and pneumonia.

What is community-associated MRSA (CA-MRSA)?

Staph and MRSA can also cause illness in persons outside of hospitals and healthcare facilities. MRSA infections that are acquired by persons who **have not** been recently (within the past year) hospitalized or had a medical procedure (such as dialysis, surgery, catheters) are know as CA-MRSA infections. Staph or MRSA infections in the community are usually manifested as skin infections, such as pimples and boils, and occur in otherwise healthy people.

How common are staph and MRSA infections?

Staph bacteria are one of the most common causes of skin infection in the United States and are a common cause of pneumonia, surgical wound infections, and bloodstream infections. The majority of MRSA infections occur among patients in hospitals or other healthcare settings; however, it is becoming more common in the community setting. Data from a prospective study in 2003, suggests that 12% of confirmed MRSA infections are community-associated, but this varies by geographic region and population.

What does a staph or MRSA infection look like?

Staph bacteria, including MRSA, can cause skin infections that may look like a pimple or boil and can be red, swollen, painful, or have pus or other drainage. More serious infections may cause pneumonia, bloodstream infections, or surgical wound infections.

Are certain people at increased risk for community-associated staph or MRSA infections?

CDC has investigated clusters of CA-MRSA skin infections among athletes, military recruits, children, Pacific Islanders, Alaskan Natives, Native Americans, men who have sex with men, and prisoners.

Factors that have been associated with the spread of MRSA skin infections include: close skin-to-skin contact, openings in the skin such as cuts or abrasions, contaminated items and surfaces, crowded living conditions, and poor hygiene.

How can I prevent staph or MRSA skin infections?

Practice good hygiene:

1. Keep your hands clean by washing thoroughly with soap and water or using an alcohol-based hand sanitizer.
2. Keep cuts and scrapes clean and covered with a bandage until healed.
3. Avoid contact with other people's wounds or bandages.
4. Avoid sharing personal items such as towels or razors.

Are people who are positive for the human immune deficiency virus (HIV) at increased risk for MRSA? Should they be taking special precautions?

People with weakened immune systems, which include some patients with HIV infection, may be at risk for more severe illness if they get infected with MRSA. People with HIV should follow the same prevention measures as those without HIV to prevent staph infections, including practice good hygiene, cover wounds (e.g., cuts or abrasions) with clean dry bandages, avoid sharing personal items such as towels and razors, and contact their doctor if they think they have an infection.

Can I get a staph or MRSA infection at my health club?

In the outbreaks of MRSA, the environment has not played a significant role in the transmission of MRSA. MRSA is transmitted most frequently by direct skin-to-skin contact. You can protect yourself from infections by practicing good hygiene (e.g., keeping your hands clean by washing with soap and water or using an alcohol-based hand rub and showering after working out); covering any open skin area such as abrasions or cuts with a clean dry bandage; avoiding sharing personal items such as towels or razors; using a barrier (e.g., clothing or a towel) between your skin and shared equipment; and wiping surfaces of equipment before and after use.

What should I do if I think I have a staph or MRSA infection?

See your healthcare provider.

Are staph and MRSA infections treatable?

Yes. Most staph and MRSA infections are treatable with antibiotics. If you are given an antibiotic, take all of the doses, even if the infection is getting better, unless your doctor tells you to stop taking it. Do not share antibiotics with other people or save unfinished antibiotics to use at another time.

However, many staph skin infections may be treated by draining the abscess or boil and may not require antibiotics. Drainage of skin boils or abscesses should only be done by a healthcare provider.

If after visiting your healthcare provider the infection is not getting better after a few days, contact them again. If other people you know or live with get the same infection tell them to go to their healthcare provider.

Is it possible that my staph or MRSA skin infection will come back after it is cured?

Yes. It is possible to have a staph or MRSA skin infection come back (recur) after it is cured. To prevent this from happening, follow your healthcare provider's directions while you have the infection, and follow the prevention steps after the infection is gone.

If I have a staph, or MRSA skin infection, what can I do to prevent others from getting infected?

You can prevent spreading staph or MRSA skin infections to others by following these prevention steps:

1. **Cover your wound.** Keep wounds that are draining or have pus covered with clean, dry bandages. Follow your healthcare provider's instructions on proper care of the wound. Pus from infected wounds can contain staph and MRSA, so

keeping the infection covered will help prevent the spread to others. Bandages or tape can be discarded with the regular trash.

2. **Clean your hands.** You, your family, and others in close contact should wash their hands frequently with soap and warm water or use an alcohol-based hand sanitizer, especially after changing the bandage or touching the infected wound.
3. **Do not share personal items.** Avoid sharing personal items such as towels, washcloths, razors, clothing, or uniforms that may have had contact with the infected wound or bandage. Wash sheets, towels, and clothes that become soiled with water and laundry detergent. Drying clothes in a hot dryer, rather than air-drying, also helps kill bacteria in clothes.
4. **Talk to your doctor.** Tell any healthcare providers who treat you that you have or had a staph or MRSA skin infection.

What should I do if someone I know has a staph or MRSA infection?

If you know someone that has a staph or MRSA infection you should follow the prevention steps.

EMPLOYER INFORMATION
MRSA (Methicillin-Resistant *Staphylococcus aureus*) AND THE WORKERS' COMPENSATION PROCESS

MRSA is a type of staph that is resistant to certain antibiotics. For workers' compensation purposes, a MRSA infection may be considered an ordinary disease of life. Ordinary diseases of life are those to which the general public is exposed outside of the employment. Under some circumstances, ordinary diseases of life may be covered by workers' compensation. If you have an employee who develops a MRSA infection and reports it to you as work-related, you should file the claim with the Office of Workers' Compensation for investigation.

Tips for filing claims

- Use the date the employee was diagnosed with MRSA and told by their physician that the infection was work-related as the date of injury.
- Include any information that you may have about the source of the employee's exposure; for example, was it a co-worker, customer, patient, inmate, etc.
- If known, include any documentation to show that the source of the exposure was positive for the disease.
- If known, include information on possible route of transmission of the disease; for example, breaks in the skin.
- If known, document the dates the employee was exposed to the known source.
- Medical records for the employee will be obtained and reviewed and a statement may be obtained from the employee.
- In cases of suspected MRSA, you may wish to consider including the employee's personal physician or the physician who diagnosed the MRSA infection to the panel you offer affected employees due to the unique nature of this condition.

Investigation Process

The Benefit Coordinator will need to document certain information to make a recommendation on the claim's compensability:

- Has there been a plausible **route of transmission** for the disease that may have occurred during the course and scope of employment?

- Was the **source positive** for MRSA?

- If the employee tests positive for disease, does the evidence support that the disease was contracted in the course of the employment, arose out of the employment, did not result from causes outside of the employment, is characteristic of the employment and was caused by conditions peculiar to the employment?

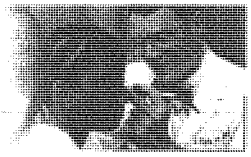
- If a claim is accepted as compensable coverage would be provided for authorized time out of work based upon approval of disability from the panel physician, testing and medical care for MRSA.
- If the claim is denied, a letter explaining why the claim has not been voluntarily accepted will be sent to the agency, the employee and the Virginia Workers' Compensation Commission. The employee's letter will instruct them to utilize their health insurance and VSDP benefits for medical care and disability.

INITIATIVES

LEADERSHIP LOG-IN
Forgot your password?
user name go

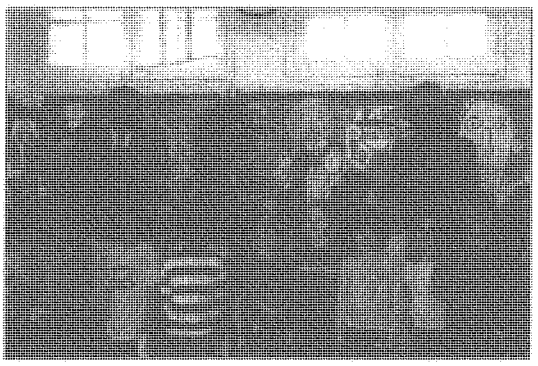
antibiotic resistance awareness campaign

Acting as a Catalyst...
By Addressing Specific
Health Issues in Virginia.



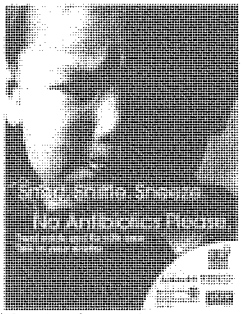
In 2003, the MSV Foundation and the Virginia Department of Health kicked off the *Get Smart Virginia: Know When Antibiotics Work* antibiotic resistance awareness campaign. The focus of this initiative is to promote the message that antibiotics need to be used appropriately and judiciously. The campaign has a broad base of support: both the Virginia Academy of Family Physicians and the Virginia Chapter of the American Academy of Pediatrics have endorsed the project. In addition, Governor Mark Warner and Governor Tim Kaine each designated a week in October as appropriate antibiotic use awareness week.

Based on the Centers for Disease Control guidelines, the MSV Foundation and the Virginia Department of Health have jointly developed a variety of educational resources and tools. These are being used in physician offices, clinics, schools, pharmacies, daycare centers, and other venues to educate the public about appropriate antibiotic usage. Tens of thousands of these materials have been distributed across the Commonwealth. These educational tools and resources are available free of charge to health care professionals and community organizations in Virginia.



back to top

Antibiotic Resistance:
Resources & Tools
Partners & Sponsors
Get Involved



Click here to enlarge poster.

INITIATIVES

LEADERSHIP LOG-IN
Forgot your password?

user name go

ANTIBIOTIC RESISTANCE AWARENESS CAMPAIGN

RESOURCES & TOOLS

Physicians, other health professionals, and community organizations can place orders for printed materials and other resources designed to educate the public about the differences between bacterial and viral infections and how to appropriately use antibiotics. The materials are provided at no charge. They can either be downloaded from the web or requested by faxing or emailing your order form to 804.377.1056 or knagy@msv.org.

Downloadable Materials:

- "What You Need to Know About Antibiotics" Brochure
- Condensed Antibiotic Resistance Information Sheet
- Viral Prescription Pad (English)
- Viral Prescription Pad (Spanish)
- Viral Prescription Pad – Pediatric
- Germ-buster cut-out and color work sheet
- Germ-buster maze
- Germ-buster song
- Germ-buster word jumbles
- Self-Care Guide
- "Wash Your Hands" Poster

Additional Web Resources:

- The Virginia Department of Health's Get Smart Virginia Campaign
- The Centers for Disease Control Get Smart Campaign
- Johns Hopkins Antibiotic Guide for your handheld (downloadable)
- The Council for Affordable Healthcare's Save Antibiotic Strength Campaign
- Do Bugs Need Drugs?: A Community Project for Wise Use of Antibiotics

You may need to download Adobe Reader to view the above files.
To download, click on the following image.

INITIATIVES

LEADERSHIP LOG-IN
Forgot your password?
user name go

ANTIBIOTIC RESISTANCE AWARENESS CAMPAIGN

PARTNERS & SPONSORS

The following organizations have partnered with the MSV Foundation to support the appropriate use of antibiotics.

Partners:

American Academy of Pediatrics
DEDICATED TO THE HEALTH OF ALL CHILDREN™
Virginia Chapter

Anthem

GET SMART VIRGINIA
Know When Antibiotics Work

VDH VIRGINIA DEPARTMENT OF HEALTH
Protecting You and Your Environment

Sponsors:

Anthem

Pfizer

Mr. TOWNS. Thank you very much, Dr. Burns.
Dr. Bancroft, we will hear from you now.

STATEMENT OF ELIZABETH A. BANCROFT, M.D., S.M.

Dr. BANCROFT. Thank you. I am pleased to be here to present a public health context of community MRSA.

As has well been testified earlier today, the recent CDC study estimated there is approximately 94,000 invasive infections of MRSA in the United States each year. And this is greater than the combined number of infections caused by the most invasive bacterial organisms that we commonly follow in public health, including group A strep and pneumococcal disease, which is another important antibiotic-resistant infection. Furthermore, the number of estimated deaths associated with MRSA, approximately 18,000, exceeds the number of deaths due to HIV/AIDS, though all of those death with MRSA may not have actually been due to that organism. On the other hand, the estimated number of deaths due to MRSA is only half the estimated number of deaths due to influenza in the United States, to help put this disease into perspective.

Community MRSA has been well described, occurs in those who have not had any significant exposure to healthcare in the year prior to their infection. It comprises only 14 percent of all invasive MRSA infections and has a rate of infection in the community, at least for the invasive kind, within the range of other significant community organisms. Furthermore, only 6 percent of community MRSA cases results in invasive disease. The vast majority of community MRSA cases are skin and soft tissue infections, and many of these infections can be cured by a simple drainage procedure and may not even require antibiotics. In fact, we would prefer that doctors hold off on treating many of these cases with antibiotics so as not to have the organism develop further resistance to the antibiotics.

Despite all the media attention on children with MRSA, the two CDC studies have demonstrated that school-age children 2 to 17 years are at lowest risk for being diagnosed with community MRSA, at lowest risk for having invasive disease due to community MRSA and at lowest risk for dying due to community MRSA. So while the media attention is understandable on the children, the children actually have the lowest risk of acquiring this disease. Though community MRSA is relatively benign compared to healthcare MRSA, outbreaks of skin infections due to this organism tax the public health system, as can you see what happened in Virginia.

In Los Angeles County, we have been addressing community MRSA since 2002, when we first investigated outbreaks of skin infections due to this organism in diverse settings, including the jail, men who have sex with men and an athletic team. We have developed extensive health education for consumers and healthcare workers, including some really gross pictures of skin infections in order to get people's attention. In conjunction with the CDC, we developed guidelines for preventing the spread of staph in community settings. And back in 2004, we actually disseminated those prevention guidelines to homeless shelters, schools and gyms.

Though there has been a lot of media attention on children, our largest outbreak has actually been in the Los Angeles County Jail, where more than 3,000 cases of MRSA skin infections have been diagnosed in each of the past several years. The county has spent literally millions of dollars trying to reduce the spread of MRSA in the jail. And only now, after 5 years, are we seeing a leveling off of these infections, though I doubt we are actually going to completely eliminate these infections because of the close, crowded living conditions in the jail, because of the substandard hygiene that is often in a jail, and because these infections are often reintroduced into the jail by people in the community who have the infection and bring it into the jail.

Separately, we have also had to address concerns by firefighters, police, paramedics, social workers and sheriffs' deputies and other first responders who are worried about getting this infection on the job. For example, I recently had a call by a social worker who refused to go into the home of a foster child because that child had MRSA. So there is a lot of hysteria surrounding this disease, especially in our first responders.

Controlling community MRSA, as you have heard, or any outbreak of skin infections is not rocket science. We know the basics: hand washing, maintaining good hygiene, limiting sharing of personal items and keeping draining infections covered with a clean, dry bandage. However, there are still questions as to the role of the environment and the transmission of this infection; if and when to perform surveillance for MRSA, there are many pros and cons for performing surveillance; and how best to control outbreaks with minimal interventions and maximal impact. And we want and are looking forward to working with CDC and other public health agencies to address these questions. Thank you.

[The prepared statement of Dr. Bancroft follows:]

Testimony of Elizabeth A Bancroft, MD to the House Committee on Oversight and Government Reform on "Drug Resistant Infections in the Community: Consequences for Public Health"

Wednesday, November 7, 2007

Good Morning. I want to thank the Committee for the opportunity to talk to you about MRSA and antibiotic resistance in the community.

According to a CDC study published October 17, 2997, in the Journal of the American Medical Association, the rate of invasive MRSA, meaning MRSA that has gotten to the blood, spinal fluid or other deep body sites, was greater than the combined rate of invasive disease caused by the most significant bacterial infections that we commonly follow in public health (including group A strep [the so-called "flesh eating disease"], and pneumococcal disease, another important antibiotic resistant infection). Furthermore, the number of deaths associated with invasive MRSA, approximately 18,000, was estimated to exceed the number of deaths due to HIV/AIDS. On the other hand, the estimated number of deaths due to MRSA is only half of the estimated number of deaths due to influenza in the United States each year (36,000 deaths) which is, or should be, a largely preventable infection.

In the same way that there are 2 main strains of politicians in Washington, Republicans and Democrats, it is important to recognize that there are 2 main "strains" of MRSA: healthcare associated MRSA and community associated MRSA. Healthcare associated MRSA occurs in people who have had significant exposure to healthcare (hospitalization, surgery, dialysis, nursing home) in the year prior to their infection. It tends to affect the elderly and is associated with a relatively high rate of death. In contrast, community MRSA occurs in those who have not had any significant exposure to healthcare in the year prior to their infection. It comprises only 14% of all invasive MRSA infections, is sensitive to many oral antibiotics, and results in many fewer deaths than healthcare MRSA. From laboratory studies, it appears that the strains of healthcare MRSA and community MRSA arose separately and that community MRSA is not simply a rogue hospital strain.

The media have commonly confuse the 2 strains of MRSA, conferring the attributes of healthcare MRSA (invasive disease and high rate of death) to that of community MRSA. Much of the recent media has focused on deaths due to MRSA in school children. However, according to the CDC study, the lowest rate of invasive MRSA occurs in school age children 2-17 years and the death rate in children with community MRSA was estimated to be 0, though obviously there can be exceptions. Only 6% of community MRSA cases result in invasive disease. The vast majority of community MRSA cases are skin and soft tissue infections. Many of these infections can be cured by a simple drainage procedure and may not even require antibiotics.

Despite the relatively low burden of invasive disease caused by community MRSA, outbreaks of skin infections due to this organism tax the public health system and the

facilities in which they occur. For example, just one case of an MRSA skin infection in a school recently resulted in the closure of a school system for environmental decontamination. This causes disruption to the school system, students, and their parents, and is not consistent with any public health recommendations.

In Los Angeles County, we have been addressing community MRSA since 2002 when we first investigated outbreaks of this organism in diverse settings including the Jail, men who have sex with men, and an athletic team. We have developed extensive health education for consumers and healthcare workers about community associated MRSA along with graphic pictures illustrating the range of infections caused by this bug. Separately we have had to address concerns by fire fighters, the police, paramedics, social workers, and sheriff's deputies who are worried about getting this infection on the job. In conjunction with the CDC, we developed guidelines for the prevention of Staph in non-healthcare settings and have disseminated those to homeless shelters, schools, and commercial gyms. Though the media concentrates on children with MRSA, our largest recurring outbreak has been in the Los Angeles County Jail where more than 3,000 cases of MRSA skin infections have been diagnosed in each of the past several years. The County has spent millions of dollars trying to reduce the spread of MRSA in the Jail and only now, after 5 years, are we seeing a leveling off of infections. However, with the constant re-introduction of this organism into the Jail from the community and the close, crowded living conditions inherent in correctional facilities, I don't think that we will be able to eliminate these infections.

Controlling community MRSA, or any outbreak of skin infections, is not rocket science. We know the basics: handwashing, maintaining good hygiene, limiting sharing of personal items, and keeping draining infections covered with a clean, dry bandage. There are still some questions as to the role of the environment, if and when to perform surveillance for MRSA, and how best to control outbreaks with minimal interventions and maximal impact. We want to work with CDC and other public health agencies to address these questions.

Finally, healthcare acquired infections are conservatively estimated to cause 100,000 deaths a year in the United States. MRSA may only cause ~10% of hospital acquired infections so controlling MRSA in hospitals must be seen as a part of a larger effort to control all healthcare acquired infections. Controlling healthcare acquired infections can be accomplished with evidence based interventions including handwashing, isolating patients, and using vigorous infection control techniques when performing invasive medical procedures. These techniques are well known but they are imperfectly and intermittently practiced. We lack enforcement agencies that will regularly inspect hospitals and hold them to infection control standards. In public health, we routinely inspect restaurants more often than we inspect hospitals. Simply put, we need to same resources that we use for inspecting restaurants to inspect hospitals. We need to hold hospitals to the same standards as we hold McDonalds. The good news is that all the interventions used to control MRSA, in the community and in healthcare, will also control the spread of other infections.

Mr. TOWNS. Thank you very much, Dr. Bancroft.
Dr. Daum.

STATEMENT OF ROBERT S. DAUM, M.D.

Dr. DAUM. Good afternoon. I am delighted to have this opportunity to communicate information regarding what I consider to be epidemic community-associated MRSA disease in Chicago and in most locales in the United States. I am a pediatrician. I take care of patients, children with MRSA and severe MRSA infections all the time. I also have a laboratory, where I look at both basic and applied research questions related to MRSA.

I am here today on my own support, because I feel that this is an important question that should be sort of discussed and dealt with. It is important to recognize that I have been in practice, in hospital-based infectious disease practice, in pediatrics since 1978, and I have never seen anything like what I have seen in the last decade. The problem is here; it is certainly not going away. In the last 6 weeks at our institution alone, we admitted five children to the hospital with severe invasive MRSA infections that require prolonged stays in the hospital, prolonged antibiotics and prolonged use of medical resources.

When MRSA was first recognized in 1960, shortly after the introduction of it as an antibiotic, we had the good luck of having it remain confined largely to healthcare environments. But the situation changed dramatically in the mid-1990's when we started noticing MRSA infections in perfectly healthy children and adults in the community who had not had any healthcare exposure at all. These infections might be just skin and soft tissue infections for the most part, and that is true, but in fact, they are frequent and often require hospitalization for aggressive surgical drainage and prolonged antibiotics.

What we realized fairly shortly after the onset of this epidemic in the community around the year 2000 was that the MRSA strains that were in the community were not what everybody thought was happening at first, and that is to say, the hospital strains migrating out into the community. These were novel strains that had arisen in the community, and they are both antibiotic-resistant, and they have virulence factors and virulence properties that the hospital strains do not have.

It is important to understand that nothing is Black and White, and the hospital strains have migrated out into the community to some extent. But what is driving epidemic disease at our center and in most centers around the United States is in fact these novel strains that are out in the community. Work is going on as to try and identify what the toxins are, what the genes are that these novel strains have that are able to make it cause severe disease, but to date, they have not been found.

I would like to call attention to a couple of slides very quickly that I brought. This is my assistant's concept of a pyramid. And you can see, as you heard this morning—I won't belabor it—that asymptomatic colonization is the most common manifestation by far and then skin and soft tissue infection. But at the top of that pyramid is a substantial health burden, in children and adults, of severe invasive disease that is really beginning to tax our

healthcare system. We don't know a lot of information that we need to know about how this organism is so successful at spreading in the community. Household contacts are frequently themselves involved with these MRSA infections, implying that this is a very contagious disease. Other examples of close contact situations that you have heard about include daycare centers, military installations, correctional facilities and athletic facilities.

Before this MRSA epidemic began, such evidence of spread in these groups was extremely rare and hardly ever described. In addition, there may be some racial and ethnic group predisposition. Native Americans, Pacific Islanders are two examples of groups that might possibly have some predisposition to this. Careful epidemiology badly needs to be done to determine what the exact risk of various members of our community are.

We heard this morning that colonization rates asymptomatically are 0.9 or 1 or 2 percent. In some institutions where they are having epidemic disease, colonization rates of 9 or 10 percent have been reported. In most U.S. cities, community MRSA is now the most common pathogen isolated from skin and soft tissues presenting to emergency rooms. And USA 300, the so-called community strain, is responsible for 97 percent of them.

So if we could see the next slide really briefly, and hit the first PowerPoint, whatever, necrotizing pneumonia is one of the severe community syndromes. That is normal long on the left. It looks like a sponge. Those white spaces are where we exchange oxygen. If we could press it again. This is a child with necrotizing pneumonia who died. Necrotizing pneumonia is all too common with this. And you can see those blue things in the field are staphylococcal colonies, and the red stuff is blood.

Next slide, please. This is a child who died and with a novel staphylococcal syndrome caused by community MRSA strains. You can see the rash that he had made it look like a kind of meningitis called meningococcal disease that patients and teenagers are known to die from. This is a novel finding that has not been described before among staphylococcal disease.

Next, and finally, these patients who died, this is the adrenal gland, which is an endocrine gland, sits on top of the kidney, nice normal layers of cells on the right. Next you can see that is this adrenal hemorrhage. And this is a mode of death from severe community MRSA disease. This was novel enough to get published in the New England Journal of Medicine. Before the onset of epidemic community MRSA, this was never seen before.

So just to go very briefly to a couple more points, the MRSA epidemic has changed the paradigm of clinical practice. No longer can we use penicillins and cephalosporins for routine treatment of putative staph infections. We are forced to rely on older drugs like clindamycin and Bactrim now as the front line drugs. These drugs have not been adequately evaluated for community MRSA. They are tough horses to ride. They are old antibiotics. Vancomycin, the so-called antibiotic of last resort used to treat inpatients with severe community MRSA disease that needs hospitalization, is starting to erode, with global decreasing resistance noted across the country. Screening tests, people have been desperate enough to do something about this that they felt like they have to institute pro-

cedures that don't make a lot of purse sense to me personally, screening tests performed at the entrance to the hospital. The epicenter of community MRSA is no longer in the hospital. We spent the morning talking about it. But the problem has now shifted to the community. Identifying carriers at the door of the hospital has created a lot of anxiety among people that are colonized and not sick. They call, and they e-mail me, what should they do now? We have no answers for them. We don't know what the notion is that someone is identified as a carrier, what their disease attack rate is.

. If that is for me, I just want to finish by saying that I think this is the epidemic now. This is not like bird flu, which I am not denigrating the importance of that, which is something we do need to work on and prepare for, but this is happening now. Dr. Bancroft and the CDC authors of the JAMA paper concluded that this is a major and enormous public health burden. We need to fill the resources in with the multiple information gaps with how MRSA is spreading in our community. We don't know how that is happening, and we have a lot, a lot of missing information. Both the NIH and the CDC, in my opinion, have to massively increase their agenda and fund efforts to control this infection. The STAAR Act, as part of the Infectious Disease Society of America initiative, will go a long way to fill in this huge amount of missing information. I apologize for going over and thank you very much.

[The prepared statement of Dr. Daum follows:]

A presentation by:

Robert S. Daum MD
Professor of Pediatric Infectious Diseases
University of Chicago
rdaum@peds.bsd.uchicago.edu

November 7, 2007

I am delighted to have this opportunity to communicate information regarding epidemic community-associated methicillin-resistant *Staphylococcus aureus* (CA-MRSA) disease that we are experiencing in Chicago and most locales in the United States.

My presentation today includes two recent articles that I hope will be helpful. The first is called "Community-Associated Methicillin-Resistant *Staphylococcus aureus*," by Susan E Crawford, Susan Boyle-Vavra and myself. The second is entitled "Skin and Soft Tissue Infections Caused by Methicillin-Resistant *Staphylococcus aureus*." My hope is that these two recent review articles will provide helpful background material. In this document, I would like to highlight a few points representing my views and concerns regarding the current CA-MRSA.

The term methicillin-resistant *Staphylococcus aureus* refers to bacterial isolates that are resistant to all penicillin-type antibiotics and cephalosporin antibiotics that are currently available. The term methicillin resistant *Staphylococcus aureus* isolates, or MRSA, has persisted despite the fact that methicillin is no longer used clinically. When methicillin was introduced into clinical practice in the early 1960s, some MRSA isolates were noted almost immediately. Over the next several decades, their prevalence slowly increased. It

wasn't until the mid 1970s that these MRSA infections were recognized in the United States. Previous reports had emanated from Western Europe and Australia.

Even after their recognition in the United States, MRSA isolates remained confined to the health care environment – almost exclusively. Thus, if you were a patient who frequented such environments because, for example, you had a chronic illness or the need for recurrent medical attention, you were at risk for acquiring MRSA. Healthy persons in the community who did not frequent such environments generally did not encounter MRSA.

The situation changed in the mid-1990s with the detection of MRSA infections in the community. People who had not had contact with the health care system began presenting with MRSA infections, often sick enough to require hospitalization. What was apparent, almost immediately, was that the MRSA bacteria isolated from these "health care risk free" patients in the community appeared to be different from the MRSA bacteria found in the health care environment. That is to say, the *Staphylococcus aureus* bacterial strains were different. The differences included susceptibility to most antibiotics besides penicillin and cephalosporins. In contrast to the hospital-associated strains, the community strains were usually susceptible to non-penicillin, non-cephalosporin antibiotics, whereas the hospital strains were commonly resistant to them. Moreover, molecular typing of these so-called community isolates revealed that the community-associated strains of MRSA affecting healthy people in the community were not the hospital strains simply migrating into the community (although that has also occurred to some extent), but rather the development of novel strains that have arisen *de novo*. This is

a crucial point that many people trying to understand the CA-MRSA epidemic have not yet grasped.

Thus, so-called health care-associated MRSA strains and community-associated strains are only distant cousins to each other and exhibit susceptibility to different antibiotics. For example, CA-MRSA strains are more susceptible to clindamycin and less resistant to multiple non-penicillin, non-cephalosporin antibiotics than healthcare-associated MRSA. Another distinguishing feature of these community MRSA isolates is a high prevalence of genes encoding a toxin called the Panton Valentine leukocidin or PVL. This toxin is present in nearly all community-associated MRSA strains and very few (less than 5 percent) of hospital-associated MRSA strains. The role of PVL in causing the community MRSA disease is controversial and is the subject of ongoing research. Additionally, the community strains contain novel DNA cassettes, or pieces of DNA that insert themselves into the bacterial chromosome, that express the methcillin resistant phenotype. These DNA cassettes are small and presumably promiscuous. That is to say, they spread from strain to strain relatively easily and have been identified for the first time in community strains. Hospital MRSA strains contained similar cassettes but they are much larger in size and presumably less able to move from strain to strain.

Reports have suggested that these new community MRSA strains are easily transmissible in settings where people are in close contact. For example, multiple members in the household are frequently plagued by skin and soft tissue infections. Other examples of close contact situations include daycare centers, military institutions, correctional

facilities, and athletic facilities. Before the community MRSA epidemic began, such evidence of contagion among close contacts was infrequent. Other groups that have been reported to be at increased frequency for community MRSA infections include Native Americans, Pacific Islanders and men who have sex with men. Careful epidemiology needs to be done to demonstrate whether reporting of outbreaks or clusters of cases in these groups truly represents high risk or reporting artifacts.

Individual institutions have similarly reported large increases in the occurrence community-associated MRSA infections. In particular, at Driscoll Children's Hospital in Corpus Christi, the number of MRSA infections increased from 9 per year in 1999 to 459 per year in 2003. Similar increases have been documented at Texas Children's Hospital in Houston. In most US cities, community-associated MRSA is the most common pathogen isolated from skin and soft tissue infections presenting to Emergency Rooms, although, curiously, the epidemic has not still yet spread to all regions of the United States. It is noteworthy that CA-MRSA not only stays in the locales it invades, but spreads to new locales daily.

The most common manifestation of community-associated MRSA infections is asymptomatic colonization, usually of the nose, throat and, occasionally, of the skin. Several studies have suggested that the incidence of such asymptomatic colonization is increasing both in children and adults. Rates approaching 10 percent have been documented among healthy children in Nashville and among adolescents and adults in Atlanta.

Among patients with clinical disease, skin and soft tissue infections (SSTIs) represent the most frequent disease syndrome. SSTIs probably account for 75 – 80 percent of individuals who become ill with community MRSA. Interestingly, SSTIs often resemble the bite of a spider although these lesions are found persons that live in areas where the species of spiders do not produce bite like this. The reason these lesions look like spider bites is not clear, although some have attributed it to the PVL toxin, which is locally dermonecrotic (kills the skin), described above.

A number of new, or at least more severe, community MRSA infections have also accompanied the advent of invasive CA-MRSA disease. In particular, an aggressive form of pneumonia called necrotizing pneumonia has been documented and is a cause of morbidity, the need for intensive care, and severe lung infections. The term necrotizing refers to an infection that actually destroys part of the lung that it is infecting. In addition, necrotizing fasciitis, a disease that requires immediate surgical removal of dead tissue as well as antibiotic therapy, has been described with community-associated MRSA infections. A novel clinical syndrome called septic phlebitis (infection of the vein) with pulmonary embolization has occurred particularly in large veins in the pelvis and particularly among adolescents. This severe infection often presents with fever and a limp. It is frequently misdiagnosed. It requires admission to the hospital and often to intensive care units. Patients with this "pelvic syndrome" often have the need for frequent visits to the operating room to evacuate pus from the pelvic region. They often have infections of the pelvic bones and joints such as the hip joint. The most severe of the

CA-MRSA syndromes is called severe sepsis, sometimes with purpura fulminans, an aggressive hemorrhagic skin rash and the Waterhouse Friderichsen Syndrome or hemorrhage into the adrenal glands, often a fatal event.

The advent of epidemic CA-MRSA has posed a number of emergent issues. First, it has changed the paradigm of medical practice. No more can clinicians pull a ß-lactam (penicillin or cephalosporin) off the shelf with confidence that it will reliably treat a patient seeking urgent care for a skin and soft tissue infection. Practitioners have been forced to resort to old drugs with minimal track records in the therapy of any *S. aureus* infection such as clindamycin or trimethoprim/sulfamethoxazole (TMP/SMX, Bactrim or Septra). It is not known how well these compounds actually work in the therapy of CA-MRSA disease. The National Institutes of Health has come to the rescue, funding two large trials to evaluate these agents, scheduled to begin in mid-2008. Linezolid has emerged as a new alternative but is very expensive. Resistance has already become a clinical issue, especially for clindamycin and linezolid.

For patients ill enough to require hospitalization, there are also new problems and ominous black clouds on the horizon. Vancomycin, long the antibiotic of last resort reserved for hospitalized patients with MRSA infections, has begun to undergo serious erosion. Frank resistance has emerged and is a growing concern. Moreover, a phenomenon called MIC creep has emerged whereby *S. aureus* isolates have become steadily and globally less susceptible to this crucial antibiotic. There are, to be sure, several so-called beyond vancomycin compounds. They are few in number and all have

problems. For example, the newly licensed daptomycin has not been evaluated in children. Higher doses have been associated with increased toxicity in adults. The drug is ineffective in pneumonia, a common *S. aureus* syndrome. Worse, resistance occurs frequently during therapy. Tigecycline has a very broad antibacterial spectrum, too broad for treating solely CA-MRSA infections. It is also not suitable for therapy of children because it is a cousin to tetracycline and can stain bones and teeth. **We need new antibiotics.**

In some instances, technology and the drive to "do something" has outstripped our ability to construct paradigms to deal with new tests. For example, it is now possible to detect MRSA on a swab placed into the nostril to identify carriers. The problem here is simple. We have no data on the meaning of such detection. Is the person at risk for disease? Is the person at risk to spread MRSA to others? How should we deal with the anxiety that identification of such carriers creates? I receive emails from people identified as carriers who ask me what it means that they carry MRSA and if they should take action. We do not have an effective strategy to eliminate carriage. Nor do we know if it is even necessary. The State of Illinois has responded to the presence of this test by enacting legislation requiring screening and isolation of all patients admitted to ICUs. While at first glance, this may sound like a helpful strategy, it is an expensive program that is likely, at best, to effect a modest reduction in ICU transmission of MRSA. It offers multiple downsides; it is expensive, it provides false reassurance that it will diminish the overall burden of MRSA disease, and it creates a new cohort of anxious individuals who may (or may not) be carriers with no real strategy to change their carrier status.

Expanding screening programs with our present state of knowledge is not the way to proceed!

A recent paper from the public health sector published in the JAMA calls attention to rates of invasive MRSA disease in the ABC surveillance network much higher than had been believed. Most of these infections had their onset in the community. There are several crucial inferences from the ABC network data. First, invasive infections and the mortality caused by them is only the tip of the iceberg. If these rates reflect the burden of invasive MRSA disease, one has to suppose that the incidence of MRSA disease prompting medical attention is an order of magnitude higher. **Invasive MRSA infections in general, and CA-MRSA in particular, constitute an enormous and pressing public health problem.**

The ABC data have been widely interpreted as a wake-up call for better prevention and reporting of MRSA infections in hospitals. One can hardly counter this. There are too many nosocomial infections and we tolerate them far too much. However, the epidemiology of MRSA has changed. The hospital is no longer the epicenter. The focus has moved to the community. The ABC network data tell us this: **about 2/3 of the invasive disease detected by this network had an onset in the community.**

What are the lessons we have learned from the aggregate and growing literature on our ongoing epidemic of CA-MRSA disease in the United States? First, CA-MRSA is the epidemic now. The CDC authors and JAMA editorialist Dr. Elizabeth Bancroft conclude

that this is an enormous public health burden. We must act. We need to create resources to fill in the multiple information gaps created largely by the continuing focus on MRSA in hospitals instead of MRSA in the community. We need to immediately institute a multi-pronged program to provide the missing information. We must answer the following questions regarding the epidemiology of CA-MRSA: Who is at risk? How do the novel organisms responsible for much of the community disease spread? Which interventions work and which do not work? Is there an important role for inanimate objects (fomite transmission) such as athletic equipment, towels, linens, etc, that helps to account for high rates of transmission on athletic teams, in households, and in jails? **We need an enhanced CDC effort to answer these questions and to help us define MRSA in the community, study its new epidemiology and find methods to control it.**

The NIH is the public institute that clearly sets our research agenda. We require their support in helping us build targeted research programs that address the following lengthy list of questions: What do the novel CA-MRSA isolates have that make them such effective pathogens? Which of their genes is the "new" virulence determinant (s)? What is the role of the ubiquitous PVL genes? Are they virulence determinants or are they markers for something else that is? What is the best method for treating MRSA infections? Which antibiotic is best for managing skin and soft tissue infections in outpatients? Which parenteral drugs are best for in-patients? What is the best way to foster the development, identification and deployment of new antibiotics? How do the antibiotics we have now actually work? How do bacteria strategize to become resistant to antibiotics and what can we learn about watching how they do this? Our current system is

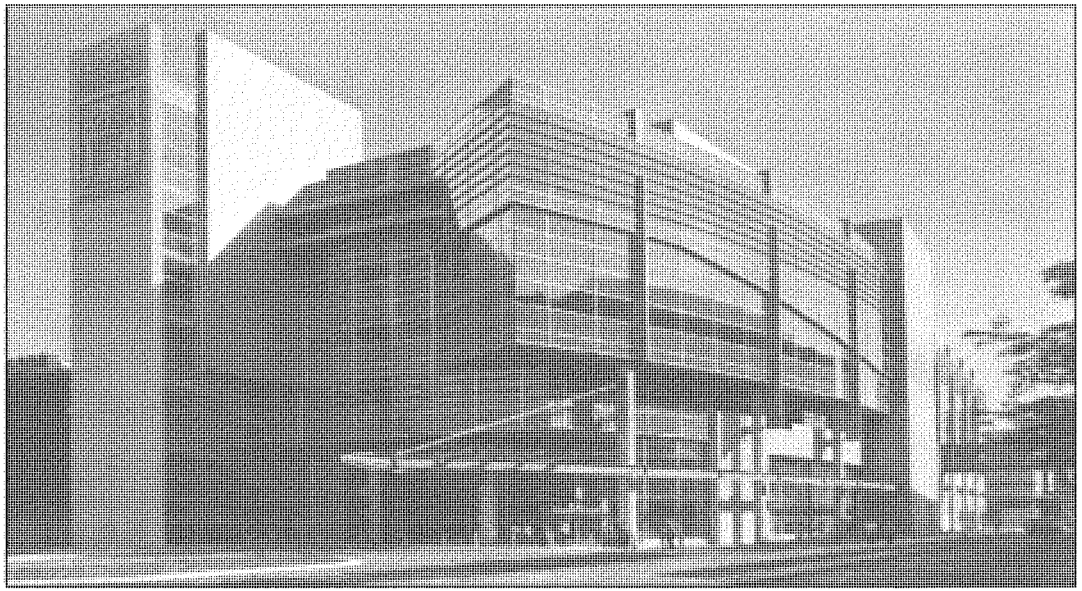
not serving us optimally; the identification of new targets for antimicrobials has drastically slowed. What is the best formula to re-energize this process? There are no easy answers for this area. I suggest a blue ribbon panel consisting of industry, academic experts, and public health experts to survey the state of the art of antibiotic development and devise strategies to assist the ailing process.

There are more questions to be answered. How do human beings become immune to *S. aureus* infections? Some have suggested that immunity is sufficiently poor and that the recurrence rates of MRSA disease are unacceptably high. Why is this? How can it be overcome? These basic questions will also require an NIH initiative. We need new programs targeted at understanding how a common commensal pathogen, *S. aureus,* is able to fly under the radar and elude our immune system all too often.

Finally, as a pediatrician, I recognize MRSA as a disease that is more and more difficult to treat with increasing rates of invasive disease; my thoughts turn to the development of a vaccine. The idea that a universal vaccine directed against *S. aureus* would be a useful strategy to prevent invasive disease has been belied by the belief that the general population is not at high risk for invasive infections. The ABC surveillance data change that. The rates of disease described by the public health sector authors in the JAMA article are among the highest for any invasive bacterial infection for which the general population is at risk. Vaccine development must therefore be considered a priority, and a directed program should be initiated by the NIH to foster vaccine development investigative groups in both industry and academic institutions.

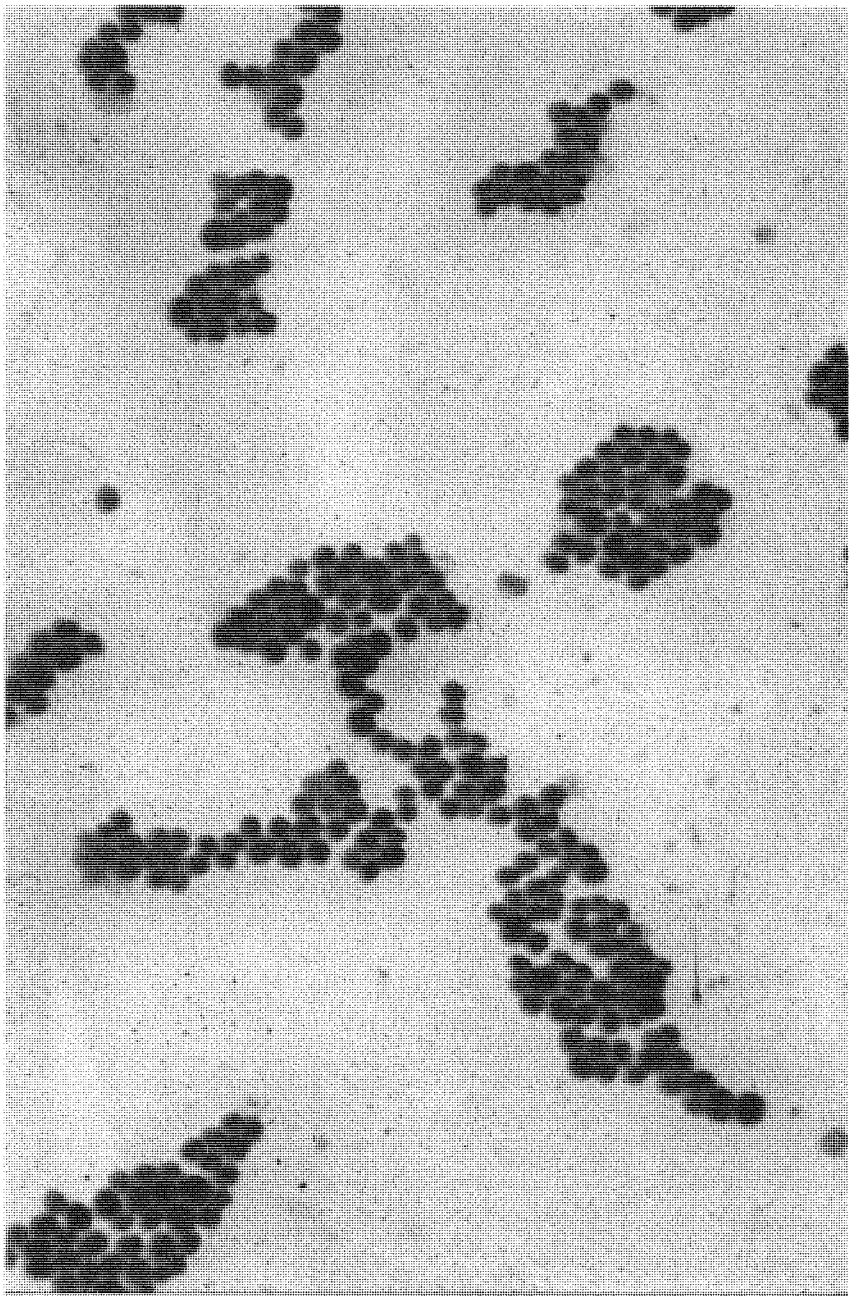
I hope these perspectives are helpful. MRSA is only one of many antimicrobial resistant infections plaguing our population. Multiply resistant Acinetobacter and extended spectrum ß-lactamases also require our attention. At this time they largely remain confined to the hospital, but cause too many complications in patients, particularly those requiring intensive care. The Infectious Diseases Society of America (IDSA) has an Antibiotic Resistance Working Group (of which I am a member) that is working with several congressional groups, including the sponsors of the STARR legislation, and a new initiative from Senator Durbin's office to foster the needed global attack on these problems. More needs to be done. The CA-MRSA epidemic truly requires an intense new effort to achieve control and elimination. We owe our children and adults nothing less. Thank you.

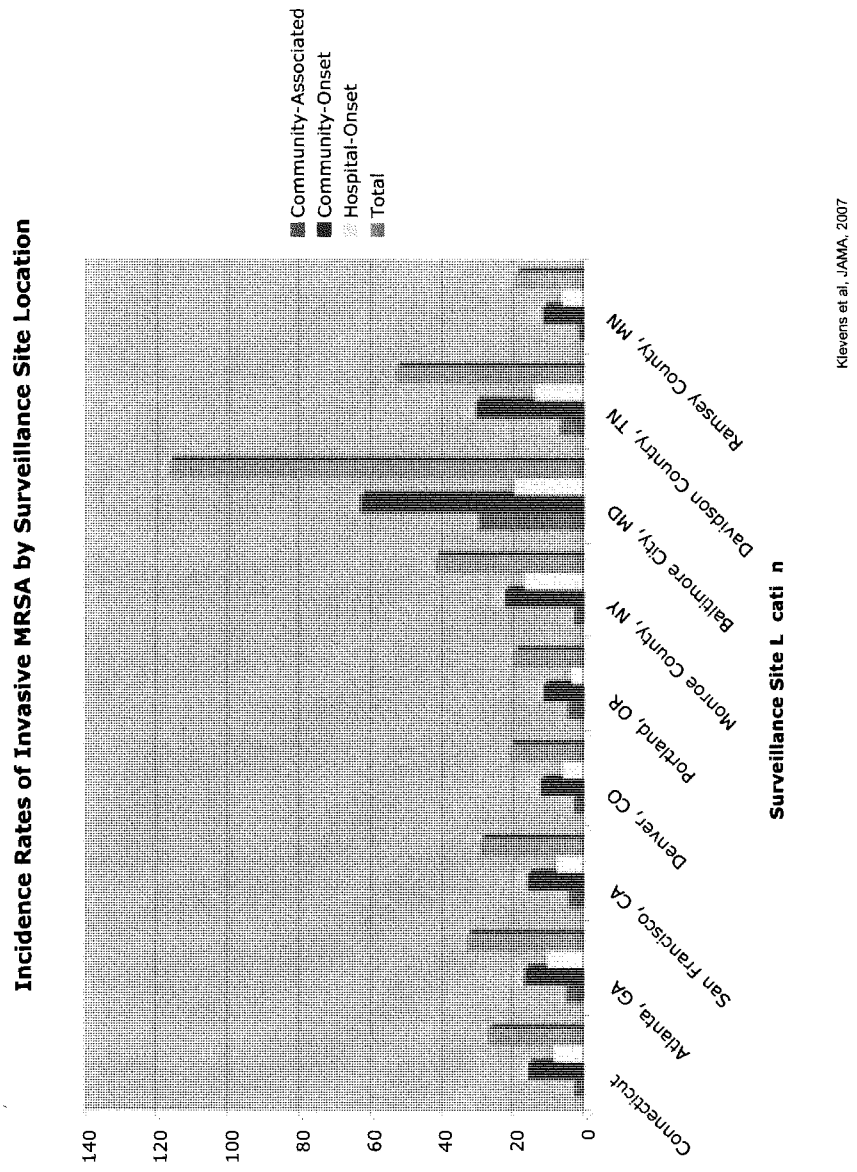
Epidemic community-acquired MRSA: Current Controversies



Robert S. Daum, M.D., C.M.

November 2007





Klevens et al, JAMA, 2007

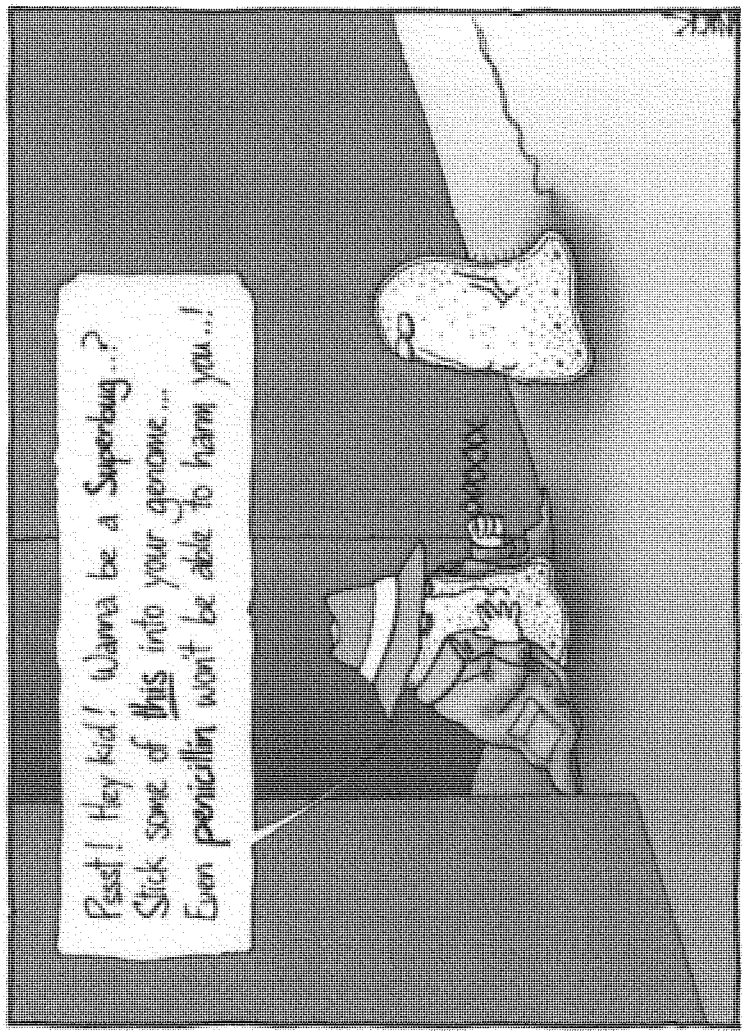
Incidence of Notifiable Diseases of Public Health Importance

MRSA	33.4
S. pneumoniae	12.8*
Group B Streptococcus	7.3*
Group A Streptococcus	3.3*
H. influenzae	1.4*
N. meningitidis	0.31*

ABC data, 2004

CA-MRSA Epidemiology: High-Risk Groups

- Children
  - Now >84% SSTIs in U. Chicago peds ED
- Jail and prison inmates
  - Now >85% of all SSTIs in Cook County Jail
- Poor, homeless young adults
- Soldiers: Boot Camps
- Daycare center and family outbreaks
- Pacific Islanders in Hawaii
- Athletes: Professional, college, high school

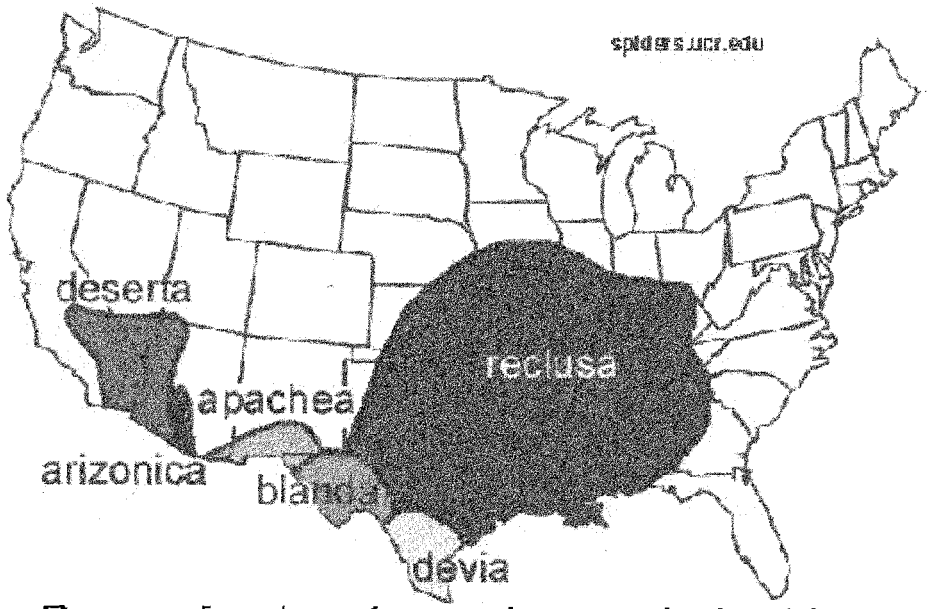


It was on a short-cut through the hospital kitchens that Albert was first approached by a member of the Antibiotic Resistance.

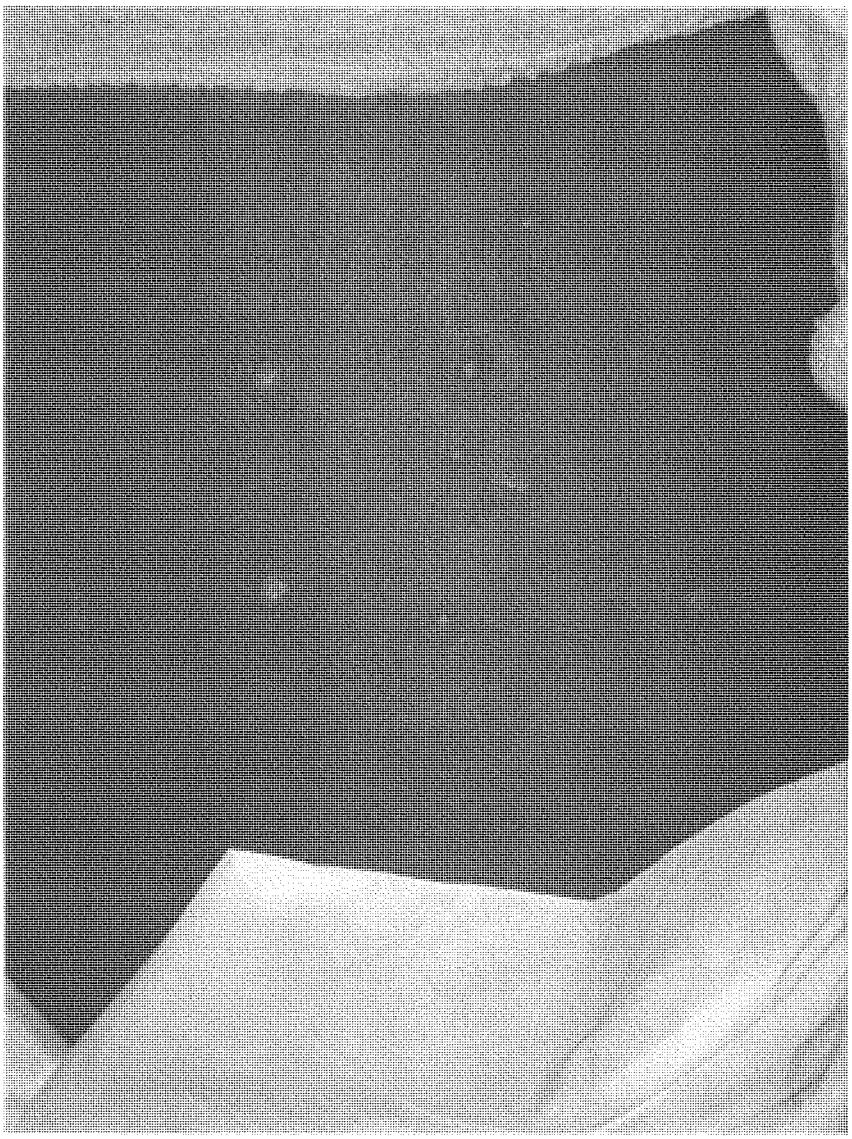
"The choice of appropriate antimicrobial agents for suspected *S. aureus* infections of skin and soft tissue in patients in the community should now take into account the emergence of community-associated MRSA."
CDC 2005

Severe Sepsis
Skeletal Infection
Necrotizing pneumonia
Intravascular Infectious Disease
Necrotizing fasciitis
SSTI
ASYMPTOMATIC COLONIZATION

“Spider bites” and MRSA



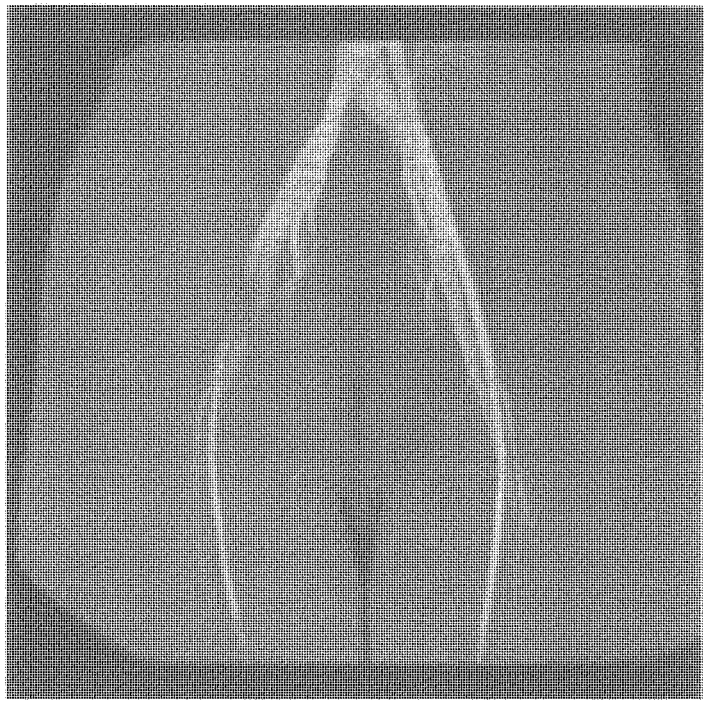
Range of recluse (genus Loxosceles) spiders in the United States



Severe CA-MRSA Sepsis in Adolescents: Vascular Complications & Thrombosis

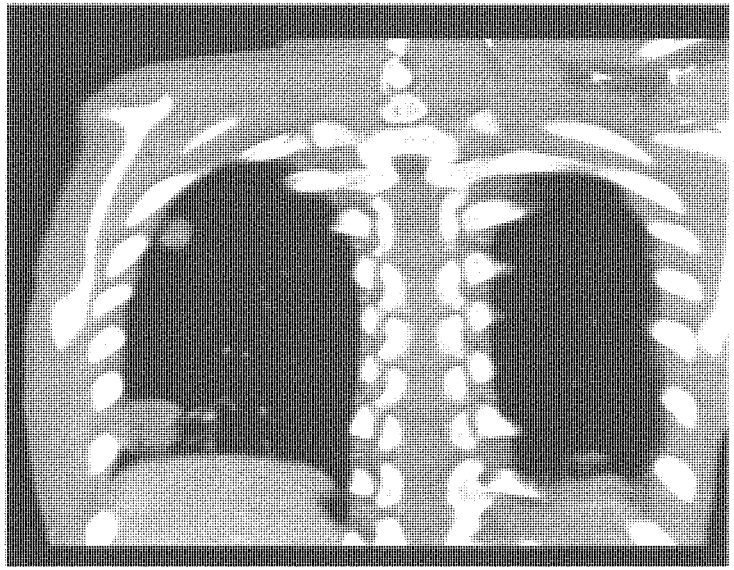
29% of patients had vascular complications:

- Deep venous thrombosis
- Pseudoaneurysms

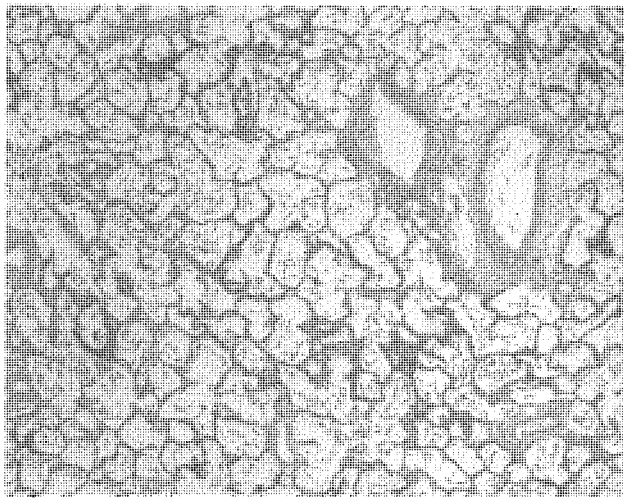


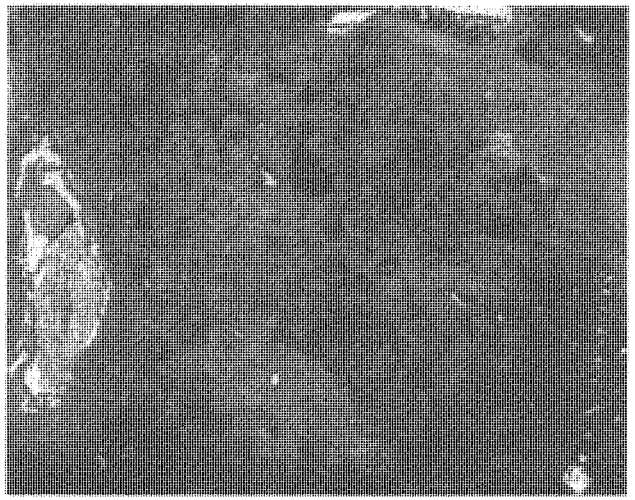
Throws emboli like endocarditis

- 9/13: Chest CT for PE: multiple nodular densities c/w septic emboli, no PE.



CA-MRSA necrotizing pneumonia





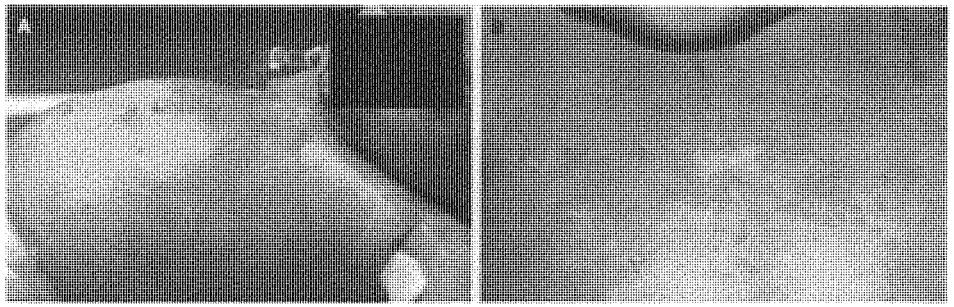
The NEW ENGLAND JOURNAL of MEDICINE

BRIEF REPORT

Staphylococcus aureus Sepsis and the Waterhouse–Friderichsen Syndrome in Children

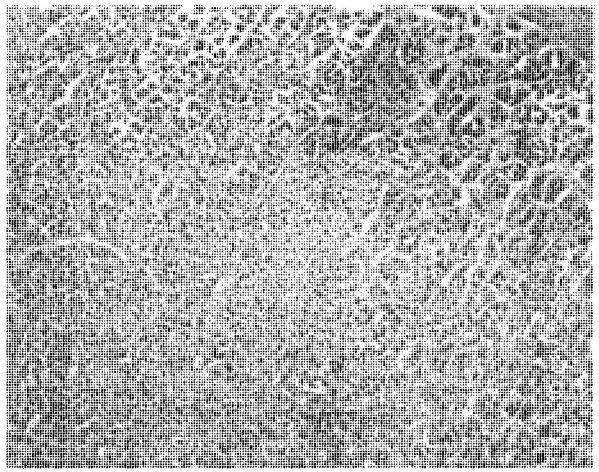
Patricia V. Adem, M.D., Christopher P. Montgomery, M.D., Aliya N. Husain, M.D., Tracy K. Koogler, M.D., Valerie Arangelovich, M.D., Michel Humilier, M.D., Susan Boyle-Vavra, Ph.D., and Robert S. Daum, M.D.

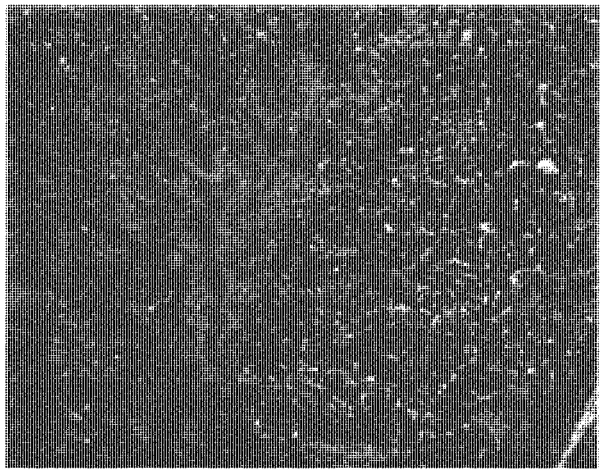
petechial and desquamating rash of CA-MRSA and MSSA



Adem et al. NEJM 353;12
september 22, 2005

Adrenal hemorrhage caused by CA-MRSA infection



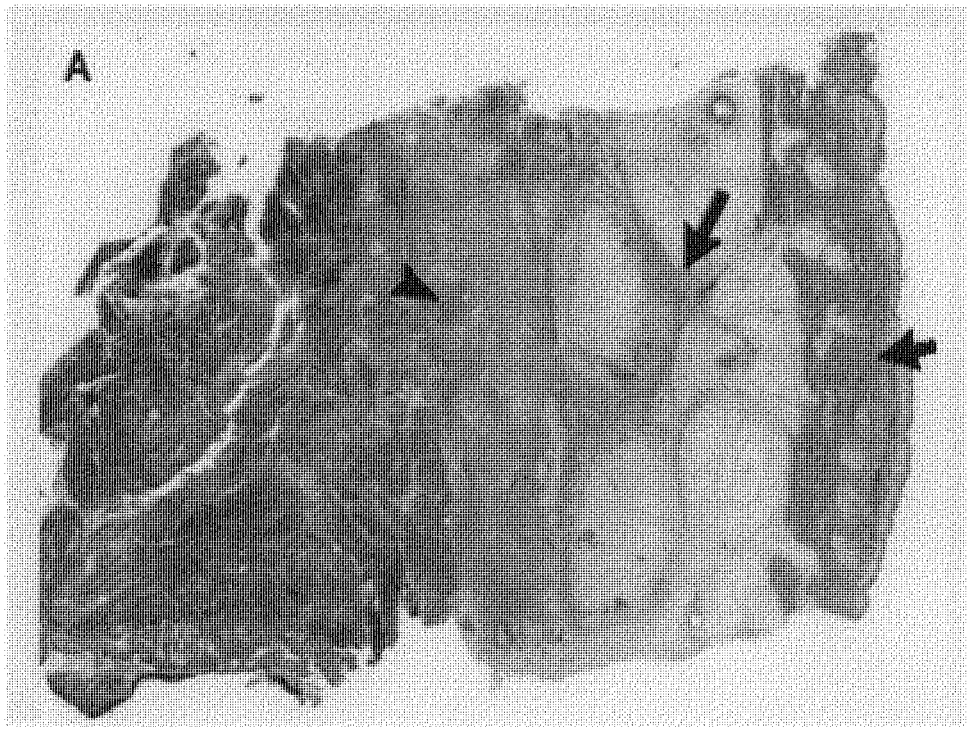


The "new" *S. aureus* sepsis syndrome

- Infants and young childen
- Hypotension and shock
- Necrotizing pneumonia
- Coagulopathy
- Thrombocytopenia
- High mortality
- NEW: Adrenal Hemorrhage

- MSSA or MRSA (SCC*mec* IV),
  - pulsotype G.
  - MLST 1. USA 400. Now also with MLST 8 USA 300
- More common than meningococcemia at UCCH
  - » NEJM, 2005

Necrotizing Fasciitis & CA-MRSA



Take Homes

- Multiple MR *S. aureus* isolates are circulating in the community
- PVL major virulence determinant but not universal and not the whole story of pathogenesis
- Many (?most) CA-MRSA isolates are MSSA isolates with SCC*mec* IV (? Or V) in them
- Mechanism of SCC*mec* spread not known
- Mechanism of CA-MRSA transmission unclear

Quo vamos?

- New antibiotics?
- Vaccines?

CA-MRSA-What are the questions?

The epidemiology. Who is at risk? How does it spread? What interventions work?

The pathogenesis. Which are the "new" virulence determinant (s)?

The treatment. Outpatient? Inpatient? Adjuncts?

The immunity. Role of antibody? Opsonic?

The prevention. Vaccine? Active? Passive?

Many, many -the Peds UC *S aureus* team (et al)

- University of Chicago
  - Susan Boyle-Vavra (aka Susan Daum)
  - Yin So-Wei, Nick Heaton, Amos Adler, Jie Peng
  - Susan Crawford, Michael David, Danny Glikman
  - Christopher Montgomery, Benjamin "Helicopter" Yoon
- CA-MRSA network
  - J Siegel, Dallas, A Frank, UI, T Hennessey, CDC (Alaska), CC Wang, Taipei
- With the collaboration of
  - Loren Miller, Henry "Chip" Chambers
- Not to mention
  - Sophie Miller, Samantha Eels, Michelle Downing
- Sine qua nons
  - NIAID, CDC, Grant HealthCare Foundation, Children's Research Foundation, Clorox, Pfizer, GeneOhm

EDITORIAL

Editorials represent the opinions of the authors and JAMA and not those of the American Medical Association

Antimicrobial Resistance

It's Not Just for Hospitals

Elizabeth A. Bancroft, MD, SM

METHICILLIN-RESISTANT *STAPHYLOCOCCUS AUREUS* (MRSA) is a well-known hospital pathogen. More than 10% of bloodstream infections in hospitals are due to MRSA, and patients with MRSA have worse outcomes than those with methicillin-sensitive *S aureus*.[1,2] In recent years, identification of MRSA in otherwise healthy individuals in the community (community-associated MRSA) has become increasingly common.

Health care–associated and community-associated MRSA have different clinical and molecular epidemiology. Health care–associated MRSA is associated with invasive disease, health care exposure, and multidrug resistance. Community-associated MRSA has been primarily reported in young, healthy individuals with no recent health care exposure. The strains have generally been sensitive to non–β-lactam antibiotics, although most have had genes for the Panton-Valentine leukocidin and other enterotoxins that may make these strains more virulent.[3-5] Health care–associated MRSA is typified by a USA100 pulse-field electrophoretic pattern, while USA300 is the most commonly reported community-associated MRSA pattern in the United States.[6] Complicating the issue is that patients can unknowingly be colonized with MRSA and therefore have onset of disease away from the source of exposure (hence the terms "community onset" or "health care onset"). Furthermore, molecular studies reveal that either strain can appear in both locations.

Despite an increase in reports of MRSA, traditionally this organism has not been considered of major public health significance. Most community outbreaks have involved skin or soft tissue infections, and little has been reported on invasive infections originating outside health care settings. Few health departments or jurisdictions have systematic surveillance programs for antimicrobial resistance. Of the list of reportable diseases in the United States, only 3 are specifically observed for being caused by antimicrobial-resistant organisms (drug-resistant *Streptococcus pneumoniae*, vancomycin-intermediate *S aureus*, and vancomycin-resistant *S aureus*).

Two reports in this issue of *JAMA*, however, make it clear that antimicrobial resistance is an increasing problem outside of hospitals. Klevens and colleagues[7] used data from the well-described Active Bacterial Core surveillance network to estimate the rate of invasive (bloodstream or other sterile site isolates) MRSA in the United States in 2005. The rate of invasive MRSA was an astounding 31.8 per 100 000. To put this number into context, the estimated rate of invasive MRSA is greater than the combined rate in 2005 for invasive pneumococcal disease (14.1 per 100 000), invasive group A streptococcus (3.6 per 100 000), invasive meningococcal disease (0.35 per 100 000), and invasive *H influenzae* (1.4 per 100 000).[8-11] Furthermore, Klevens et al report that among 5287 patients hospitalized with MRSA during 2005, there were 988 deaths; based on these data, the authors estimate that were 18 650 deaths in patients with invasive MRSA in the United States in 2005. If their projection is accurate, these deaths would exceed the total number of deaths attributable to human immunodeficiency virus/AIDS in the United States in 2005.[12]

Invasive MRSA is only the tip of the drug-resistance iceberg. Another Centers for Disease Control and Prevention study found that 6% of community-associated MRSA was invasive.[13] In another study, 9% of children hospitalized in 2003 for community-associated MRSA had invasive disease.[14] Therefore, it appears that the total burden of MRSA may be much greater than what was estimated in this study.

The report by Pichichero and Casey[15] in this issue of *JAMA* is based on a smaller sample size but nonetheless highlights the importance of surveillance for antibiotic resistance and strain detection in a community setting. Pichichero and Casey documented 9 cases of multidrug-resistant *S pneumoniae* in middle ear fluid samples from children with acute otitis media occurring after the introduction of the 7-valent pneumococcal conjugate vaccine. All cases were due to serotype 19A (a serotype not covered in the vaccine) that was recently reported to increase in Alaskan children after the vaccine was widely used.[16] While it appears that the overall decrease in invasive pneumococcal disease still outweighs the increase in serotype 19A, it is clear that surveillance needs to continue for this important pathogen, both for strain type and antibiotic resistance.

There are important limitations to these 2 studies. In the study by Pichichero and Casey,[15] the total number of cases was small, and the cases identified were those with recurrent or acute otitis media with treatment failure limited to 1 practice in 1 geographic region of the country. Therefore, care must be taken in extrapolating these data beyond the confines of

See also pp 1763 and 1772.

Author Affiliation: Los Angeles County Department of Public Health, Los Angeles, California

Corresponding Author: Elizabeth A. Bancroft, MD, SM, Acute Communicable Disease Control, Los Angeles County Department of Public Health, 313 N Figueroa, Suite 212, Los Angeles, CA 90012 (ebancroft@ph.lacounty.gov)

the cases presented. In the study by Klevens et al,[7] the data are based on a more robust surveillance system, representing approximately 6% of the US population, however, community-associated MRSA rates in skin infections vary considerably by geographic region, and it is unknown whether the surveillance sites in this report represent the distribution of MRSA in the United States. Furthermore, there is likely to be misclassification error in attributing the source of MRSA. The presence of a health care risk factor does not preclude acquisition of a community strain of MRSA from exposure in the community, yet by surveillance definitions those cases would be classified as health care–associated. Moreover, if health care risk factors were not recorded in hospital charts, cases classified as community-associated might have acquired their MRSA from a health care setting or some other unidentified nosocomial source, such as a health care worker in the home. In addition, mortality data were collected from patient charts, and there are no data to firmly establish that MRSA was the actual cause of death.

With aging of the US population and the increase of community-associated MRSA, rates of invasive MRSA will continue to increase unless effective interventions are implemented. Until a successful vaccine is developed (and the study by Pichichero and Casey suggests that vaccines may have unintended consequences), clinicians and public health professionals will have to use the tools now available to control the spread of this organism. Strategies to prevent MRSA infections in hospitals—eg, handwashing, surveillance cultures, judicious antibiotic use, limiting invasive devices, decolonization, and environmental cleaning—are well known but imperfectly practiced. Strategies to prevent sporadic community-associated MRSA are not as well described, although handwashing, not sharing personal items, and keeping wounds clean, dry, and covered are commonly mentioned as methods to control outbreak.

Interestingly, the majority (58%) of MRSA cases were among patients who had health care risk factors but community onset of disease. The majority of these patients had the USA100 genotype, suggesting a health care origin of the organism. It appears that what happens in the hospital does not stay in the hospital. Patients are discharged from health care facilities with MRSA colonization that likely is often unidentified and only later develop invasive MRSA disease. More research is needed to determine the risk factors for developing invasive disease after hospital discharge and the prevention measures necessary to decrease infection. Working vigorously to decrease transmission of MRSA in health care facilities may decrease both nosocomial and community-onset MRSA that occurs in persons with prior health care exposure.

The reports in this issue of JAMA reveal that infections with significant antimicrobial-resistant pathogens, the types formerly seen only in hospitals, now have onset in the community. Old diseases have learned new tricks. Consequently, new collaborations between the public health and medical communities are needed to identify and control antimicrobial resistance. It is not practical for public health departments to perform surveillance for MRSA or other highly prevalent resistant organisms without a robust system of electronic laboratory reporting. In the meantime, population surveillance can be achieved by public health personnel working with hospitals and laboratories in their jurisdictions to develop aggregate antibiograms. Clinicians also should be encouraged to report to the health department any new trends in antibiotic resistance that they identify.

Collaborative research is needed to determine how to control health care–associated, community-onset MRSA and how to prevent community-associated MRSA from entering the hospital. Public health personnel and clinicians should combine efforts to ensure judicious antibiotic use. Additional resources may be needed to monitor and enforce infection control in health care facilities. For instance, in California, restaurants are routinely inspected more frequently (once per year) than nursing homes (once every 2 years), hospitals (once every 3 years), or physicians' offices (never). To be serious about controlling nosocomial disease and antibiotic resistance will require cleaning up the source.

Financial Disclosures: None reported

REFERENCES

1. Wisplinghoff H, Bischoff T, Tallent SM, et al. Nosocomial bloodstream infections in US hospitals. *Clin Infect Dis*. 2004;39(3):309-317.
2. Cosgrove SE, Sakoulas G, Perencevich EN, et al. Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia: a meta-analysis. *Clin Infect Dis*. 2003;36(1):53-59.
3. Diep BA, Carleton HA, Chang RF, et al. Roles of 34 virulence genes in the evolution of hospital- and community-associated strains of methicillin-resistant *Staphylococcus aureus*. *J Infect Dis*. 2006;193(11):1495-1503.
4. Diep BA, Gill SR, Chang RF, et al. Complete genome sequence of USA300, an epidemic clone of community-acquired methicillin-resistant *Staphylococcus aureus*. *Lancet*. 2006;367(9512):731-739.
5. Baba T, Takeuchi F, Kuroda M, et al. Genome and virulence determinants of high virulence community-acquired MRSA. *Lancet*. 2002;359(9320):1819-1827.
6. McDougal LK, Steward CD, Killgore GE, et al. Pulsed-field gel electrophoresis typing of oxacillin-resistant *Staphylococcus aureus* isolates from the United States. *J Clin Microbiol*. 2003;41(11):5113-5120.
7. Klevens RM, Morrison MA, Nadle J, et al. Invasive methicillin-resistant *Staphylococcus aureus* infections in the United States. *JAMA*. 2007;298(15):1763-1771.
8. Active Bacterial Core Surveillance Report: *Streptococcus pneumoniae*, 2005. Centers for Disease Control and Prevention Web site. 2006. http://www.cdc.gov/ncidod/dbmd/abcs/survreports/spneu05.pdf. Accessed September 23, 2007.
9. Active Bacterial Core Surveillance Report: group A Streptococcus, 2005. Centers for Disease Control and Prevention Web site. 2006. http://www.cdc.gov/ncidod/dbmd/abcs/survreports/gas05.pdf. Accessed September 23, 2007.
10. Active Bacterial Core Surveillance Report: *Neisseria meningitidis*, 2005. Centers for Disease Control and Prevention Web site. 2006. http://www.cdc.gov/ncidod/dbmd/abcs/survreports/mening05.pdf. Accessed September 23, 2007.
11. Active Bacterial Core Surveillance Report: *Haemophilus influenzae*, 2005. Centers for Disease Control and Prevention Web site. 2006. http://www.cdc.gov/ncidod/dbmd/abcs/survreports/hib05.pdf. Accessed September 23, 2007.
12. Centers for Disease Control and Prevention. *HIV/AIDS Surveillance Report, 2005*. Vol 17. Rev ed. Atlanta, GA: US Dept of Health and Human Services; 2007.
13. Fridkin SK, Hageman JC, Morrison M, et al. Methicillin-resistant *Staphylococcus aureus* disease in three communities. *N Engl J Med*. 2005;352(14):1436-1444.
14. Bancroft E, Perdreau-Remington F, Hattori M, Ngo V. Pediatric population surveillance for community associated MRSA in Los Angeles County [abstract 1348]. In: *Abstracts of the 44th Annual Meeting of the Interscience Conference on Antimicrobial Agents and Chemotherapy*. Washington, DC: American Society for Microbiology; 2004.
15. Pichichero M, Casey JR. Emergence of a multiresistant serotype 19A pneumococcal strain not included in the 7-valent conjugate vaccine as an otopathogen in children. *JAMA*. 2007;298(15):1772-1778.
16. Singleton RJ, Hennessy TW, Bulkow LR, et al. Invasive pneumococcal disease caused by nonvaccine serotypes among Alaska native children with high levels of 7-valent pneumococcal conjugate vaccine coverage. *JAMA*. 2007;297(16):1784-1792.

ORIGINAL CONTRIBUTION

Invasive Methicillin-Resistant *Staphylococcus aureus* Infections in the United States

R. Monina Klevens, DDS, MPH
Melissa A. Morrison, MPH
Joelle Nadle, MPH
Susan Petit, MPH
Ken Gershman, MD, MPH
Susan Ray, MD
Lee H. Harrison, MD
Ruth Lynfield, MD
Ghinwa Dumyati, MD
John M. Townes, MD
Allen S. Craig, MD
Elizabeth R. Zell, MSTAT
Gregory E. Fosheim, MPH
Linda K. McDougal, MS
Roberta B. Carey, PhD
Scott K. Fridkin, MD
for the Active Bacterial Core surveillance (ABCs) MRSA Investigators

Context As the epidemiology of infections with methicillin-resistant *Staphylococcus aureus* (MRSA) changes, accurate information on the scope and magnitude of MRSA infections in the US population is needed.

Objectives To describe the incidence and distribution of invasive MRSA disease in 9 US communities and to estimate the burden of invasive MRSA infections in the United States in 2005.

Design and Setting Active, population-based surveillance for invasive MRSA in 9 sites participating in the Active Bacterial Core surveillance (ABCs)/Emerging Infections Program Network from July 2004 through December 2005. Reports of MRSA were investigated and classified as either health care–associated (either hospital-onset or community-onset) or community-associated (patients without established health care risk factors for MRSA).

Main Outcome Measures Incidence rates and estimated number of invasive MRSA infections and in-hospital deaths among patients with MRSA in the United States in 2005; interval estimates of incidence excluding 1 site that appeared to be an outlier with the highest incidence; molecular characterization of infecting strains.

Results There were 8987 observed cases of invasive MRSA reported during the surveillance period. Most MRSA infections were health care–associated: 5250 (58.4%) were community-onset infections, 2389 (26.6%) were hospital-onset infections; 1234 (13.7%) were community-associated infections, and 114 (1.3%) could not be classified. In 2005, the standardized incidence rate of invasive MRSA was 31.8 per 100 000 (interval estimate, 24.4-35.2). Incidence rates were highest among persons 65 years and older (127.7 per 100 000; interval estimate, 92.6-156.9), blacks (66.5 per 100 000; interval estimate, 43.5-63.1), and males (37.5 per 100 000; interval estimate, 26.8-39.5). There were 1598 in-hospital deaths among patients with MRSA infection during the surveillance period. In 2005, the standardized mortality rate was 6.3 per 100 000 (interval estimate, 3.3-7.5). Molecular testing identified strains historically associated with community-associated disease outbreaks recovered from cultures in both hospital-onset and community-onset health care–associated infections in all surveillance areas.

Conclusions Invasive MRSA infection affects certain populations disproportionately. It is a major public health problem primarily related to health care but no longer confined to intensive care units, acute care hospitals, or any health care institution.

JAMA. 2007;298(15):1763-1771 www.jama.com

After being initially reported among injecting drug users in Detroit in 1981[1] and then associated with the deaths of 4 children in Minnesota and North Dakota in 1997,[2] community-associated methicillin-resistant *Staphylococcus aureus* (MRSA) has become the most frequent cause of skin and soft tissue infections presenting to emergency departments in the United States.[3] Although community outbreaks of MRSA in diverse populations, including American Indian and Alaska Natives,[4] sports

See also p 1803 and Patient Page.

Author Affiliations: Centers for Disease Control and Prevention, Atlanta, Georgia (Drs Klevens, Carey, and Fridkin and Mss Morrison, Zell, and McDougal and Mr Fosheim); California Emerging Infections Program, Oakland (Ms Nadle), Connecticut Department of Health, Hartford (Ms Petit), Colorado Emerging Infections Program, Denver (Dr Gershman), Grady Memorial Hospital, Atlanta (Dr Ray), Maryland Emerging Infections Program and Johns Hopkins Bloomberg School of Public Health, Baltimore (Dr Harrison), Minnesota Department of Health, Minneapolis (Dr Lynfield); University of Rochester, Rochester General Hospital, Rochester, New York (Dr Dumyati), Oregon Health & Science University, Portland (Dr Townes), and Tennessee Department of Health, Nashville (Dr Craig).
The ABCs MRSA Investigators are listed at the end of this article.
Corresponding Author: R. Monina Klevens, DDS, MPH, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention, 1600 Clifton Rd (A-24), Atlanta, GA 30333 (rmk2@cdc.gov).

teams,[5,6] prison inmates,[7] and child care attendees,[8] usually involved skin disease, MRSA also can cause severe, sometimes fatal invasive disease.[9-13]

Studies of the emergence of community-associated MRSA disease over the past decade determined that isolates causing community-associated and health care–associated MRSA infections were distinct.[10] Isolates from the community were susceptible to most non–β-lactam antimicrobial agents,[10] carried staphylococcal cassette chromosome type IV,[14] and frequently encoded the dermonecrotic cytotoxin known as Panton-Valentine leukocidin.[15] The strain most often isolated in community outbreaks was pulsed-field type USA300.[16] Other strains of community origin include USA400, USA1000, and USA1100.[17] In contrast, strains most frequently associated with MRSA infections in health care settings were USA100, USA200, and less often, USA500[18]; these traditionally have been multidrug-resistant and have carried staphylococcal cassette chromosome type II.[19]

In hospitalized patients, MRSA has been a problem since the 1960s[19]; approximately 20% of bloodstream infections in the hospital setting have been caused by *S aureus*.[20] The proportion of hospital-onset *S aureus* infections that were methicillin-resistant reached 64.4% in US intensive care units in 2003.[21] In the hospital, MRSA infections are associated with greater lengths of stay, higher mortality,[22] and increased costs.[23,24] Although more recently there has been increased surveillance activity for invasive MRSA infections in the community, surveillance for MRSA bloodstream infections in the United States traditionally has been limited to hospital-onset (ie, nosocomial) disease.[20,21]

As the epidemiology of MRSA disease changes, including both community- and health care–associated disease, accurate information on the scope and magnitude of the burden of MRSA disease in the US population is needed to set priorities for prevention and control. In this report we describe the incidence and distribution of invasive MRSA disease in 9 US communities and use these results to estimate the burden of invasive MRSA infections in the United States.

METHODS

Surveillance Methodology and Definitions

The Active Bacterial Core surveillance system (ABCs) is an ongoing, population-based, active laboratory surveillance system and is a component of the Emerging Infections Program (EIP) of the US Centers for Disease Control and Prevention (CDC). From July 2004 through December 2005, 9 EIP sites conducted surveillance for invasive MRSA infections. A site number was assigned in descending order of population size: site 1, the state of Connecticut (estimated population, 3.5 million); site 2, the Atlanta, Georgia, metropolitan area (8 counties; estimated population, 3.5 million); site 3, the San Francisco, California, Bay Area (3 counties; estimated population, 3.2 million); site 4, the Denver, Colorado, metropolitan area (5 counties, estimated population, 2.3 million); site 5, the Portland, Oregon, metropolitan area (3 counties; estimated population, 1.5 million); site 6, Monroe County, New York (estimated population, 733 000); site 7, Baltimore City, Maryland (estimated population, 636 000); site 8, Davidson County, Tennessee (estimated population, 575 000); and site 9, Ramsey County (St Paul area), Minnesota (estimated population, 495 000). The total population under surveillance in 2005 was an estimated 16.5 million, or approximately 5.6% of the US population. Surveillance sites were similar to the US population in the distribution by male sex (49.2% and 49.3%, respectively); however, surveillance sites had a lower frequency of whites (72.7% and 81.0%, respectively) and of persons 65 years and older (10.8% and 12.4%, respectively).

ABCs case finding was both active and laboratory-based. Clinical microbiology laboratories in acute care hospitals and all reference laboratories processing sterile site specimens for residents of the surveillance area were contacted regularly for case identification. In hospitals without computerized microbiology data, surveillance personnel telephoned designated microbiology laboratory contacts regularly to identify new cases and request isolate submission. Where microbiology data were computerized, electronic line listings of all MRSA isolated from normally sterile sites were received on a monthly basis by surveillance staff, which investigated each potential case to confirm residency status, presence of infection, demographic characteristics, and underlying illness. The burden of disease can be estimated by this surveillance method using census data and the surveillance site–specific incidence rates and age-, race-, and sex-adjusted incidence rates pooled across all surveillance sites. This infrastructure is the same as that used for estimated incidence and disease burden for bacterial meningitis[25] and invasive infections with *Streptococcus pneumoniae*.[26,27]

Case reporting and isolate collection were determined to be surveillance activities at the CDC, in addition, each of the 9 participating surveillance sites evaluated the protocol and either deemed it a surveillance activity (eg, that involving a reportable disease) or obtained institutional review board approval with a waiver of informed consent.

A case of invasive MRSA infection was defined by the isolation of MRSA from a normally sterile body site in a resident of the surveillance area, including residents institutionalized in long-term care facilities, prisons, etc. Normally sterile sites included blood, cerebrospinal fluid, pleural fluid, pericardial fluid, peritoneal fluid, joint/synovial fluid, bone, internal body site (lymph node, brain, heart, liver, spleen, vitreous fluid, kidney, pancreas, or ovary), or other normally sterile sites. Cultures designated as "fluid" were investigated as potentially sterile culture sites, cultures designated as "tissue" with no specification of original source were not investigated.

Personnel in each EIP site abstracted data from medical records from hospital and clinic visits using a standard case report form. Information on the following health care risk factors for MRSA was collected: culture obtained more than 48 hours after admission, presence of an invasive device (eg, vascular catheter, gastric feeding tube) at time of admission or evaluation; and a history of MRSA infection or colonization, surgery, hospitalization, dialysis, or residence in a long-term care facility in the 12 months preceding the culture. Cases could have more than 1 health care risk factor. For this analysis, we used health care risk factor information to classify cases into mutually exclusive groups (those with health care–associated and community-associated infections) justified previously[28] and consistent with other studies (TABLE 1).[29,30] Health care–associated infections, in turn, were classified as either community-onset (cases with a health care risk factor but with a culture obtained ≤48 hours after hospital admission) and hospital-onset (cases with culture obtained >48 hours after admission, regardless of whether they also had other health care risk factors). Community-associated cases were those without documented health care risk factors.

Surveillance personnel also collected demographic (including race), clinical, and outcome (hospital death or discharge) information on each case from the initial hospitalization. Mortality was collected from the patient record and represented crude, in-hospital deaths only. Race was collected from information available in the medical record. Cases were considered to have a diagnosis of bacteremia, pneumonia, cellulitis, osteomyelitis, endocarditis, septic shock, or other infection, if there was documentation of such a diagnosis in the medical record, regardless of the source of the isolate. Cases could have more than 1 clinical diagnosis. Bacteremias included those classified as primary, secondary, and not specified. Use of up to 4 antimicrobial agents was recorded, but all such agents reflected only initial empirical therapy and did not include dose, duration, therapeutic changes, or procedures (eg, draining, surgical therapy). Concordant empirical therapy was defined as receipt of any antimicrobial agent to which the isolate was susceptible by laboratory testing and that was documented in the medical record. Recurrent invasive MRSA was defined as a positive culture result obtained from the same case 30 days or more after the initial culture.

Table 1. Definitions Used for Epidemiologic Classification of Invasive Methicillin-Resistant *Staphylococcus aureus* (MRSA) Infections

Classification	Definition
Health care–associated	
Community-onset	Cases with at least 1 of the following health care risk factors: (1) presence of an invasive device at time of admission, (2) history of MRSA infection or colonization, (3) history of surgery, hospitalization, dialysis, or residence in a long-term care facility in previous 12 mo preceding culture date
Hospital-onset	Cases with positive culture result from a normally sterile site obtained >48 h after hospital admission. These cases might also have ≥1 of the community-onset risk factors
Community-associated	Cases with no documented community-onset health care risk factor

Isolate Collection and Testing

Laboratories identified by the EIP site were asked to submit isolates from invasive MRSA infections. Of 123 laboratories serving residents of the surveillance areas, 48 (39%) contributed isolates. All isolates were sent to the CDC for identification, selected testing, and storage. In situations in which more than 1 isolate was available from a single case, the protocol selected 1 isolate, preferably from a nonblood sterile site. Isolates were prioritized for testing as follows: within each geographic site, all nonblood isolates and the subsequent submitted blood isolate were selected; then, among blood isolates, those from cases with a diagnosis other than uncomplicated bacteremia were selected. Testing included confirmation of *S aureus* identification using catalase and Staphaurex (Remel Europe Ltd, Dartford, United Kingdom) agglutination tests and tube coagulase if necessary, as well as description of morphology on nonselective blood agar, confirmation of oxacillin resistance by the broth microdilution method,[18] and pulsed-field gel electrophoresis (PFGE) using the restriction endonuclease *Sma*I. PFGE patterns were analyzed using BioNumerics version 4.01 (Applied Maths, Austin, Texas) and grouped into pulsed-field types using Dice coefficients and 80% relatedness, as previously described.[18] PFGE testing was conducted at the CDC and at the reference centers in Colorado, Connecticut, Georgia, Minnesota, and Oregon. All PFGE patterns were entered into a single database for analysis.

Statistical Analysis

We selected cases reported from July 2004 through December 2005 to describe epidemiologic, clinical, and microbiological characteristics. We included only cases reported from January through December 2005 for the annual 2005 incidence rate calculations. Recurrent cases were excluded from incidence calculations. We used US Census Bureau bridged-race vintage post-census population estimates for 2005, provided by the National Center for Health Statistics for surveillance area and national denominator values.

Because the surveillance sites varied in the distribution by age and race, for national estimates of burden of disease we multiplied the aggregate age-, race-, and sex-specific rates of disease in the surveillance areas by the age, race, and sex distribution of the US population for 2005. Because 1 site (site 7, Baltimore City) reported an excessively high incidence of infection, we calculated interval estimates for the age-, race-, and sex-adjusted incidence rates and estimated burden as well. This was performed by creating a lower bound by pooling data from the 3 EIP sites

Table 2. Observed Incidence Rates of Invasive Methicillin-Resistant *Staphylococcus aureus* (MRSA) by Active Bacterial Core Surveillance Site and Epidemiologic Classification, United States, 2005[a]

		Incidence per 100 000			
			Health Care–Associated		
Surveillance Site No. (Location)[b]	No. of Cases	Community-Associated	Community-Onset	Hospital-Onset	Total
1 (Connecticut)	952	2.7	15.6	8.4	27.1
2 (Atlanta, GA, metropolitan area)	1165	5.1	16.7	10.3	33.0
3 (San Francisco, CA, Bay Area)	936	4.5	15.9	7.7	29.2
4 (Denver, CO, metropolitan area)	480	2.8	12.3	6.0	21.2
5 (Portland, OR, metropolitan area)	305	4.7	11.4	3.6	19.8
6 (Monroe County, NY)	307	2.7	22.2	16.8	41.9
7 (Baltimore City, MD)	742	29.7	62.9	19.7	116.7
8 (Davidson County, TN)	305	6.8	30.4	13.9	53.0
9 (Ramsey County, MN)	95	1.6	11.5	6.1	19.2

[a] Epidemiologic classification of disease consisted of health care–associated (either hospital-onset cases with a culture collected >48 h after hospital admission or community-onset cases with health care risk factors but a culture collected ≤48 h after hospital admission) and community-associated cases (no health care risk factors).
[b] Site numbers were assigned in descending order of population size.

Table 3. Estimated Incidence Rates of Invasive Methicillin-Resistant *Staphylococcus aureus* Infections by Race, Active Bacterial Core Surveillance, United States, 2005

		Incidence per 100 000		
Age, y	No. of Cases	White	Black	Other
<1	60	14.9	65.9	14.2
1	9	3.7	5.9	0
2-4	18	1.9	6.0	0
5-17	47	0.7	4.8	0.4
18-34	434	7.3	29.1	3.2
35-49	1082	16.1	84.9	6.3
50-64	1327	35.1	127.5	15.8
≥65	2308	118.0	253.8	67.0
Total (interval estimates)[a]	5287	27.7 (21.9-32.4)	66.5 (43.5-63.1)	10.4 (10.7-16.4)

[a] Interval estimates for the overall incidence by race were calculated for the lower bound by pooling data from the 3 surveillance sites reporting the lowest incidence rates; for the upper bound, by pooling data from the 3 sites reporting the highest rates, excluding data from site 7 (Baltimore City), which reported excessively high rates. These race-specific interval estimates are adjusted by age and sex.

with lowest overall incidence (sites 4, 5, and 9) and an upper bound by pooling data from the 3 EIP sites with highest overall incidence (sites 2, 6, and 8), excluding site 7. Because data from site 7 were excluded from the interval estimates, there are occasions when the intervals do not include the overall rate. Confidence intervals are based on the properties of a sampling distribution and cannot be calculated with our data because our surveillance areas captured all cases, not a sample. We tested differences in proportions of descriptive characteristics using χ^2. Analyses were performed using SAS version 9.1.3 (SAS Institute Inc, Cary, North Carolina).

RESULTS

Incidence of Invasive MRSA

There were 8987 observed cases of invasive MRSA reported from July 2004 through December 2005. Most were health care–associated, with 5250 (58.4%) community-onset infections, 2389 (26.6%) hospital-onset infections, 1234 (13.7%) community-associated infections, and 114 (1.3%) that could not be classified.

Unadjusted incidence rates of all types of invasive MRSA ranged between approximately 20 to 50 per 100 000 in most ABCs sites but were noticeably higher in 1 site (site 7, Baltimore City) (TABLE 2). The rate of invasive community-associated MRSA was less than 3 per 100 000 in 4 sites and approximately 5 per 100 000 in 3 sites. Incidence rates were consistently higher among blacks compared with whites in the various age groups (TABLE 3). Adjusting for age, race, and sex, the standardized incidence rate of invasive MRSA for calendar year 2005 was 31.8 per 100 000 persons (TABLE 4). The overall interval estimate after exclusion of the outlier site (site 7) was 24.4 to 35.2 per 100 000.

The rate of health care–associated, community-onset infections (17.6 per 100 000; interval estimate, 14.7-18.2) was greater than either health care–associated, hospital-onset infections (8.9 per 100 000; interval estimate, 6.1-11.8) or community-associated infections (4.6 per 100 000; interval estimate, 3.6-4.4). Standardized incidence rates overall were highest among persons 65 years and older (127.7 per 100 000; interval estimate, 92.6-156.9), blacks (66.5 per 100 000; interval estimate, 43.5-63.1), and males (37.5 per 100 000; interval estimate, 26.8-39.5) (Table 4). Rates were lowest among persons aged 5 to 17 years (1.4 per 100 000, interval estimate, 0.8-1.7).

The standardized mortality rate was 6.3 per 100 000 (interval estimate, 3.3-7.5) overall, and was higher among persons 65 years and older (35.3 per 100 000; interval estimate, 18.4-44.7), blacks (10.0 per 100 000, interval estimate, 5.7-9.9), and males (7.4

per 100 000; interval estimate, 3.7-8.9) (Table 4). Among persons with MRSA, mortality for health care–associated, community-onset infections was higher (3.2 per 100 000; interval estimate, 1.7-3.7) than for health care–associated, hospital-onset infections (2.5 per 100 000; interval estimate, 1.2-3.1) or for community-associated infections (0.5 per 100 000; interval estimate, 0.3-0.6).

There were 5287 infections reported in the surveillance areas during 2005; after adjusting for age, race, and sex to the US population, we estimated that 94 360 (interval estimate, 72 850-104 000) patients had an invasive MRSA infection. There were 988 reported deaths, which we estimated were 18 650 (interval estimate, 10 030-22 070) in-hospital deaths subsequent to invasive MRSA infections in the United States (Table 4).

Pooled among all sites, we looked at the frequency of reports over the 18-month period from July 2004 through December 2005. The number of cases reported per month ranged from 443 in August 2004 to 541 in September 2005. Among all cases reported in the 18-month period, the percentage with community-associated infections ranged from 4.2% in April 2005 to 6.6% in July, August, and October 2005. When limiting the evaluation to only the 172 community-associated pneumonia reports, there was no apparent clustering by season (data not shown).

Established MRSA Risk Factors and Spectrum of Disease

Apart from community-associated cases which, by definition, had no established health care risk factors for MRSA, 4105 of 5250 (78.2%) cases with health care–associated, community-onset infections and 1993 of 2389 (83.4%) cases with health care–associated, hospital-onset infections had more than 1 health care risk factor for MRSA documented in medical records. The most common health care risk factors among cases with community-onset infections and hospital-onset infections were a history of hospitalization (76.6% and 57.7%, respectively), history of surgery (37.0% and 37.6%), long-term–care residence (38.5% and 21.9%), and MRSA infection or colonization (30.3% and 17.4%).

Of the 8792 cases with complete information, the clinical syndrome associated with invasive MRSA disease included bacteremia (75.2%), pneumonia (13.3%), cellulitis (9.7%), osteomyelitis (7.5%), endocarditis (6.3%), and septic shock (4.3%). Almost all cases (8304 [92.4%]) were hospitalized, 1598 (17.8%) of all cases died during hospitalization, and 1162 (12.9%) developed recurrent invasive infections. Cases with endocarditis had a high frequency of recurrent infections (108 [19.3%]). Clinical outcome was recorded for 8849 cases (98%). Crude

Table 4. Numbers and Incidence Rates of Invasive Methicillin-Resistant *Staphylococcus aureus* (MRSA) Infections and Deaths, by Selected Demographic Characteristics and Epidemiologic Classifications, Active Bacterial Core Surveillance, United States, 2005[a]

	Invasive MRSA Infections						Invasive MRSA Deaths					
			Incidence per 100 000						Incidence per 100 000			
				Health Care–Associated						Health Care–Associated		
Demographic	Actual No.	Estimated No.	Community	Community-Onset	Hospital-Onset	Total	Actual No.	Estimated No.	Community	Community-Onset	Hospital-Onset	Total
Sex												
Male	3066	54 790	6.1	20.6	10.1	37.5	571	10 840	0.8	3.9	2.7	7.4
Female	2220	39 360	3.2	14.7	7.9	26.3	417	7820	0.3	2.6	2.2	5.2
Age, y												
<1	60	950	3.5	4.7	14.7	23.1	5	80	0	0.3	1.6	2.0
1	9	160	2.9	0.0	1.0	3.8	0	0	0	0	0	0
2-4	18	290	0.8	1.0	0.6	2.4	1	10	0	0	0.1	0.1
5-17	47	730	0.6	0.4	0.3	1.4	3	60	0	0	0.1	0.1
18-34	434	7050	3.2	4.2	2.4	10.1	31	460	0.1	0.2	0.3	0.7
35-49	1082	16 100	6.3	11.9	5.3	24.3	92	1400	0.4	0.8	0.9	2.1
50-64	1327	22 120	6.7	23.9	12.1	43.9	224	3640	0.9	3.2	2.9	7.2
≥65	2308	46 970	8.9	78.2	39.1	127.7	632	13 000	2.1	19.7	13.4	35.3
Race												
White	2716	66 590	3.8	15.3	8.1	27.7	596	14 270	0.4	3.1	2.4	5.9
Black	1794	25 980	10.9	37.2	16.6	66.5	263	3900	0.2	4.8	3.7	10.0
Other	139	1790	1.6	5.4	3.3	10.4	38	480	0.1	1.3	1.2	2.8
Total (interval estimates)	5287	94 360 (72 850-104 000)	4.6 (3.6-4.4)	17.6 (14.7-18.2)	8.9 (6.1-11.8)	31.8 (24.4-35.2)	988	18 650 (10 050-22 100)	0.5 (0.3-0.6)	3.2 (1.7-3.7)	2.5 (1.2-3.1)	6.3 (3.3-7.5)

[a] Epidemiologic classification of disease consisted of healthcare-associated (either hospital-onset cases with a culture collected >48 hours after hospital admission or community-onset cases with healthcare risk factors but a culture collected ≤48 hours after hospital admission) and community associated cases (those with no healthcare risk factors). There were 838 cases and 91 deaths with unknown race.

mortality varied by MRSA-related diagnosis, with high rates observed among cases with septic shock (55.6%) and pneumonia (32.4%), low rates among those with cellulitis (6.1%), and moderate rates among those with bacteremia (10.2%) or endocarditis (19.3%). The proportion of cases presenting with each major clinical condition varied between epidemiologic classifications (TABLE 5). Compared with the distribution of syndromes among cases with community-associated infections, bacteremia was more common, and cellulitis and endocarditis were significantly less common, among each of the cases with health care–associated infections.

Empirical therapy was documented for 5730 of the 8987 cases (63.8%). Overall, 4720 cases (82.4%) received concordant empirical therapy. Differential outcomes based on discordant therapy were not evaluated, since required data such as dose, duration, therapy changes, and adjunctive therapy were not abstracted. Receipt of concordant therapy was slightly lower among cases with community-associated infections compared with those having health care–associated infections either of community onset (80.1% vs 82.9%, respectively; $P=.03$) or hospital onset (80.1% vs 86.0%, $P<.001$). Vancomycin was the antimicrobial agent most frequently used for empirical therapy (75%), followed by semisynthetic penicillins (28%) and fluoroquinolones (26%). Similar proportions of cases were prescribed monotherapy (31.3%), therapy with 2 antimicrobials (37.9%), or therapy with more than 2 antimicrobials (30.9%).

Table 5. Number and Percentage of Invasive Methicillin-Resistant *Staphylococcus aureus* Infections by Clinical Condition and Epidemiologic Classification, Active Bacterial Core Surveillance, United States, July 2004-December 2005[a]

Condition[b]	Community-Associated (n = 1226)	Health Care–Associated, No. (%)		Total, No. (N = 8792)[c]
		Community-Onset (n = 5191)	Hospital-Onset (n = 2375)	
Bacteremia	798 (65.1)	4013 (77.4)[e]	1794 (75.5)[e]	6611
Pneumonia	172 (14.0)	616 (11.9)[d]	383 (16.1)	1171
Cellulitis	278 (22.7)	456 (8.8)[e]	114 (4.8)[e]	848
Osteomyelitis	99 (8.1)	415 (8.0)	142 (6.0)[d]	656
Endocarditis	155 (12.6)	341 (6.6)[e]	60 (2.5)[d]	556
Septic shock	46 (3.8)	233 (4.5)	99 (1.2)	378

[a] Epidemiologic classification of disease consisted of health care–associated (either hospital-onset cases with a culture collected >48 h after hospital admission or community-onset cases with health care risk factors but a culture collected ≤48 h after hospital admission) and community-associated cases (those with no health care risk factors).
[b] Cases could have ≥1 clinical syndrome.
[c] Of 8987 observed cases with invasive methicillin-resistant *Staphylococcus aureus*, 114 (1.3%) could not be classified and 81 had missing condition.
[d] $P < .05$.
[e] $P < .01$, all comparisons use community-associated as the referent category.

Table 6. Number and Percentage of Pulsed-Field Types USA100 and USA300 of Methicillin-Resistant *Staphylococcus aureus* Isolates, Active Bacterial Core Surveillance Sites, United States, 2005[a]

Surveillance Site No. (Location)[b]	No. of Cases	Isolates at Each Site, No. (%)			
		Isolates	USA100	USA300	Other
1 (Connecticut)	1583	142 (9.0)	109 (76.8)	5 (3.5)	28 (19.7)
2 (Atlanta, GA, metropolitan area)	1995	134 (6.7)	36 (26.8)	64 (47.8)	34 (25.4)
3 (San Francisco, CA, Bay Area)	1604	141 (8.8)	66 (46.8)	53 (37.6)	22 (15.6)
4 (Denver, CO, metropolitan area)	805	85 (10.6)	68 (80.0)	14 (16.5)	3 (3.5)
5 (Portland, OR, metropolitan area)	562	175 (31.1)	83 (47.4)	77 (44.0)	15 (8.6)
6 (Monroe County, NY)	546	81 (14.8)	61 (75.3)	13 (16.3)	7 (8.6)
7 (Davidson County, TN)	423	40 (9.5)	23 (57.5)	15 (37.5)	2 (5.0)
9 (Ramsey County, MN)	130	66 (50.8)	54 (81.1)	11 (16.7)	1 (1.5)
Total	7648	864 (11.3)	500 (6.5)	252 (3.3)	112 (1.5)

[a] Isolates not available from site 7, so total does not include 1339 cases reported from that site.
[b] Site numbers were assigned in descending order of population size.

Pulsed-Field Typing

PFGE results were available for 864 of the 1201 (71.9%) isolates received from 8 of the 9 ABCs sites (isolates were not available from site 7); these results represent 11.3% of the 7648 cases reported from these 8 sites (TABLE 6). Of these results, 81.6% were from blood cultures, 4.7% from bone, 4.8% from synovial fluid, 1.9% from pleural fluid, 1.5% from peritoneal fluid, and the remaining 5.5% from other normally sterile sites; this culture site distribution is similar to the distribution of culture sites reported among all 8987 cases. Isolates tested were associated with all of the major clinical conditions previously described, including uncomplicated bacteremia (69.8%), pneumonia (19.3%), cellulitis (11.3%), osteomyelitis (10.4%), endocarditis (8.5%), and septic shock (5.0%).

USA300 was the strain type identified for 100 of 150 (66.6%) isolates from community-associated cases and also was found among 108 of 485 (22.2%) isolates from health care–associated, community-onset cases and among 34 of 216 (15.7%) health care–associated, hospital-onset cases (TABLE 7). Also, 35 of 150 (23.0%) isolates from community-associated cases were USA100. In contrast, other strains of community origin (USA400, USA1000) were rare, accounting for only 3 of 150 (2.0%) isolates from community-associated cases, perhaps reflecting that these isolates all come from normally sterile sites and not skin abscesses, where these strain types have often been reported. USA100 and USA300 were the predominant pulsed-field types in each surveillance site, with the exception of site 1 (state of Connecticut) (Table 6).

COMMENT

These data represent the first US nationwide estimates of the burden of invasive MRSA disease using population-based, active case finding. Based on 8987 observed cases of MRSA and 1598 in-hospital deaths among patients with MRSA, we estimate that 94 360 invasive MRSA infections occurred in the United States in 2005; these infections were associated with death in 18 650 cases. The standardized incidence rate of invasive MRSA for calendar year 2005 was 31.8 per 100 000 persons. The incidence of other important invasive pathogens in 2005, such as invasive infections with *S pneumoniae* or *Haemophilus influenzae*, ranged from 14.0 per 100 000 to less than 1 per 100 000, largely due to the availability and success of vaccination.[31-33]

The estimated 94 360 infections is larger than the estimate from a recent study using hospital discharge–coded data; in 2000, the CDC estimated that there were 31 440 hospitalizations for MRSA bacteremias (ie, septicemia) in the United States.[1] Some of the discrepancy may relate to a more inclusive definition of invasive disease in our study and to the limitations inherent in discharge coded data. Of the estimated 94 360 infections from this study, 75.2% were bacteremias, and 26.6% were of hospital onset; thus, our estimates would yield approximately 18 900 MRSA, hospital-onset bacteremias. In 2002, the CDC estimated that there were 248 678 hospital-acquired bacteremias in the United States,[35] of which approximately 20 390 (8.2%) could be expected to be MRSA[20]—a result consistent with our findings.

Regarding community-associated MRSA, noninvasive infections with MRSA greatly outnumber invasive MRSA infections. In fact, when 3 of the ABCs sites began surveillance in 2000 for all MRSA infections, only 7% represented invasive disease. However, findings described here further document that invasive MRSA disease does occur in persons without established health care risk factors,[18] is associated with strains of both community and health care origin,[36] and is associated with significant mortality. Molecular analysis of isolates in our study provides evidence supporting other studies[16] showing that strains of community origin do now cause some hospital-onset disease but also that, overall, most invasive MRSA disease is still caused by MRSA strains of health care origin.

Table 7. Pulsed-Field Gel Electrophoresis Type of Methicillin-Resistant *Staphylococcus aureus* Isolates Cultured From Invasive Sites, by Epidemiologic Case Classification, Active Bacterial Core Surveillance, July 2004-December 2005 (n = 864)[a]

	No. (%)				
		Community-Onset			
Pulsed-Field Type	Hospital-Onset	Health Care–Associated	Community-Associated	Unknown	Total
USA100	160 (74)	303 (62)	35 (23)	2 (15)	500 (58)
USA200	5 (2)	9 (2)	0	0	14 (2)
USA300	34 (16)	108 (22)	100 (67)	10 (77)	252 (29)
USA400	1 (<1)	4 (1)	1 (<1)	0	6 (<1)
USA500	9 (4)	30 (6)	4 (3)	0	43 (5)
USA600	1 (<1)	4 (1)	0	0	5 (<1)
USA700	0	0	1 (<1)	0	1 (<1)
USA800	0	6 (1)	1 (<1)	0	7 (1)
USA1000	0	3 (1)	2 (2)	0	5 (<1)
Iberian	4 (2)	6 (1)	3 (2)	1 (8)	14 (2)
Not typeable[b]	2 (1)	12 (2)	3 (2)	0	17 (2)
Total	216	485	150	13	864

[a] Epidemiologic classification of disease consisted of health care-associated (either hospital-onset cases with a culture collected >48 h after hospital admission or community-onset cases with health care risk factors but a culture collected ≤48 h after hospital admission) and community-associated cases (those with no health care risk factors).
[b] Small pulsed-field gel electrophoresis typing was successful in giving these isolates a pattern number, but numbers were outside of the 80% similarity range.

Compared with rates of invasive MRSA infections in 2 of our sites from 2001-2002, the incidence of invasive MRSA has increased in 2005 from 19.3 per 100 000 to 33.0 per 100 000 in Atlanta and from 40.4 per 100 000 to 116.7 per 100 000 in Baltimore.[13] These increases were in both community- and health care–associated disease. However, in the state of Connecticut, the rate of community-onset MRSA bacteremias has been relatively stable at 2.5 per 100 000 in 1998[29] and 2.8 per 100 000 in 2005.

We describe striking differences in rates of invasive MRSA infections by race among all age groups. Connecticut documented a disparity for community-onset *S aureus* bacteremias in 1998.[29] More recently, surveillance in Atlanta reported a significantly higher rate of community-associated MRSA among blacks compared with whites[13]; however, little progress has been made in understanding why. It is likely that the prevalence of underlying conditions,[37] at least some of which vary by race,[38] may play a role. The incidence of invasive pneumococcal disease varies widely by underlying chronic illness, but racial disparities persist for all conditions evaluated.[39] MRSA prevalence has been linked to socioeconomic status,[40] and this might confound the association between race and incidence of MRSA. Future analyses should focus on understanding reasons for differences in MRSA incidence rates.

The geographic variability in MRSA rates has been documented in other studies.[3,13] In this study we found that areas with lower incidence rates of invasive MRSA overall did not always have lower rates of community-associated MRSA. For example, site 6 (Monroe County, New York) had a relatively high rate of invasive MRSA overall (41.9 per 100 000) but a low rate of community-associated MRSA (2.7 per 100 000), site 5 (the Portland, Oregon, metro area) had a relatively low rate of invasive MRSA overall (19.8 per

100 000) but a high rate of community-associated MRSA (4.7 per 100 000). In addition to factors already mentioned such as socioeconomic status and underlying conditions, MRSA rates may be higher in urban areas.[29] As with differences in the incidence of invasive MRSA by race, geographic differences are probably multifactorial and complex. Improved understanding can help design and focus prevention messages as well as increase the timeliness of diagnosis and clinical management of invasive infections.

The majority of invasive MRSA cases occurred outside of the hospital (58%) but among persons with established risk factors for MRSA, such as a history of hospitalization in the past year. This observation was also made recently in a study from a single facility.[30] Patients with health care risk factors and community-onset disease likely acquired the pathogen from their health care contacts, such as those from a recent hospitalization or nursing home residence. Molecular analysis suggests that most of these infections were caused by MRSA strains of health care origin. If, in fact, these infections represent acquisition during transitions of care from acute care,[31] it follows that strategies to prevent and control MRSA among inpatients,[42,43] if properly applied, may have an impact on these infections as well as on the traditional hospital-onset infections. Since interventions for MRSA prevention are inconsistently implemented in US hospitals,[44] correlating the impact on either inpatient or outpatient disease will be challenging. Interventions used in the community to control outbreaks consist of improving hygiene and infection control along with enhanced surveillance, diagnosis, and appropriate treatment of infections[45-47]; however, studies of the effectiveness of community-based prevention and control interventions are lacking.

Our estimates have certain limitations. First, we may have underestimated the incidence of invasive MRSA disease if persons in the surveillance areas sought health care from facilities using laboratories outside the surveillance area. However, any underestimate is probably minor in light of the estimates derived from discharge data on MRSA hospitalizations.[34]

Second, we may have overestimated the incidence of community-associated MRSA if health care risk factors were not well documented in medical records. During surveillance conducted in 2000-2001, patient interviews were used to elicit undocumented health care risk factors; however, the effect on reclassification was small.[13]

Third, our surveillance sites were largely urban areas; thus, we might be overestimating the incidence of invasive MRSA.[29] Although our surveillance areas comprise a diverse set of regions and are likely representative of the United States, it is not known whether the incidence rates in the observed populations are actually representative of the distribution of incidence rates in other US cities. Since the methodology of population-based surveillance produces a single point estimate without confidence intervals (ie, all cases are identified), we calculated interval estimates excluding site 7 (Baltimore City) to allow the reader to interpret a range of estimates reflecting different metropolitan areas. Regarding the high observed incidence rates reported by site 7, we conducted an evaluation to determine whether these results were valid, including a review of case-finding methods, elimination of cases to include only those with zip codes represented in the denominator, contamination in any laboratory, and other potential causes for increased rates; however, none were in error.

Fourth, our measures of deaths represented crude, in-hospital deaths, rather than attributable mortality. It is possible that MRSA infection did not cause or contribute to some deaths.

Fifth, the evaluation of isolates in this study was meant to describe strain diversity and to shed light on the potential crossover of strains from a community origin into the hospital setting. The isolate collection was a convenience sample. Furthermore, we only had test results from isolates of 864 (11.3%) of the cases reported; extrapolation of the molecular characterization to the US population should be avoided.

In conclusion, invasive MRSA disease is a major public health problem and is primarily related to health care but no longer confined to acute care. Although in 2005 the majority of invasive disease was related to health care, this may change.

Author Contributions: Dr Klevens had full access to all of the data in the study and takes responsibility for the integrity of the data and the accuracy of the data analysis.
Study concept and design: Klevens, Morrison, Gershman, Lynfield, Townes, Craig, Carey, Fridkin
Acquisition of data: Klevens, Morrison, Nadle, Petit, Ray, Harrison, Lynfield, Dumyati, Townes, Craig, Fosheim
Analysis and interpretation of data: Klevens, Morrison, Ray, Lynfield, Zell, Fosheim, McDougal, Fridkin
Drafting of the manuscript: Klevens, Morrison, Fridkin
Critical revision of the manuscript for important intellectual content: Klevens, Morrison, Nadle, Petit, Gershman, Ray, Harrison, Lynfield, Dumyati, Townes, Craig, Zell, Fosheim, McDougal, Carey, Fridkin
Statistical analysis: Morrison, Zell
Obtained funding: Klevens, Fridkin.
Administrative, technical, or material support: Klevens, Ray, Harrison, Lynfield, Townes, Craig, Fosheim, Carey, Fridkin
Study supervision: Klevens, Gershman, Dumyati, Townes, Craig, Carey, Fridkin
Financial Disclosures: None reported
Active Bacterial Core surveillance (ABCs) MRSA Investigators: William Schaffner, MD, Tennessee Emerging Infections Program (EIP), Jessica Buck, Minnesota EIP, Jim Hadler, MD, Connecticut EIP, Monica M Farley, MD, Georgia EIP, Laurie Thompson Sanza, Maryland EIP, Michael Emerson, Oregon EIP, Brandi M. Limbago, PhD, Fred C. Tenover, PhD, and Jean B Patel, PhD, Division of Healthcare Quality Promotion, Centers for Disease Control and Prevention (CDC).
Funding/Support: This study was funded through the Emerging Infections Program, National Center for Preparedness, Detection, and Control of Infectious Diseases, Coordinating Center for Infectious Diseases, CDC.
Role of the Sponsor: No commercial entity had any role in the design and conduct of the study, the collection, management, analysis, and interpretation of the data, or the preparation, review, or approval of the manuscript.
Additional Contributions: We thank Elizabeth Partridge, Pam Daily, MPH, and Gretchen Rothrock, California EIP, Steve Burnite, Deborah Aragon, Nicole Comstock, Allison Daniels, and Jonathan Schwartz, Colorado EIP, Zack Fraser and Nancy L. Barrett, MS, MPH, Connecticut EIP, Wendy Baughman, MSPH, Janine Ladson, MPH, James Howgate, MPH, and Emily McMahan, RN, BSN, Georgia EIP, Janice Langford and Kathleen Shutt, Maryland EIP, Dave Doxrud and Selina Jawahir, Minnesota EIP, Nana Bennett, MD, Anita Gelfert, RN, and Paul Malpiedi, New York EIP, Robert Vega, Janie Tierheimer, Karen Stefonek, Michelle Barber, and Ann Thomas, MD, Oregon EIP, Brenda Barnes, Tern McMinn, Jane Conners, and Melinda Eady, Tennessee EIP, and Sandra Bulens, MPH, Chris Van Beneden, MD, MPH, Tami Skoff, MS, Carolyn Wright, and Emily Weston, CDC, for ongoing surveillance and case follow-up, Christina Crane, CDC, for microbiological testing of the isolates, John Jernigan, MD, CDC, for guidance with the design of the surveillance project,

and Jeff C Hageman, MHS, CDC, for manuscript review and surveillance guidance. None of these individuals received any compensation from industry related to this study

REFERENCES

1. Saravolatz LD, Markowitz N, Arking L, Pohlod D, Fisher E Methicillin-resistant *Staphylococcus aureus* epidemiologic observations during a community-acquired outbreak *Ann Intern Med* 1982,96(1) 11-16

2. Centers for Disease Control and Prevention Four pediatric deaths from community-acquired methicillin-resistant Staphylococcus aureus—Minnesota and North Dakota, 1997-1999 MMWR Morb Mortal Wkly Rep 1999,48(32) 707-710 http://www.cdc.gov/mmwr/preview/mmwrhtml/mm4832a2 htm Accessibility verified September 25, 2007.

3. Moran GJ, Krishnadasan A, Gorwitz RJ, et al Methicillin-resistant *S aureus* infections among patients in the emergency department *N Engl J Med* 2006; 355(7) 666-674.

4. Baggett HC, Hennessy TW, Rudolph K, et al Community-onset methicillin-resistant *Staphylococcus aureus* associated with antibiotic use and the cytotoxin Panton-Valentine leukocidin during a furunculosis outbreak in rural Alaska. *J Infect Dis* 2004,189(9) 1565-1573

5. Centers for Disease Control and Prevention Methicillin-resistant *Staphylococcus aureus* infections among competitive sports participants—Colorado, Indiana, Pennsylvania, and Los Angeles County, 2000-2003 *MMWR Morb Mortal Wkly Rep* 2003,52(33) 793-795.

6. Begier EM, Frenette K, Barrett NL, et al A high-morbidity outbreak of methicillin-resistant *Staphylococcus aureus* among players on a college football team, facilitated by cosmetic body shaving and turf burns *Clin Infect Dis* 2004,39(10) 1446-1453

7. Centers for Disease Control and Prevention Outbreaks of community-associated methicillin resistant *Staphylococcus aureus* skin infections—Los Angeles County, California, 2002-2003 *MMWR Morb Mortal Wkly Rep* 2003,52(5) 88

8. Adcock PM, Pastor P, Medley F, Patterson JE, Murphy TV Methicillin-resistant *Staphylococcus aureus* in two child care centers. *J Infect Dis* 1998;178(2). 577-580

9. Zetola N, Francis JS, Nuermberger EL, Bishai WR Community-acquired meticillin-resistant *Staphylococcus aureus* an emerging threat *Lancet Infect Dis* 2005, 5(5)·275-286

10. Naimi TS, LeDell KH, Como-Sabetti KM, et al Comparison of community-and health care–associated methicillin-resistant *Staphylococcus aureus* infection *JAMA* 2003;290(22) 2976-2984

11. Kaplan SL, Hulten KG, Gonzalez BE, et al Three-year surveillance of community-acquired *Staphylococcus aureus* infections in children *Clin Infect Dis* 2005,40(12) 1785-1791

12. Francis JS, Doherty MC, Lopatin U, et al Severe community-onset pneumonia in healthy adults caused by methicillin-resistant *Staphylococcus aureus* carrying the Panton-Valentine leukocidin genes *Clin Infect Dis* 2005;40(1) 100-107

13. Fridkin SK, Hageman JC, Morrison M, et al Methicillin-resistant *Staphylococcus aureus* disease in three communities *N Engl J Med* 2005,352(14) 1436-1444

14. Ma XX, Ito T, Tiensasitorn C, et al Novel type of staphylococcal cassette chromosome mec identified in community-acquired methicillin-resistant *Staphylococcus aureus* strains *Antimicrob Agents Chemother* 2002,46(4) 1147-1152

15. Lina G, Piémont Y, Godail-Gamot F, et al Involvement of Panton-Valentine Leukocidin-producing *Staphylococcus aureus* in primary skin infections and pneumonia *Clin Infect Dis* 1999,29 (5) 1128-1132

16. Tenover FC, McDougal LK, Goering RV, et al Characterization of a strain of community-associated methicillin-resistant *Staphylococcus aureus* widely disseminated in the United States *J Clin Microbiol* 2006, 44(1) 108-118.

17. McDougal LK, Wenming Z, Patel JB, Tenover FC Characterization of two new community-associated oxacillin-resistant *Staphylococcus aureus* pulsed-field types consisting of U S isolates that carry SCCmecIV and the Panton-Valentine leukocidin gene [abstract] Presented at American Society for Microbiology 104th General Meeting; May 23-27, 2004, New Orleans, LA

18. McDougal LK, Steward CD, Killgore GE, Chaitram JM, McAllister SK, Tenover FC Pulsed-field gel electrophoresis typing of oxacillin-resistant *Staphylococcus aureus* isolates from the United States. establishing a national database *J Clin Microbiol* 2003; 41(11) 5113-5120

19. Boyce JM Methicillin-resistant *Staphylococcus aureus* in hospitals and long-term care facilities microbiology, epidemiology, and preventive measures *Infect Control Hosp Epidemiol* 1992,13(12):725-737

20. Wisplinghoff H, Bischoff T, Tallent SM, Seifert H, Wenzel RP, Edmond MB. Nosocomial bloodstream infections in US hospitals analysis of 24,179 cases from a prospective nationwide surveillance study *Clin Infect Dis* 2004,39(3) 309-317

21. Klevens RM, Edwards JR, Tenover FC, McDonald LC, Horan T, Gaynes R Changes in the epidemiology of methicillin-resistant *Staphylococcus aureus* in intensive care units in U S hospitals, 1992-2003 *Clin Infect Dis*. 2006,42(3):389-391

22. Cosgrove SE, Sakoulas G, Perencevich EN, Schwaber MJ, Karchmer AW, Carmeli Y Comparison of mortality associated with methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* bacteremia a meta-analysis *Clin Infect Dis* 2003,36(1) 53-59

23 Engemann JJ, Carmeli Y, Cosgrove SE, et al Adverse clinical and economic outcomes attributable to methicillin resistance among patients with *Staphylococcus aureus* surgical site infection *Clin Infect Dis* 2003,36(5) 592-598

24. Cosgrove SE, Qi Y, Kaye KS, Harbarth S, Karchmer AW, Carmeli Y The impact of methicillin resistance in *Staphylococcus aureus* bacteremia on patient outcomes· mortality, length of stay, and hospital charges *Infect Control Hosp Epidemiol* 2005,26 (2).166-174

25. Schuchat A, Robinson K, Wenger JD, et al Bacterial meningitis in the United States in 1995. *N Engl J Med* 1997,337(14) 970-976

26. Whitney CG, Farley MM, Hadler J, et al. Increasing prevalence of multidrug-resistant *Streptococcus pneumoniae* in the United States *N Engl J Med* 2000, 343(26) 1917-1924

27. Centers for Disease Control and Prevention Active Bacterial Core Surveillance methodology—case definition and ascertainment http //www cdc gov /ncidod/dbmd/abcs/meth-case htm Accessibility verified September 21, 2007.

28. Klevens RM, Morrison MA, Fridkin SK, et al Spread of community-associated methicillin-resistant *Staphylococcus aureus* (MRSA) strains in healthcare settings *Emerg Infect Dis* 2006,12(12) 1991-1993

29. Monn CA, Hadler JL Population-based incidence and charactenstics of community-onset *Staphylococcus aureus* infections with bacteremia in 4 metropolitan Connecticut areas, 1998 *J Infect Dis* 2001, 184(8) 1029-1034

30. Schramm GE, Johnson JA, Doherty JA, Micek ST, Kollef MH Increasing incidence of sterile-site infections due to non-multidrug-resistant, oxacillin-resistant *Staphylococcus aureus* among hospitalized patients *Infect Control Hosp Epidemiol* 2007,28 (1) 95-97

31. Centers for Disease Control and Prevention. Progress toward elimination of *Haemophilus influenzae* type b invasive disease among infants and children, United States, 1998–2000 *MMWR Morb Mortal Wkly Rep* 2002,51(11) 234-237

32. Rosenstein NEPB, Stephens DS, Popovic T, Hughes JM. Meningococcal disease *N Engl J Med* 2001, 344(18) 1378-1388

33. Whitney CG, Farley MM, Schaffner W, et al Effectiveness of seven-valent pneumococcal conjugate vaccine against invasive pneumococcal disease a matched case-control study *Lancet* 2006;368(9546)· 1495-1502

34. Kuehnert MJ, Hill HA, Kupronis BA, Tokars JI, Solomon SL, Jernigan DB Methicillin-resistant *Staphylococcus aureus* hospitalizations, United States. *Emerg Infect Dis*. 2005;11(6):868-872.

35. Klevens RM, Edwards JR, Richards CL, et al. Estimating healthcare-associated infections and deaths in U.S hospitals, 2002 *Public Health Rep*. 2007, 122(2) 160-166

36. Seybold U, Kourbatova EV, Johnson JG, et al. Emergence of community-associated methicillin-resistant *Staphylococcus aureus* USA300 genotype as a major cause of health care-associated blood stream infections *Clin Infect Dis*. 2006,42(5):647-656

37. Laupland KB, Church DL, Mucenski M, Sutherland LR, Davies HD Population-based study of the epidemiology of and the risk factors for invasive *Staphylococcus aureus* infections *J Infect Dis* 2003,187 (9)·1452-1459

38. Mokdad AH, Ford ES, Bowman BA, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA* 2003,289(1).76-79

39. Kyaw MH, Rose CE Jr, Fry AM, et al, Active Bacterial Core Surveillance Program of the Emerging INfections Program Network The influence of chronic illnesses on the incidence of invasive pneumococcal disease in adults *J Infect Dis* 2005,192(3) 377-386

40. Bagger JP, Zindrou D, Taylor KM Postoperative infection with methicillin-resistant *Staphylococcus aureus* and socioeconomic background *Lancet* 2004, 363(9410) 706-708

41. Hidron AI, Kourbatova EV, Halvosa JS, et al Risk factors for colonization with methicillin-resistant *Staphylococcus aureus* (MRSA) in patients admitted to an urban hospital. emergence of community-associated MRSA nasal carriage. *Clin Infect Dis* 2005;41(2).159-166.

42. Muto CA, Jernigan JA, Ostrowsky BE, et al; SHEA SHEA guideline for preventing nosocomial transmission of multidrug-resistant strains of *Staphylococcus aureus* and *Enterococcus Infect Control Hosp Epidemiol*. 2003;24(5).362-386.

43. Siegel JD, Jackson M, Chiarello L, Healthcare Infection Control Practices Advisory Committee Management of multidrug-resistant organisms in healthcare settings, 2006 2006 http://www cdc gov/ncidod /dhqp/index.html. Accessed June 29, 2007.

44. Sunenshine RH, Liedtke LA, Fridkin SK, Strausbaugh LJ; Infectious Diseases Society of America Emerging Infections Network Management of inpatients colonized or infected with antimicrobial-resistant bacteria in hospitals in the United States *Infect Control Hosp Epidemiol* 2005,26(2) 138-143

45. Centers for Disease Control and Prevention Methicillin-resistant *Staphylococcus aureus* infections in correctional facilities—Georgia, California, and Texas, 2001-2003. *MMWR Morb Mortal Wkly Rep* 2003, 52(41) 992-996

46. Zinderman CE, Conner B, Malakooti MA, LaMar JE, Armstrong A, Bohnker BK Community-acquired methicillin-resistant *Staphylococcus aureus* among military recruits *Emerg Infect Dis* 2004,10(5) 941-944

47. Wootton SH, Arnold K, Hill HA, et al Intervention to reduce the incidence of methicillin-resistant *Staphylococcus aureus* skin infections in a correctional facility in Georgia *Infect Control Hosp Epidemiol* 2004,25(5) 402-407

THE NEW ENGLAND JOURNAL OF MEDICINE

CLINICAL PRACTICE

Skin and Soft-Tissue Infections Caused by Methicillin-Resistant *Staphylococcus aureus*

Robert S. Daum, M.D., C M

This Journal *feature begins with a case vignette highlighting a common clinical problem. Evidence supporting various strategies is then presented, followed by a review of formal guidelines, when they exist. The article ends with the author's clinical recommendations.*

A 37-year-old man presents for the evaluation of localized swelling and tenderness of the left leg just below the knee. He suspects this lesion developed after a spider bite, although he did not see a spider. Examination of the leg reveals an area of erythema and warmth measuring approximately 5 by 7 cm. At the center of the lesion is a fluctuant area measuring approximately 2 by 2 cm, overlaid by a small area of necrotic skin. The man's temperature is 38.3°C. The pulse rate is 115 beats per minute. The blood pressure is 116/78 mm Hg. How should this patient be evaluated and treated?

THE CLINICAL PROBLEM

From the Section of Infectious Diseases, Department of Pediatrics, University of Chicago, Chicago

N Engl J Med 2007;357:380-90

Methicillin-resistant *Staphylococcus aureus* (MRSA) refers to isolates that are resistant to all currently available β-lactam antibiotics, including penicillins and cephalosporins.[1] MRSA isolates were first recognized shortly after the introduction of methicillin into clinical practice in the early 1960s. Their prevalence slowly increased during the next three decades,[2] although they remained confined almost exclusively to patients who frequented health care facilities; other persons at risk for MRSA colonization or infection included those in contact with a person who had an MRSA infection or with a history of illicit drug use.

In the mid-1990s, MRSA infections began to be detected in the community in persons who did not have contact with the health care system.[3] Molecular typing of isolates from these community-associated cases of MRSA infection has shown that they are largely caused by new MRSA strains.[4]

As compared with health care–associated MRSA isolates, community-associated MRSA isolates are usually susceptible to clindamycin, and they are less often multiply resistant to other non–β-lactam antibiotics.[5] Other distinguishing features of community-associated MRSA isolates include a high prevalence of genes encoding the two-component Panton–Valentine leukocidin[6]; this exotoxin is associated with necrosis of the skin, severe necrotizing pneumonia,[7] and abscess formation, although its role in the pathogenesis of community-associated MRSA infections remains controversial.[8,9] In addition, small DNA cassettes mediating methicillin resistance[4,10,11] have been detected in community-associated MRSA isolates of multiple genetic backgrounds, suggesting easy transfer. These cassettes differ from those in hospital-associated MRSA strains, which are larger and presumably less mobile. The classification of circulating community-associated MRSA strains according to pulsed-field electrophoretic patterns[12] has revealed global, geographic variations. In most areas of the United States, a community-associated MRSA genotype called USA300 has emerged as the major circulating strain and has even emerged as a nosocomial strain in many areas.[13]

Numerous reports have suggested the easy transmission of these new community-associated MRSA isolates in settings where people are in close contact. These settings include households,[14] day-care centers,[15,16] and military installations.[17] These isolates also may be spread among prison and jail detainees[18] and athletes.[19] Before the 1990s, such evidence of contagion among otherwise healthy members of the community was documented infrequently. Other groups reported to be at increased risk for community-associated MRSA infection include Native Americans[20] and Pacific Islanders[21] and men who have sex with men.[22]

There has been a dramatic increase in the occurrence of *S. aureus* infections in general and community-associated MRSA infections in particular. At Driscoll Children's Hospital in Corpus Christi, Texas, the number of community-associated MRSA infections increased from 9 in 1999 to 459 in 2003[23]; in 2003, these infections constituted 98% of *S. aureus* infections overall in that institution. In most, but not all, U.S. cities, community-associated MRSA is now the most common pathogen cultured from patients with skin and soft-tissue infections in emergency departments.[24] Epidemic community-associated MRSA disease has also been reported from some rural areas, although epidemic disease has not yet spread to all regions of the United States.

Consistent with the occurrence of epidemic, symptomatic, community-associated MRSA disease in the United States are observations of the increasing prevalence of asymptomatic colonization of MRSA among children[25] and adults[26] in the community. Recent data indicate that 9.2% of healthy children in Nashville have asymptomatic colonization[23] (74% of these infections are community-associated MRSA [Creech CB: personal communication]), as compared with 0.8% in 2001, and 7.3% of adolescents and adults in Atlanta have asymptomatic colonization, including both hospital- and community-acquired MRSA isolates.[24]

Skin and soft-tissue infections represent the majority of the community-associated MRSA disease burden[27] and are the focus of this article. Examples of such infections are shown in Figures 1 and 2. (Other examples are in the Supplementary Appendix, available with the full text of this article at www.nejm.org.) Necrotic skin lesions are a common presentation and are often incorrectly attributed to bites by brown recluse spiders (even in areas where these spiders do not live) or insect bites. In addition, necrotizing pneumonia,[28] pleural empyema, necrotizing fasciitis,[29] septic thrombophlebitis with pulmonary embolization,[30] myositis,[31] and severe sepsis with purpura fulminans and the Waterhouse–Friderichsen syndrome[32] have been described in association with community-associated MRSA.[28,29,33]

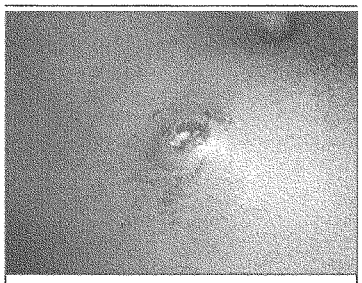


Figure 1. Anterior Abdominal-Wall Abscess in a 15-Year-Old Boy.

There was a 3-day history of drainage from this abscess, which had increased in size to 1 cm in length and become more painful. It was fluctuant and tender on examination. Incision and drainage were performed, about 2 ml of purulent material was obtained. A culture yielded MRSA that was susceptible to clindamycin. The results of the D-zone test were negative.

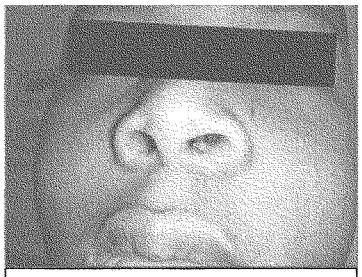


Figure 2. Swelling and a Small Amount of Drainage Involving the Left Naris in a 10-Year-Old Girl.

There was a 5-day history of drainage from the lesion. The child appeared well and did not have a fever. Incision and drainage yielded 0.5 ml of purulent material. A culture yielded MRSA that was susceptible to clindamycin. The results of the D-zone test were negative.

STRATEGIES AND EVIDENCE

EVALUATION

Suspicion that community-associated MRSA may be the cause of a skin and soft-tissue infection should be heightened by a history of previous MRSA infection in the patient or a household contact. Table 1 lists other groups likely to be at risk for community-associated MRSA transmission. However, many patients with community-associated MRSA infection have none of these risk factors. Furthermore, no clinical features distinguish with certainty skin and soft-tissue infections caused by MRSA from those caused by methicillin-susceptible *S. aureus*.[38]

Information on local antibiotic-resistance patterns (e.g., from local hospitals) can help clinicians to assess the likelihood of community-associated MRSA infection and guide decisions regarding empirical treatment. Some have suggested that management strategies should be tailored to the possibility of community-associated MRSA infection on the basis of an arbitrary threshold of 10% or more methicillin resistance among *S. aureus* isolates.

Obtaining a specimen for culture and susceptibility testing, which was considered to be unnecessary when the prevalence of MRSA was low, is useful in guiding therapy. Specimens are most commonly obtained at the time of incision and drainage of purulent skin and soft-tissue lesions. In nonpurulent cellulitis that is not amenable to incision and drainage, a possible approach is a biopsy with culture of the material obtained. In practice, this procedure is infrequently performed.[39] Moreover, although many patients with MRSA bacteremia also have nasal colonization with the organism,[40] it is not known whether screening for such colonization in a patient with a skin and soft-tissue infection has useful predictive value. Such screening is not currently recommended.

TREATMENT

The recommended treatment of community-associated MRSA infection depends on an assessment of the severity of the clinical presentation and the type of skin and soft-tissue infection. Purulent skin and soft-tissue infections without associated systemic signs, such as fever, tachycardia, or hemodynamic instability, are generally managed with incision and drainage, with or without oral antimicrobial therapy; incision and drainage alone may suffice, particularly for abscesses that are small. Lee et al.[41] have defined small abscesses as those that are less than 5 cm in length, but this definition may not be appropriate for skin and soft-tissue infections in infants and in certain areas of the body (e.g., the head and neck). In patients with larger abscesses, systemic signs of infection, or both, antimicrobial therapy is generally recommended in addition to incision and drainage (for purulent lesions). The type and route of therapy should be guided by the severity of the clinical syndrome.

Outpatient Therapies

Topical antimicrobial therapy is sometimes used to treat superficial MRSA skin infections such as impetigo, although comparative outcome data are lacking. Bacitracin, alone or in combination with polymyxin and neomycin, mupirocin (Bactroban), and retapamulin (Altabax) are commercially available for this purpose. For bacitracin, in vitro susceptibility factors that predict the clinical outcome have not been defined.[42] For mupirocin, isolates with low-level resistance and those with high-level resistance have been identified; the latter do predict clinical failure and may be increasing in prevalence among MRSA isolates.[43,44] Retapamulin is newly licensed for children 9 months of age or older. It has good in vitro activity against MRSA infection, but mutants with decreased susceptibility can be selected in vitro.[45]

For oral systemic treatment, β-lactam antibiotics can no longer be considered to be reliable as empirical therapy for community-acquired skin and soft-tissue infections. The optimal antibiotic

Table 1. Persons at Risk for Skin and Soft-Tissue Infections Caused by Community-Associated MRSA.

Household contacts of a patient with proven community-associated MRSA infection[14]
Children[34]
Day-care center contacts of hospitalized patients with MRSA infections[15,16]
Men who have sex with men[22]
Soldiers[17,18]
Incarcerated persons[18]
Athletes, particularly those involved in contact sports[19]
Native Americans[20]
Pacific Islanders[21]
Persons with a previous community-associated MRSA infection[35,36]
Intravenous drug users[37]

therapy when community-associated MRSA infection is suspected is not clear. Results of susceptibility testing and clinical experience provide support for a primary role of older antibiotics such as clindamycin, trimethoprim–sulfamethoxazole, and tetracyclines, although their effectiveness for skin and soft-tissue infections due to community-associated MRSA has not been rigorously evaluated or compared in clinical trials.

Table 2 lists oral agents that are useful in the outpatient management of community-associated MRSA infections. An observational study showed that clindamycin, a lincosamide antibiotic, was uniformly effective in 39 patients with clindamycin-susceptible community-associated MRSA infection who were mildly to moderately ill.[46] The disadvantages of this medication include its association with diarrhea caused by *Clostridium difficile* and increasing rates of clindamycin resistance in some regions of the world.[11,47,48] Clindamycin resistance among community-associated MRSA isolates should be monitored locally, and some experts recommend avoiding empirical therapy with clindamycin when local rates of clindamycin resistance exceed 10 to 15% among MRSA isolates causing skin and soft-tissue infections.

Moreover, the results of testing for clindamycin susceptibility may be misleading; occasional treatment failures have been documented when the results of tests showed that an MRSA isolate was susceptible to clindamycin but resistant to erythromycin.[46,49] In such cases, use of the D-zone test (Fig. 3) is warranted to detect inducible clindamycin resistance; positive results in 10 to 20% of tested isolates (with one notable outlier[49]) have been reported, but these rates may be increasing. The Clinical and Laboratory Standards Institute suggests that isolates that are positive on the D-zone test should be reported as being resistant to clindamycin despite a positive result of single-agent susceptibility testing.[50] The institute suggests permissive language to accompany the result of the susceptibility testing: "The isolate is presumed to be resistant based on detection of inducible clindamycin resistance. Clindamycin might still be effective in some patients." In practice, when the results of the D-zone test become known, the use of clindamycin should be reconsidered on the basis of the clinical response.

Neither trimethoprim–sulfamethoxazole nor tetracyclines are generally recommended as sole empirical therapy for a nonpurulent cellulitis of unknown cause because of concerns regarding the resistance of group A streptococci to these agents. Such resistance is well documented for tetracyclines, although it is less clear for trimethoprim–sulfamethoxazole.[39] However, these agents are reasonable choices in cases in which community-associated MRSA infection is confirmed or strongly suggested by the presence of purulent material. Some clinicians suggest the addition of a β-lactam antibiotic, that is active against streptococci if trimethoprim–sulfamethoxazole or a tetracycline is used for a nonpurulent cellulitis of uncertain cause.

Testing of nearly all community-associated MRSA isolates shows susceptibility to trimethoprim–sulfamethoxazole, but data on the outcomes of treatment are limited. In a study at an outpatient clinic in Boston where almost half of community-associated MRSA isolates were clindamycin-resistant and where trimethoprim–sulfamethoxazole became the most frequently used antimicrobial agent for skin and soft-tissue infections caused by community-associated MRSA,[47] the percentage of patients with clinical resolution of the MRSA infection increased in parallel with trimethoprim–sulfamethoxazole use during the study period (1998 to 2005). In another study, however, treatment failure occurred in 6 of 12 adults who received double-strength trimethoprim–sulfamethoxazole.[51] Few data are available to provide support for the efficacy of doxycycline or minocycline. In one retrospective review of skin and soft-tissue infections caused by community-associated MRSA, the cure rate was 83%.[52]

Linezolid, a newer antimicrobial agent in the oxazolidinone family, is active against almost all community-associated MRSA isolates and group A streptococci. The disadvantages of this agent include its high cost, the lack of routine availability, hematologic side effects, and the potential for resistance among *S. aureus* strains, possibly by multiple mechanisms. Prolonged linezolid administration increases the likelihood of resistance, probably through the accumulation of mutations in multiple copies of the 23S ribosomal RNA *S. aureus* gene.[53]

Rifampin is highly active against susceptible community-associated MRSA isolates, but a high frequency of mutations to rifampin resistance is a contraindication for the use of rifampin alone.[54] Thus, a combination of trimethoprim–sulfamethoxazole or doxycycline with rifampin is sometimes used for the treatment of skin and soft-tissue infections caused by community-asso-

Table 2. **Oral Agents for the Outpatient Treatment of Putative Community-Associated MRSA Infections.**

Medication	Usual Dose*		Formulations	Main Side Effects and Contraindications	Comments
	Adults	Children			
Clindamycin (Cleocin)	300 mg thrice daily	30 mg/kg of body weight/day, in three or four divided doses	Tablet, suspension	Diarrhea caused by *Clostridium difficile*	Many patients dislike the taste of the suspension
Trimethoprim–sulfamethoxazole (Bactrim, Septra)	1 to 2 double-strength tablets twice daily (each tablet containing trimethoprim, 160 mg, and sulfamethoxazole, 800 mg)	Trimethoprim, 8–12 mg/kg/day, and sulfamethoxazole, 40–60 mg/kg/day, in two divided doses	Tablet, suspension	Nausea, vomiting, rash, photosensitivity, hematologic suppression (especially thrombocytopenia), the Stevens–Johnson syndrome	
Tetracyclines					
Doxycycline (Doryx, Adoxa, Doxy-100, Monodox, Vibramycin, Vibra-Tabs)	100–200 mg/day, in one dose or two divided doses	2–4 mg/kg/day, in one dose or two divided doses	Capsule, tablet, suspension	Nausea, photosensitivity, deposition in teeth and bones Contraindicated in children younger than 9 years of age because of potential deposition in teeth and bones	
Minocycline (Dynacin, Minocin)	200 mg/day, in two divided doses	4 mg/kg/day, in two divided doses	Capsule, tablet, suspension	Nausea, photosensitivity, deposition in teeth and bones, vestibular toxicity Contraindicated in children younger than 9 years of age because of potential deposition in teeth and bones	
Linezolid (Zyvox)	600 mg twice daily	30 mg/kg/day, in three divided doses	Tablet, suspension	Myelosuppression (usually thrombocytopenia), but can cause anemia or neutropenia, mostly with prolonged use	The cost is relatively high; oral suspension may not be immediately available at many pharmacies
Rifampin (Rifadin, Rimactane)	20 mg/kg/day, in one dose or two divided doses; maximum dose, 600 mg/day	20 mg/kg/day, in one dose or two divided doses; maximum dose, 600 mg/day	Capsule	Discoloration of body fluids, abnormalities in liver function, drug–drug interactions Cannot be used alone because resistant mutants are selected at an unacceptably high rate	No suspension is commercially available; capsule powder may be sprinkled on food such as applesauce

* Optimal doses have not been established for all drugs listed

ciated MRSA,[51] although data are lacking to provide support for this approach.

Fluoroquinolones should not be used to treat skin and soft-tissue infections caused by community-associated MRSA. Resistance to them develops readily in *S. aureus* and is already widely prevalent.[24]

Inpatient Therapies

Some patients with community-associated MRSA infection will require more aggressive treatment than incision and drainage with or without oral antimicrobial therapy on an outpatient basis. A decision to hospitalize a patient for parenteral therapy (Table 3) depends on several factors, including clinical judgment regarding the severity of the illness. The presence of a large abscess, fever, other signs of systemic infection, or high-risk characteristics such as an age younger than 6 months, diabetes, or immunodeficiency should prompt consideration of hospitalization. The detailed management of invasive disease due to community-associated MRSA is beyond the scope of this review.

Vancomycin is still considered the first-line treatment for hospitalized patients with invasive *S. aureus* infection. However, this drug should be switched if susceptibility testing indicates that a more rapidly bactericidal β-lactam agent such as oxacillin would be appropriate. Microbiologic treatment failure may occur with vancomycin even if there is no increase in the minimal inhibitory concentration (MIC) on susceptibility testing.[55,56] *S. aureus* isolates with low-level (so-called intermediate) resistance to vancomycin (MIC, >2 μg per milliliter) as well as those with high-level resistance (MIC, >16 μg per milliliter) have been described, and they may not be identified by means of routine techniques for susceptibility testing.[57] Although resistant isolates are believed to be infrequent, global decreased susceptibility (so-called MIC creep) among *S. aureus* isolates has been documented in several locations in the United States,[58-60] and this decreased susceptibility may limit the continued effectiveness of vancomycin. Some experts have proposed that the use of a higher dose and maintenance of high serum levels of vancomycin may be beneficial, but the efficacy of these strategies has not been proved.

Parenteral clindamycin may be useful in regions where the likelihood of a resistant organism is low. It should not be used as sole therapy when the patient is moderately to severely ill.

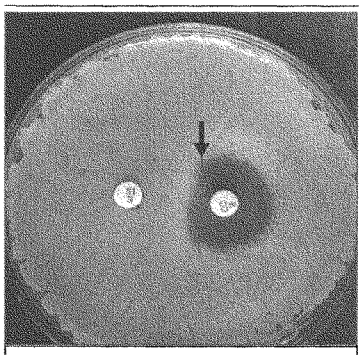


Figure 3. The D-Zone Test for Erythromycin-Resistant, Clindamycin-Susceptible Isolates.

The Clinical and Laboratory Standards Institute advises clinical microbiology laboratories to perform a D-zone test on erythromycin-resistant, clindamycin-susceptible isolates. This test detects inducible clindamycin resistance; blunting of the clindamycin zone of inhibition (arrow) suggests the presence of an *erm* gene in the test isolate that is inducible by erythromycin. The *erm* gene can confer the macrolide–lincosamide–streptogramin B phenotype to an isolate with cross-resistance to macrolide antibiotics such as erythromycin, lincosamide antibiotics such as clindamycin, and streptogramin B antibiotics. E denotes erythromycin, and CC clindamycin concentration.

Intravenous trimethoprim–sulfamethoxazole has undergone minimal evaluation for invasive *S. aureus* infection. A study of intravenous drug abusers with serious *S. aureus* infections antedated the epidemic of community-associated MRSA infection, and it indicated that intravenous trimethoprim–sulfamethoxazole was significantly less effective than vancomycin.[61]

Parenteral linezolid lacks bactericidal activity, which some experts believe is important in treating intravascular infection, a common feature of invasive disease. Moreover, reports of a case of endocarditis caused by a susceptible organism during linezolid therapy and of clinical failure in patients treated with linezolid for endocarditis have raised concerns about its use alone for severe, invasive *S. aureus* infections[62,63] (an exception is health care–associated MRSA pneumonia, for which linezolid has proved efficacious[64]).

Tigecycline, a parenteral glycylcycline–minocycline derivative, was also recently approved by the Food and Drug Administration (FDA) for the

Table 3. **Parenteral Agents for the Treatment of Putative Community-Associated MRSA Infections.**

Medication	Usual Dose*		Main Side Effects and Contraindications	Comments
	Adults	Children		
Vancomycin (Vancocin)	2–4 g/day, in two to four divided doses	40 mg/kg/day, in three to four divided doses	The red-man syndrome (a histamine-release syndrome usually manifested as flushing)	Slowing the rate of administration is usually sufficient management for the red-man syndrome, but accompanying hypotension may require discontinuation of the drug or additional intervention in rare cases Excretion is slowed in patients with renal failure, and serum levels should be monitored in such patients to avoid drug accumulation; whether such monitoring is routinely necessary in patients with normal renal function is not clear, but it should be performed when multiple nephrotoxic drugs are administered simultaneously
Clindamycin (Cleocin)	300 mg thrice daily	30 mg/kg/day, in three divided doses	Diarrhea caused by *C. difficile*	
Daptomycin (Cubicin)	4–6 mg/kg, once daily	Unknown	Potential muscle toxicity	Resistance was documented in 6 of 120 patients receiving this therapy† Excretion is slowed in patients with renal failure, and dosage adjustment is recommended
Tigecycline (Tygacil)	100 mg loading dose, then 50 mg every 12 hr	Unknown	Nausea, vomiting, photosensitivity, deposition in teeth and bones Contraindicated in children younger than 9 years of age because of potential deposition in teeth and bones	
Linezolid (Zyvox)	600 mg, every 12 hr	30 mg/kg/day, in two to three divided doses	Myelosuppression (usually thrombocytopenia, but also anemia or neutropenia), mostly with prolonged use	The cost is relatively high
Quinupristin and dalfopristin (Synercid)	7.5 mg/kg, every 8–12 hr	7.5 mg/kg, every 8–12 hr	Hyperbilirubinemia, arthralgias and myalgias, phlebitis, drug–drug interactions (especially with cytochrome P450 3A4 substrates)	Dosage adjustment may be necessary in patients with hepatic impairment

* Optimal doses have not been established for all drugs listed.
† Data are from Fowler et al.[55]

treatment of skin and soft-tissue infections caused by MRSA.[65] This approval was granted on the basis of data showing microbiologic eradication in 25 of 32 adults (78%) with complicated skin and soft-tissue infections.

A fixed combination of the streptogramins quinupristin and dalfopristin (Synercid) was licensed by the FDA for the treatment of skin and soft-tissue infections caused by methicillin-susceptible *S. aureus*. Its use has been limited by the potential for drug–drug interactions and by side effects (including arthralgias, myalgias, and gastrointestinal toxic effects).

Daptomycin, a cyclic lipodepsipeptide, has been approved by the FDA for use in patients with skin and soft-tissue infections. The success rate with the use of daptomycin for these infections is 75% — similar to that of vancomycin. It is also approved for MRSA bacteremia,[55] including that associated with right-sided endocarditis, but it should not be used for pneumonia, for which its efficacy has been limited by its propensity for binding surfactant.[66]

AREAS OF UNCERTAINTY

The optimal oral antimicrobial regimen for the treatment of skin and soft-tissue infections is not

known. A trial addressing this question, sponsored by the National Institutes of Health, is expected to be initiated this year.

The optimal management of recurrent community-associated MRSA disease is also uncertain. Although not well studied, the recurrence rate is believed to be 10% or higher. It is not clear whether recurrences represent autoinoculation or a new MRSA infection. At present, recurrent episodes are generally treated in the same way as the initial episode. In addition, "decolonization" strategies are frequently recommended in such cases, although neither the indications for their use nor their effectiveness in reducing the risk of recurrences is clear. One such strategy is the use of intranasal mupirocin to reduce nasal carriage of MRSA; however, eradication of nasal colonization appears to be transient, and the use of this agent remains controversial. Moreover, the recent identification of a mupirocin-resistance gene in USA300 isolates (which accounted for 97% of isolates in a recent study[24]) and of mupirocin resistance among 11 community-associated MRSA isolates in Boston raises serious concern about exposing populations of staphylococci to this agent.[67] Some experts have also proposed adjunctive attempts at skin decolonization. Topical chlorhexidine gluconate or 1 tsp (3.4 g) of bleach diluted in 1 gallon (3.8 liters) of bath water is commonly suggested, although these approaches have not been rigorously evaluated. The optimal strength of the chlorhexidine solution is not known, nor is it clear whether it is more effective if the solution is permitted to remain on the skin before rinsing.

Contagion among the close household contacts of patients, as well as correctional facility, school, and sports-team contacts, is well recognized. Although the risk of transmission has not been well quantified, anecdotal evidence suggests that more than 60% of households of children hospitalized with community-associated MRSA infections have one or more members with a history of a putative MRSA infection in the previous 6 months. If this estimate proves to be correct, it will lend support to the empirical treatment of an entire household (perhaps even including pets) if an effort to eradicate community-associated MRSA colonization in a patient is undertaken. The efficacy of such an approach has not been studied.

The role of fomites needs to be clarified. Hospital-aequired MRSA isolates can survive on a variety of inanimate surfaces, sometimes for weeks. It is unclear whether this is also true for community-associated MRSA isolates; if it is, their presence on such items as clothing, towels, and athletic equipment might contribute to outbreaks. Pets (including dogs and cats), livestock, and birds have been identified as MRSA carriers; their role in MRSA transmission to humans requires further evaluation.[68] Local hygiene measures recommended by an expert panel from the Centers for Disease Control and Prevention (CDC) are shown in Table 4.

No vaccine is currently available for *S. aureus*. Many experts believe that it is unlikely that a single-antigen approach will prove to be effective.

Table 4. Recommended Measures to Limit the Spread of Community-Associated MRSA Isolates.*

Cover draining wounds with clean bandages.
Wash hands, especially after contact with a contaminated wound
Launder clothing after contact with a contaminated area on the skin
Bathe regularly with use of soap.
Avoid sharing items (e.g., towels, bedding, clothing, razors, or athletic equipment) that may become contaminated by contact with wounds or skin flora.
Clean sports equipment with agents that are effective against staphylococci (e.g., a detergent or disinfectant registered by the Environmental Protection Agency, such as quaternary ammonium compounds or a solution of dilute bleach)

* Information is modified from Gorwitz et al.[69]

GUIDELINES

The CDC has issued guidelines for the prevention and management of community-associated MRSA infections.[69] The recommendations in this article are largely concordant with this review.

CONCLUSIONS AND RECOMMENDATIONS

With the increasing prevalence of community-associated MRSA infection, the management of skin and soft-tissue infections requires knowledge of local rates of MRSA infection. Many experts suggest an arbitrary threshold of more than 10% methicillin resistance among *S. aureus* isolates

causing skin and soft-tissue infections acquired in the community and recommend inclusion of antimicrobial therapy against community-associated MRSA when managing a putative *S. aureus* infection.

In a patient such as the man described in the vignette, presenting with an abscess or a purulent and necrotic skin lesion, incision and drainage are the cornerstones of therapy; purulent material should be cultured. In many patients, particularly those with small lesions (<5 cm in length), incision and drainage alone will be adequate therapy. If the skin lesions are large or accompanied by systemic signs of infection or if there is evidence of an increased risk of complicated community-associated MRSA disease, antimicrobial therapy that is active against community-associated MRSA is also recommended. Therapy ultimately should be guided by the results of susceptibility testing of cultures obtained before the initiation of therapy.

Although data directly comparing antimicrobial agents for the treatment of community-associated MRSA infection are lacking, clindamycin, trimethoprim–sulfamethoxazole, or a long-acting tetracycline such as doxycycline is a reasonable initial choice; linezolid is another possibility. Follow-up is essential, since relapse or recurrence may occur.

Supported by grants from the National Institute of Allergy and Infectious Diseases (RO1AI40481 and 5RO1AI067584), the Centers for Disease Control and Prevention (RO1CCR 523379, RO1CI000373, and U01-CI000384), and the Grant HealthCare Foundation.

Dr. Daum reports serving on paid advisory boards for Clorox, Sanofi Pasteur, GlaxoSmithKline, Pfizer, and the MRSA National Faculty Meeting (sponsored by Astellas and Theravance), receiving lecture fees from Nabi Biopharmaceuticals and Pfizer; and receiving grant support from Clorox, Pfizer, Sage Products, and Sanofi Pasteur. No other potential conflict of interest relevant to this article was reported.

I thank Michael David, M.D., Daniel Glikman, M.D., Stephen Weber, M.D., Loren Miller, M.D., and Sharmeen Younus, Pharm.D., for helpful critical comments and Mark A. Hostetler, M.D., of the Department of Pediatrics, University of Chicago, for the photographs of patients.

REFERENCES

1. Crawford SE, Boyle-Vavra S, Daum RS. Community associated methicillin-resistant *Staphylococcus aureus*. In: Hooper D, Scheld M, eds. Emerging infections. Vol. 7. Washington, DC: ASM Press, 2007:153-79.
2. Chambers HF. The changing epidemiology of *Staphylococcus aureus*? Emerg Infect Dis 2001;7:178-82.
3. Herold BC, Immergluck LC, Maranan MC, et al. Community-acquired methicillin-resistant *Staphylococcus aureus* in children with no predisposing risk. JAMA 1998;279:593-8
4. Daum RS, Ito T, Hiramatsu K, et al. A novel methicillin-resistance cassette in community-acquired methicillin-resistant *Staphylococcus aureus* isolates of diverse genetic backgrounds. J Infect Dis 2002;186:1344-7.
5. Naimi TS, LeDell KH, Como-Sabetti K, et al. Comparison of community- and health care-associated methicillin-resistant *Staphylococcus aureus* infection. JAMA 2003;290:2976-84.
6. Vandenesch F, Naimi T, Enright MC, et al. Community-acquired methicillin-resistant *Staphylococcus aureus* carrying Panton-Valentine leukocidin genes: worldwide emergence. Emerg Infect Dis 2003;9:978-84.
7. Gillet Y, Issartel B, Vanhems P, et al. Association between *Staphylococcus aureus* strains carrying gene for Panton-Valentine leukocidin and highly lethal necrotising pneumonia in young immunocompetent patients. Lancet 2002;359:753-9.
8. Voyich JM, Otto M, Mathema B, et al. Is Panton-Valentine leukocidin the major virulence determinant in community-associated methicillin-resistant *Staphylococcus aureus* disease? J Infect Dis 2006;194:1761-70.
9. Labandeira-Rey M, Couzon F, Boisset S, et al. *Staphylococcus aureus* Panton Valentine leukocidin causes necrotizing pneumonia. Science 2007;315:1130-3.
10. Ito T, Ma XX, Takeuchi F, Okuma K, Yuzawa H, Hiramatsu K. Novel type V staphylococcal cassette chromosome *mec* driven by a novel cassette chromosome recombinase, *ccrC*. Antimicrob Agents Chemother 2004;48:2637-51.
11. Boyle-Vavra S, Ereshefsky B, Wang CC, Daum RS. Successful multiresistant community-associated methicillin-resistant *Staphylococcus aureus* lineage from Taipei, Taiwan, that carries either the novel staphylococcal chromosome cassette *mec* (SCC*mec*) type V_T or SCC*mec* type IV. J Clin Microbiol 2005;43:4719-30. [Erratum, J Clin Microbiol 2005;43:6223.]
12. McDougal LK, Steward CD, Killgore GE, Chaitram JM, McAllister SK, Tenover FC. Pulsed-field gel electrophoresis typing of oxacillin-resistant *Staphylococcus aureus* isolates from the United States: establishing a national database. J Clin Microbiol 2003;41:5113-20.
13. Marcel CL, Daum RS, Boyle-Vavra S, Matayoshi K, Miller LG. Community-associated methicillin-resistant *Staphylococcus aureus* isolates causing healthcare-associated infections. Emerg Infect Dis 2007;13:236-42.
14. Dietrich DW, Auld DB, Mermel LA. Community-acquired methicillin-resistant *Staphylococcus aureus* in southern New England children. Pediatrics 2004;113(4):e347-e352.
15. Adcock PM, Pastor P, Medley F, Patterson JE, Murphy TV. Methicillin-resistant *Staphylococcus aureus* in two child care centers. J Infect Dis 1998;178:577-80.
16. Shahin R, Johnson IL, Jamieson F, McGreer A, Tolkin J, Ford-Jones EL. Methicillin-resistant *Staphylococcus aureus* carriage in a child care center following a case of disease. Arch Pediatr Adolesc Med 1999;153:864-8.
17. Ellis MW, Hospenthal DR, Dooley DP, Gray PJ, Murray CK. Natural history of community-acquired methicillin-resistant *Staphylococcus aureus* colonization and infection in soldiers. Clin Infect Dis 2004;39:971-9.
18. Aiello AE, Lowy FD, Wright LN, Larson EL. Meticillin-resistant *Staphylococcus aureus* among US prisoners and military personnel: review and recommendations for future studies. Lancet Infect Dis 2006;6:335-41.
19. Kazakova SV, Hageman JC, Matava M, et al. A clone of methicillin-resistant *Staphylococcus aureus* among professional football players. N Engl J Med 2005;352:468-75
20. Groom AV, Wolsey DH, Naimi TS, et al. Community-acquired methicillin-resistant *Staphylococcus aureus* in a rural American Indian community. JAMA 2001;286:1201-5.
21. Castrodale LJ, Beller M, Gessner BD. Over-representation of Samoan/Pacific Islanders with methicillin-resistant *Staphylococcus aureus* (MRSA) infections at a large family practice clinic in Anchorage, Alaska, 1996-2000. Alaska Med 2004,46:88-91.
22. Lee NE, Taylor MM, Bancroft E, et al. Risk factors for community-associated methicillin-resistant *Staphylococcus aureus*

skin infections among HIV-positive men who have sex with men. Clin Infect Dis 2005;40:1529-34. [Erratum, Clin Infect Dis 2005;41:135.]

23. Purcell K, Fergie J. Epidemic of community-acquired methicillin-resistant *Staphylococcus aureus* infections: a 14-year study at Driscoll Children's Hospital. Arch Pediatr Adolesc Med 2005;159:980-5.

24. Moran GJ, Krishnadasan A, Gorwitz RJ, et al. Methicillin-resistant *S. aureus* infections among patients in the emergency department. N Engl J Med 2006;355:666-74.

25. Creech CB II, Kernodle DS, Alsentzer A, Wilson C, Edwards KM. Increasing rates of nasal carriage of methicillin-resistant *Staphylococcus aureus* in healthy children. Pediatr Infect Dis J 2005;24:617-21.

26. Hidron AI, Kourbatova EV, Halvosa JS, et al. Risk factors for colonization with methicillin-resistant *Staphylococcus aureus* (MRSA) in patients admitted to an urban hospital: emergence of community-associated MRSA nasal carriage. Clin Infect Dis 2005;41:159-66.

27. Kaplan SL, Hulten KG, Gonzalez BE, et al. Three-year surveillance of community-acquired *Staphylococcus aureus* infections in children. Clin Infect Dis 2005;40:1785-91.

28. Mongkolrattanothai K, Boyle S, Kahana MD, Daum RS. Severe *Staphylococcus aureus* infections caused by clonally related community-acquired methicillin-susceptible and methicillin-resistant isolates. Clin Infect Dis 2003;37:1050-8.

29. Miller LG, Perdreau-Remington F, Rieg G, et al. Necrotizing fasciitis caused by community-associated methicillin-resistant *Staphylococcus aureus* in Los Angeles. N Engl J Med 2005;352:1445-53.

30. Gonzalez BE, Teruya J, Mahoney DH Jr, et al. Venous thrombosis associated with staphylococcal osteomyelitis in children. Pediatrics 2006;117:1673-9.

31. Pannaraj PS, Hulten KG, Gonzalez BE, Mason EO Jr, Kaplan SL. Infective pyomyositis and myositis in children in the era of community-acquired, methicillin-resistant *Staphylococcus aureus* infection. Clin Infect Dis 2006;43:953-60.

32. Adem PV, Montgomery CP, Husain AN, et al. *Staphylococcus aureus* sepsis and the Waterhouse–Friderichsen syndrome in children. N Engl J Med 2005;353:1245-51.

33. Kravitz GR, Dries DJ, Peterson ML, Schlievert PM. Purpura fulminans due to *Staphylococcus aureus*. Clin Infect Dis 2005; 40:941-7.

34. Fridkin SK, Hageman JC, Morrison M, et al. Methicillin-resistant *Staphylococcus aureus* disease in three communities. N Engl J Med 2005;352:1436-44.

35. Szumowski JD, Cohen DE, Kanaya F, Mayer KH. Treatment and outcomes of infections by methicillin-resistant *Staphylococcus aureus* at an ambulatory clinic. Antimicrob Agents Chemother 2007;51:423-8.

36. Skiest DJ, Brown K, Cooper TW, Hoffman-Roberts H, Mussa HR, Elliott AC. Prospective comparison of methicillin-susceptible and methicillin-resistant community-associated *Staphylococcus aureus* infections in hospitalized patients. J Infect 2007;54:427-34.

37. Young DM, Harris HW, Charlebois ED, et al. An epidemic of methicillin-resistant *Staphylococcus aureus* soft tissue infections among medically underserved patients. Arch Surg 2004;139:947-53.

38. Miller LG, Perdreau-Remington F, Bayer AS, et al. Clinical and epidemiologic characteristics cannot distinguish community-associated methicillin-resistant *Staphylococcus aureus* infection from methicillin-susceptible *S. aureus* infection: a prospective investigation. Clin Infect Dis 2007;44:471-82.

39. Swartz MN. Cellulitis. N Engl J Med 2004;350:904-12.

40. von Eiff C, Becker K, Machka K, Stammer H, Peters G. Nasal carriage as a source of *Staphylococcus aureus* bacteremia. N Engl J Med 2001;344:11-6.

41. Lee MC, Rios AM, Aten MF, et al. Management and outcome of children with skin and soft tissue abscesses caused by community-acquired methicillin-resistant *Staphylococcus aureus*. Pediatr Infect Dis J 2004;23:123-7.

42. Jones RN, Li Q, Kohut B, Biedenbach DJ, Bell J, Turnidge JD. Contemporary antimicrobial activity of triple antibiotic ointment: a multiphased study of recent clinical isolates in the United States and Australia. Diagn Microbiol Infect Dis 2006; 54:63-71.

43. Han LL, McDougal LK, Gorwitz RJ, et al. High frequencies of clindamycin and tetracycline resistance in methicillin-resistant *Staphylococcus aureus* pulsed-field type USA300 isolates collected at a Boston ambulatory health center. J Clin Microbiol 2007;45:1350-2.

44. Diep BA, Gill SR, Chang RF, et al. Complete genome sequence of USA300, an epidemic clone of community-acquired meticillin-resistant *Staphylococcus aureus*. Lancet 2006;367:731-9.

45. Gentry DR, Rittenhouse SF, McCloskey L, Holmes DJ. Stepwise exposure of *Staphylococcus aureus* to pleuromutilins is associated with stepwise acquisition of mutations in *rplC* and minimally affects susceptibility to retapamulin. Antimicrob Agents Chemother 2007;51:2048-52.

46. Martinez-Aguilar G, Hammerman WA, Mason EO Jr, Kaplan SL. Clindamycin treatment of invasive infections caused by community-acquired methicillin-resistant and methicillin-susceptible *Staphylococcus aureus* in children. Pediatr Infect Dis J 2003; 22:593-8.

47. Szumowski JD, Cohen DE, Kanaya F, Mayer KH. Treatment and outcomes of infections by methicillin-resistant *Staphylococcus aureus* at an ambulatory clinic. Antimicrob Agents Chemother 2007;51:423-8.

48. Kaplan SL, Hulten KG, Gonzalez BE, et al. Three-year surveillance of community-acquired *Staphylococcus aureus* infections in children. Clin Infect Dis 2005;40: 1785-91.

49. Frank AL, Marcinak JF, Mangat PD, et al. Clindamycin treatment of methicillin-resistant *Staphylococcus aureus* infections in children. Pediatr Infect Dis J 2002;21: 530-4.

50. Performance standards for antimicrobial susceptibility testing; seventeenth informational supplement. M100-S17. Wayne, PA: Clinical and Laboratory Standards Institute, 2007:52.

51. Iyer S, Jones DH. Community-acquired methicillin-resistant *Staphylococcus aureus* skin infection: a retrospective analysis of clinical presentation and treatment of a local outbreak. J Am Acad Dermatol 2004, 50:854-8.

52. Ruhe JJ, Monson T, Bradsher RW, Menon A. Use of long-acting tetracyclines for methicillin-resistant *Staphylococcus aureus* infections: case series and review of the literature. Clin Infect Dis 2005;40:1429-34.

53. Peeters MJ, Sarria JC. Clinical characteristics of linezolid-resistant *Staphylococcus aureus* infections. Am J Med Sci 2005; 330:102-4.

54. Strausbaugh LJ, Jacobson C, Sewell DL, Potter S, Ward TT. Antimicrobial therapy for methicillin-resistant *Staphylococcus aureus* colonization in residents and staff of a Veterans Affairs nursing home care unit. Infect Control Hosp Epidemiol 1992;13: 151-9.

55. Fowler VG Jr, Boucher HW, Corey GR, et al. Daptomycin versus standard therapy for bacteremia and endocarditis caused by *Staphylococcus aureus*. N Engl J Med 2006; 355:653-65.

56. Moore MR, Perdreau-Remington F, Chambers HF. Vancomycin treatment failure associated with heterogeneous vancomycin-intermediate *Staphylococcus aureus* in a patient with endocarditis and in the rabbit model of endocarditis. Antimicrob Agents Chemother 2003;47:1262-6.

57. Centers for Disease Control and Prevention. VISA/VRSA: vancomycin-intermediate/resistant *Staphylococcus aureus*. (Accessed July 2, 2007, at http://www.cdc.gov/ncidod/dhqp/ar_visavrsa.html.)

58. Wang G, Hindler JF, Ward KW, Bruckner DA. Increased vancomycin MICs for *Staphylococcus aureus* clinical isolates from a university hospital during a 5-year period. J Clin Microbiol 2006;44:3883-6.

59. Kapadia M, Coyle E, Prince R, et al. Declining in vitro activity of vancomycin against *Staphylococcus aureus* isolates from cancer patients. In: Programs and abstracts of the 45th Interscience Conference on Antimicrobial Agents and Chemotherapy, Washington, DC, December 16–19, 2005. Washington, DC: American Society for Microbiology, 2005. abstract.

60. Golan Y, Baiez-Giangreco C, O'Sullivan C, Snydman DR. Trends in vancomycin susceptibility among consecutive MRSA bacteremic isolates. In: Proceedings of the 44th Annual Meeting of the Infectious Dis-

eases Society of America, Toronto, October 12–15, 2006. Arlington, VA: Infectious Diseases Society of America, 2006:LB11. abstract.

61. Markowitz N, Quinn EL, Saravolatz LD. Trimethoprim-sulfamethoxazole compared with vancomycin for the treatment of *Staphylococcus aureus* infection. Ann Intern Med 1992;117:390-8.

62. Ben Mansour EH, Jacob E, Monchi M, et al. Occurrence of MRSA endocarditis during linezolid treatment. Eur J Clin Microbiol Infect Dis 2003;22:372-3.

63. Corne P, Marchandin H, Macia JC, Jonquet O. Treatment failure of methicillin-resistant *Staphylococcus aureus* endocarditis with linezolid. Scand J Infect Dis 2005;37:946-9.

64. Wunderink RG, Rello J, Cammarata SK, Croos-Dabrera RV, Kollef MH. Linezolid vs vancomycin: analysis of two double-blind studies of patients with methicillin-resistant *Staphylococcus aureus* nosocomial pneumonia. Chest 2003;124:1789-97.

65. Stein GE, Craig WA. Tigecycline: a critical analysis. Clin Infect Dis 2006;43:518-24.

66. Silverman JA, Mortin LI, Vanpraagh AD, Li T, Alder J. Inhibition of daptomycin by pulmonary surfactant: in vitro modeling and clinical impact. J Infect Dis 2005;191:2149-52.

67. Diep BA, Gill SR, Chang RF, et al. Complete genome sequence of USA300, an epidemic clone of community-acquired meticillin-resistant *Staphylococcus aureus*. Lancet 2006;367:731-9.

68. Leonard FC, Meticillin-resistant BKM. *Staphylococcus aureus* in animals: a review. Vet J (in press).

69. Gorwitz RJ, Jernigan DB, Powers JH, Jernigan JA. 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. (Accessed July 2, 2007, at http://www.cdc.gov/ncidod/dhqp/pdf/ar/CAMRSA_ExpMtgStrategies.pdf.)

CORRECTION

Skin and Soft-Tissue Infections Caused by Methicillin-Resistant *Staphylococcus aureus*

Skin and Soft-Tissue Infections Caused by Methicillin-Resistant *Staphylococcus aureus* . The last sentence of the third paragraph (page 380) should have read "In most areas of the United States, a community-associated MRSA genotype called USA300 has emerged as the major circulating strain and has even emerged as a nosocomial strain in many areas," rather than "USA300 has emerged as the major circulating and nosocomial strain." In Table 2 (page 384) the usual dose of doxycycline for adults should have read "100–200 mg/day, in one dose or two divided doses" rather than "in two or four divided doses." The usual dose of doxycycline for children should have read "2–4 mg/kg/day, in one dose or two divided doses" rather than "2–4 mg/kg/day, in two or four divided doses " Also in Table 2, the usual dose of rifampin for adults should have read "20 mg/kg/day, in one dose or two divided doses" rather than "in two or four divided doses " The usual dose of rifampin for children should have read "20 mg/kg/day, in one dose or two divided doses" rather than "in two or four divided doses." In Table 3 (page 386) the usual dose of daptomycin for adults should have read "4–6 mg/kg, once daily" rather than "4–6 mg/kg/day, in four divided doses " The usual dose of linezolid (Zyvox) for adults should have read "600 mg, every 12 hr" rather than "600 mg/day, in two divided doses " The text and tables have been corrected on the *Journal*'s Web site at www.nejm.org. We regret the errors.

N Engl J Med 2007;357:1357-a

Emerging Infections 7
Edited by W. M. Scheld, D. C Hooper, and J. M Hughes

Chapter 9

Community-Associated Methicillin-Resistant *Staphylococcus aureus*

Susan E. Crawford, Susan Boyle-Vavra, and Robert S. Daum

Staphylococcus aureus is a pathogen associated with a wide range of community- and hospital-associated diseases, ranging from relatively trivial skin and soft tissue infections to severe sepsis with high mortality (82). The organism may be found in the nasopharyngeal or skin flora of 25 to 40% of otherwise healthy children and adults (129).

Penicillin was the first highly effective antimicrobial compound active against *S. aureus*. However, β-lactamase-producing strains emerged soon after the use of penicillin became widespread (11, 113). The plasmid-borne gene for β-lactamase production conferred resistance to penicillin and could be found in most *S. aureus* isolates by the end of World War II. The trend of increasing resistance to penicillin has continued to this day, with about 95% of clinical isolates resistant to this and related compounds.

Antibiotics relatively resistant to β-lactamase-induced hydrolysis (e.g., methicillin or oxacillin) were introduced in the 1960s. Resistance to them, however, was recognized almost immediately (64), and within a year after their introduction, additional reports of strains resistant to these antibiotics emerged in Europe and Australia (7, 10). These resistant strains were called "methicillin-resistant *Staphylococcus aureus*" (MRSA), a term that implied cross-resistance to all β-lactams, including a wide range of penicillins and cephalosporins. MRSA isolates first appeared in the United States in 1961, and by the late 1970s, MRSA outbreaks were reported in large urban tertiary-care teaching hospitals (8, 12, 107). From the 1970s to the late 1990s, the prevalence of asymptomatic MRSA colonization and symptomatic infection slowly increased, but the causative isolates remained largely confined to health care environments and to the personal ecologies of the patients who frequented them. Risk factors for MRSA colonization or disease other than exposure to a hospital or long-term health care facility included antibiotic use in the past 12 months, contact with a household member who had a risk factor for MRSA acquisition, chronic disease, and nonmedicinal intravenous-drug use (13, 126). Therapeutic options to treat MRSA were few; vancomycin, a glycopeptide antibiotic, was pressed into heavy service in the treatment of MRSA infections and was called the "antibiotic of last resort."

Susan E. Crawford, Susan Boyle-Vavra, and Robert S. Daum • Department of Pediatric Infectious Diseases, University of Chicago, 5841 S. Maryland, MC 6054, Chicago, IL 60637.

EPIDEMIOLOGY

In the past decade, this view of MRSA epidemiology has changed. No longer confined to hospital environments or isolated only from patients with identifiable risk factors, MRSA strains now circulate in the community among previously healthy patients with no risk factors for acquisition of "hospital-associated" MRSA (HA-MRSA). These community isolates differ from HA-MRSA in their epidemiology and spectrum of disease. Their rapidly increasing prevalence has also created a need for reconsideration of basic therapeutic paradigms.

Reports of MRSA infections first identified in the community emerged in several geographic locations in the 1990s (54, 57, 84, 95, 114). The early reports were initially thought to reflect the carriage of MRSA from hospital environments into the community. In support of this interpretation, many community-onset MRSA infections were identified in persons with known risk factors for acquisition of MRSA in the hospital, including recent hospitalization, residence in a long-term care facility, dialysis, recent surgery, indwelling catheters or devices, and intravenous-drug use (33, 77, 118, 119, 120).

A distinct phenomenon, however, was subsequently observed when "community-associated" MRSA (CA-MRSA) cases were reported among patients, predominantly children, without these typical risk factors (27, 53, 57, 59, 60). At the University of Chicago Children's Hospital, the prevalence of CA-MRSA infections among children without predisposing risk for MRSA requiring hospitalization for serious *S. aureus* infections increased from 10 per 100,000 admissions in 1988 to 1990 to 259 per 100,000 admissions in 1993 to 1995 (57) and remained high in a follow-up study performed in 1998 and 1999 (59). In this context, risk was defined as the presence of any of the following: previous hospitalization or antimicrobial therapy within 6 months of the date of MRSA isolation, a history of endotracheal intubation, an underlying chronic disorder, presence of an indwelling venous or urinary catheter, a history of any surgical procedure, or notation in the medical record of a household contact with an identified risk factor.

This same dramatic increase in CA-MRSA disease has now been observed by many others, and outbreaks of disease have occurred among members of sports teams and in prisons and military units (18, 24, 25, 35, 42, 79, 105, 111, 112).

Several clinical and epidemiologic factors initially suggested that the newly recognized CA-MRSA isolates differed from HA-MRSA strains. In addition to MRSA disease being found in persons without the traditional risk factors, the CA-MRSA isolates had antibiotic susceptibility profiles distinct from those of HA-MRSA isolates (57, 114). Whereas the isolation of MRSA in the hospital often dictated the use of vancomycin because of its multiple antibiotic resistance phenotype, community strains were usually susceptible to a variety of non-β-lactam antimicrobials. This finding suggested that therapeutic options for CA-MRSA infections might be expanded to include treatment with clindamycin, trimethoprim-sulfamethoxazole, or doxycycline, options infrequently considered previously in the treatment of hospital-acquired MRSA infections. Later investigations revealed the evolutionary basis for these differences in antibiotic susceptibilities among the community and hospital MRSA strains.

The further observation was made that CA-MRSA disease syndromes resembled those caused by "community-associated" methicillin-susceptible *S. aureus* (CA-MSSA), rather than those seen as a result of HA-MRSA infections (57). Like CA-MSSA, the majority of

identified disease caused by CA-MRSA consisted of skin and soft tissue infections, such as boils, furuncles, and abscesses (57, 96, 112, 133). HA-MRSA typically caused infections such as bacteremia associated with an indwelling venous device, postoperative wound infections, or ventilator-associated pneumonia (96). It quickly became apparent that CA-MRSA also caused relatively infrequent but severe invasive diseases, such as necrotizing pneumonia, necrotizing fasciitis, osteomyelitis, and a septic shock syndrome characterized by multiorgan involvement with high mortality among children (2, 22, 52, 91). The similarity in presentation between CA-MSSA and CA-MRSA suggested that the genetic backgrounds of the "CA" *S. aureus* isolates might be similar, as was later confirmed by molecular typing methods.

DISEASE BURDEN

With the recognition of CA-MRSA as a distinct, emerging etiologic agent, reports of outbreaks of CA-MRSA infections across the country and beyond became numerous. A large burden of CA-MRSA disease was reported by prison and jail systems in California, Texas, Mississippi, and Georgia. Outbreaks in these facilities have suggested that conditions in the prison and jail systems might facilitate the spread of CA-MRSA isolates (5, 25, 35, 105). Indeed, hypothesized factors that probably aid in the spread of MRSA include suboptimal personal hygiene, poor access to medical care, infrequent or inadequate laundering of clothing, and limited or restricted access to soap (25). It has been proposed that jails and prisons serve as reservoirs for MRSA in which short inmate stays may provide sufficient time for transmission of CA-MRSA and conditions may facilitate an increase in prevalence with easy spread and return of the isolates into the community. Proposals to diminish the spread of CA-MRSA include skin infection screening and monitoring, culturing of relevant lesions, administration of appropriate antibiotics, improving inmate hygiene, and improving access to medical care. Many issues in the roles of the jail and prison require additional study and definition.

Outbreaks among players on high school, college, and professional sports teams have also occurred. Several individuals have required hospitalization and temporary exclusion from play (24, 71, 79). Contact sports, including wrestling and football, appear to increase the risk of MRSA transmission, and players with the most intense person-to-person contact (e.g., linemen and linebackers in football) have had a higher risk for disease (71, 100). Even members of teams in which skin-to-skin contact was minimal have experienced problems; multiple cases of CA-MRSA infection among members of a fencing club led to the hypothesis that contaminated equipment worn by multiple players might be responsible for transmission (24).

Additional sites where close contact has provided opportunity for the spread of CA-MRSA include military training centers (19, 135) and day care centers (1, 122). The need for improved hygiene, increased monitoring of skin lesions, and improved awareness of the overall problem are issues raised by each of these outbreaks.

Outbreaks have provided incentives to examine the epidemiology of CA-MRSA in closer detail. Additionally, evidence of increasing endemic occurrence of CA-MRSA infections has been provided through MRSA surveillance performed in several communities. Surveillance by the Community Health Network of San Francisco (20) tracked MRSA infections from 1996 to 2002 and found that the number of MRSA isolates increased from

160 in 1996 to 563 in 2002. Eighty-two percent of the total number of MRSA infections from 1998 to 2002 above the baseline rate in 1996 to 1997 could be attributable to CA-MRSA, as defined by an organism isolated in the outpatient setting or within 72 hours of hospitalization. Confirmation that the organisms were indeed "community onset-type" organisms was provided by genotyping to show that the responsible isolates were not "feral" descendents of hospital isolates migrating into the community (see "Bacterial Genetic Investigations" below). The University of California at San Francisco has established a unique clinic specifically for the evaluation and treatment of skin and soft tissue infections (the Integrated Skin and Soft Tissue Clinic) due to the large number of patients requiring physician visits and operating room time for incision and drainage of abscesses caused by CA-MRSA (133).

More evidence to substantiate the idea that CA-MRSA infections and the overall burden of *S. aureus* infections are both dramatically increasing was provided by investigators at Driscoll Children's Hospital in Corpus Christi, Texas. Purcell et al. documented an increase in the number of infections caused by CA-MRSA in their institution from 9 in 1999 to 459 in 2003 (111, 112). The number of MRSA cases almost doubled in 1 year, from 282 infections in 2002 to 467 infections in 2003, with 98% of the infections due to CA-MRSA. Importantly, these increases were directly translated into similar increases in the overall burden of *S. aureus* disease. At Texas Children's Hospital in Houston, similar increases in both the absolute number of community-acquired *S. aureus* infections and the percentage of CA-MRSA compared with all *S. aureus* infections increased in a 3-year period. The percentage of CA-MRSA isolates increased from 71.5% (551 of 771 *S. aureus* isolates) in year 1 to 76.4% (1,193 of 1,562 isolates) in year 3 (69). Other centers have experienced similar increases in the disease burden due to CA-MRSA. This dramatic increase in the *S. aureus* burden and CA-MRSA has not occurred in all geographic locales. Centers already experiencing the increase, however, have continued to do so, and their numbers have relentlessly increased with time

Certain individuals appear to be at higher risk for CA-MRSA disease. In prospective surveillance performed in Baltimore and Atlanta, children younger than 2 years of age had a higher risk for disease than others (48). In the same study African-Americans had a higher risk than whites in Atlanta, but this difference did not hold true in Baltimore. Other studies have suggested a relatively higher incidence of disease among Pacific Islanders, American Indians, and Alaskan Natives (4, 55). Factors that may contribute to the disease burden in certain populations include increased prevalence of certain underlying diseases or differences in socioeconomic factors (e.g., household/community crowding or decreased access to medical care). Study design may have influenced the results and conclusions from some of these studies. For example, a definition of CA-MRSA that includes only MRSA obtained from persons without risk factors for hospital-acquired MRSA may exclude individuals infected with isolates that are genetically defined CA-MRSA isolates (see "Bacterial Genetic Investigations" below). Members of certain populations also may not be sampled or cultured with the same frequency as others.

BACTERIAL GENETIC INVESTIGATIONS

Important genetic phenomena are believed to be responsible for the phenotypic differences observed in comparisons of CA-MRSA and HA-MRSA isolates. Methicillin

resistance is conferred by the *mecA* gene, which encodes penicillin-binding protein 2a (PBP2a), an enzyme catalyzing transpeptidation of *S. aureus* peptidoglycan. PBP2a has low affinity for β-lactam antibiotics. PBP2a, in partnership with native *S. aureus* PBP2, allows the synthesis of peptidoglycan even in the presence of a β-lactam antimicrobial, thus rendering the bacteria resistant to β-lactam antibiotics (26, 109).

mecA is located on a mobile genetic island called the staphylococcal chromosomal cassette *mec* (SCC*mec*) (61), which is present in all MRSA isolates with a single exception (132). The SCC*mec* cassette contains a *mec* complex consisting of *mecA* and its variably present regulatory elements *mecR1* and *mecI*, and *ccr* genes that encode recombinases responsible for the excision of SCC*mec* and its integration into the staphylococcal chromosome. The MecR1 protein binds to β-lactam antibiotics with subsequent proteolytic cleavage of MecI (134). This cleavage of MecI results in derepression of *mecA*, enabling the transcription of *mecA*.

These SCC*mec* elements have been found in multiple *S. aureus* backgrounds, although the mechanism for their movement from strain to strain is not known. Site-specific chromosomal integration of an SCC*mec* element is the genetic event that converts a methicillin-susceptible *S. aureus* strain into a methicillin-resistant strain. Molecular testing of *Staphylococcus epidermidis* isolates dating from 1973 to 1983 also revealed the presence of SCC*mec* elements in that species, suggesting that interspecies transfer of those genetic elements from *S. epidermidis* to *S. aureus* may have occurred (130). SCC elements lacking *mecA* found in *Staphylococcus hominis* (70) and *S. epidermidis* (94) have lent credence to the idea that coagulase-negative species act as a reservoir for the variable DNA sequences found in SCC*mec* elements.

Initial characterization of SCC*mec* elements from MRSA isolates revealed three types in which the DNA sequences of the *ccr* genes (*ccr* complex) and the molecular anatomies of the *mecA* complexes differed (61). SCC*mec* types II and III contained genes that mediated resistance to non-β-lactam antibiotics, consistent with the multidrug resistance phenotype found among HA-MRSA isolates. For example, SCC*mec* type II contains the *ermA* gene, which confers resistance to erythromycin and inducible or constitutive resistance to clindamycin, as well as resistance determinants for cadmium and neomycin (61).

The three SCC*mec* element types initially characterized were 34, 53, and 67 kb in size and were identified in a survey of HA-MRSA isolates (61). Their sizes were believed to limit facile transfer of the elements to different strains on a frequent basis. Thus, prior to the mid-1990s, dissemination of MRSA relied upon transfer of the entire bacterium, implying potential effectiveness for hospital infection control measures.

In contrast, CA-MRSA strains most often contain the novel SCC*mec* type IV, a 21- to 24-kb element, smaller and probably more mobile than the types II and III found in HA-MRSA isolates. Moreover, five of the six sequenced SCC*mec* IV elements (IVa, GenBank accession numbers AB063172 and NC_003923; IVb, accession number AB063173; IVc, accession numbers AY271717 and AB096217; and IVe, accession number AJ810121) lacked antibiotic resistance genes other than the *mecA* gene, consistent with the CA-MRSA phenotype of susceptibility to multiple non-β-lactam antibiotics (36, 83, 93); one had a gentamicin resistance determinant at the left extremity (strain MR108, accession number AB096217). CA-MRSA strains containing the type IV element often remain susceptible to clindamycin, in part because the sequenced type IV elements are not known to contain the *erm* gene (61). Clindamycin-resistant CA-MRSA strains may have acquired the *erm* gene,

though the location of the *erm* gene has not yet been elucidated (29). More frequently, erythromycin resistance is detected in CA-MRSA strains, as other genetic elements mediating erythromycin resistance, such as *msrA*, can be found elsewhere on a plasmid or in the *S. aureus* genome (18, 29).

SCC*mec* IV has been found in multiple *S. aureus* genetic backgrounds, supporting the hypothesis that it is readily transferred from strain to strain (36, 103, 115). Although both HA-MRSA and CA-MRSA clones can spread as the entire bacterium is transferred, it is suspected that CA-MRSA clones can increase in number as MSSA backgrounds acquire the SCC*mec* type IV element (93).

Recently, another SCC*mec* type, type V, that appears similar to type IV in size (27 kb) and probably in mobility has been discovered. Type V was first identified in several strains from Australia, where it had already entered three *S. aureus* genetic backgrounds (sequence types 45, 8, and 152) (31). A V-like (type V_T) element was subsequently identified in multiply resistant sequence type 59 CA-MRSA strains in Taipei, Taiwan, and was the predominant background found in CA-MRSA in Taipei (15). Thus, there are now five different SCC*mec* elements that have been described, designated SCC*mec* I to V. Additionally, an SCC*mec* element described by Oliveira et al. in strain HDE288 (104), originally described as SCC*mec* IV, cannot actually be classified among types I through V (Table 1). New SCC*mec* genetic elements are being discovered, as the SCC*mec* elements appear to evolve rapidly; recent characterization of strains from patients in Ireland has revealed seven novel variants of extant SCC*mec* element types (123). The rapid evolution of these elements may make current SCC*mec* nomenclature strategies inadequate for classification.

Different methods have been employed to define the genetic background and characteristics of *S. aureus* strains. Pulsed-field gel electrophoresis (PFGE) has been used to follow rapid evolutionary events in the *S. aureus* genome. It is especially useful for assessing the relatedness of strains in an outbreak and for determining the clonal repertoires of strains in the community. A classification system that categorizes strains by their PFGE restriction fragment patterns into lineages designated USA 100, USA 200, etc., has been described and is in wide use (88). Another isolate-fingerprinting technique, multilocus sequence typing (MLST), provides information on slower-paced evolution of *S. aureus* strains, because polymorphisms in the partial sequences of the seven housekeeping genes examined by this

Table 1. Classification scheme of SCC*mec* elements

SCC *mec* type	*ccr* complex	*ccr* gene	*mec* complex
I	1	AB1	B
II	2	AB2	A
III	3	AB3	A
IV[a]	2	AB2	B
V	5	C_1	C2
V_T	5	C_2	C2
HDE288	4	AB4	B

[a]Type IV elements have been subtyped, e.g., a to g, according to polymorphisms in the left extremity of the element, the so-called L-C region, and the right extremity, the so-called I-R region (62, 73, 82, 93, 122). A unified nomenclature system does not exist, however. Both uppercase and lowercase letters have been used, and they sometimes refer to different things; e.g., SCC*mec* IVa has a different DNA sequence from SCC*mec* IVA

method are well conserved (41). CA-MRSA and HA-MRSA often have distinct PFGE and MLST patterns, although some overlap exists

TOXIN GENES AND PATHOPHYSIOLOGY OF DISEASE

The toxin gene repertoire among CA-MRSA isolates has been hypothesized to contribute to the difference in disease spectra between CA-MRSA and HA-MRSA (97). A survey of 16 toxin genes known to be present in genomically sequenced *S. aureus* strains revealed that important differences can be identified when HA-MRSA and CA-MRSA isolates are compared. Six exotoxin genes were found significantly more often among CA-MRSA isolates, and seven were found significantly more often among HA-MRSA strains (97). The exotoxin genes more commonly found in CA-MRSA isolates included *lukS-PV/lukF-PV*, *sea*, *seb*, *sec*, *seh*, and *sek*. It is not clear which of these, if any, confer special virulence characteristics on CA-MRSA isolates.

Two toxin genes present particularly frequently in CA-MRSA isolates, *lukS-PV/lukF-PV*, which encode the Panton-Valentine leukocidin (PVL), have been suspected to play important roles in the virulence of CA-MRSA organisms. PVL is a synergohymenotropic toxin that disrupts the integrity of polymorphonuclear leukocytes, and perhaps other cells. The toxin is hypothesized to cause neutropenia and extensive tissue damage, perhaps mediated by the release of toxic products from neutrophils. The PVL genes are transferred from strain to strain by one of several bacteriophages (98). They insert at a site-specific chromosomal location that is distinct from the SCC*mec* element insertion site.

PVL is not a newly identified toxin, but the epidemiology of *S. aureus* isolates carrying the PVL genes has changed (51, 106). The genes encoding PVL were found in only about 1 to 2% of unselected MSSA isolates (89, 110). However, when disease-causing MSSA isolates were examined, the genes encoding PVL were found in 93% of isolates obtained from patients with furunculosis and 85% of isolates from patients with community-acquired *S. aureus* pneumonia (32, 78). In contrast, *S. aureus* isolates obtained from blood rarely contain the PVL genes (89). PVL genes have also been associated with isolates causing empyema and a distinctive necrotizing pneumonia (44, 52). In a case-control study of MSSA and MRSA isolates causing community-acquired *S. aureus* pneumonia, isolates containing the PVL genes caused more severe disease characterized by hemoptysis, tissue necrosis, and higher morbidity and mortality than isolates that lacked the genes (50).

Data on the prevalence of PVL genes among colonizing CA-MRSA strains obtained by the National Health and Nutrition Survey in 2001 and 2002 suggest that PVL genes are less frequently found among colonizing CA-MRSA strains. This population-based survey detected MRSA carriage in 75 of 9,622 surveyed individuals, with 37 of the 75 MRSA isolates (50%) containing SCC*mec* type IV and 38 containing SCC*mec* type II. Of the 37 people colonized with SCC*mec* type IV-containing strains, only 6 (16%) carried the genes encoding PVL, and none of the SCC*mec* type II-containing strains contained these genes. Additionally, among asymptomatic CA-MRSA isolates colonizing the noses of military personnel, the genes encoding PVL were present in 58% of the strains (40). Nasal swabs collected from 500 healthy children at a Tennessee clinic presenting for a health maintenance visit found that 46, or 9.2%, of the children had nasal colonization with MRSA; only 10, or 22%, of these strains contained the genes for PVL (34). Thus, the presence of PVL in

CA-MRSA strains does not appear to be necessary for colonization and presumably, therefore, spread

Although the PVL genes are not consistently present in nasal-colonization strains obtained from otherwise healthy individuals, there is a strong correlation between the presence of PVL genes and CA-MRSA disease isolates. Isolates from a case series of patients with necrotizing fasciitis and necrotizing myositis all contained PVL genes, and these, along with *lukD* and *lukE*, were the only toxin genes detected among the 14 MRSA disease isolates (91). CA-MRSA isolates obtained from children and adults with necrotizing pneumonia have also been found to contain *lukS-PV/lukF-PV* (44, 93). Among disease-causing CA-MRSA isolates, 77 to 100% contain the PVL genes (92, 97, 103, 127).

The CA-MRSA epidemic has been fueled by multiple *S. aureus* genetic backgrounds containing the PVL genes. Analysis of CA-MRSA strains containing SCC*mec* IV from the United States and Australia found PVL in five different CA-MRSA backgrounds defined by MLST (103). Analysis of 117 CA-MRSA disease-causing strains from the United States, France, Switzerland, Australia, New Zealand, and Western Samoa found that the CA-MRSA strains uniformly contained both SCC*mec* type IV and the PVL loci (127). These CA-MRSA isolates belonged to six different clonal groups, as defined by PFGE and MLST. These data support the notion that the dramatic increase in CA-MRSA disease largely represents the spread of multiple and diverse *S. aureus* genetic backgrounds rather than the spread of a single clone. Moreover, SCC*mec* IV and PVL together seem to confer a selective advantage for pathogenicity. It is not at present understood why the prevalence of PVL among CA-MRSA strains is so high, as the genes encoding PVL are not believed to be transferred with the SCC*mec* IV complex. Recently, PVL genes were also found in SCC*mec* type V_T strains from patients and healthy children in Taiwan (15). It is also not understood why the spread of CA-MRSA strains containing PVL has occurred so rapidly, whereas disease-causing MSSA strains containing PVL are not known to have increased rapidly. Further research is needed to understand these phenomena.

CLINICAL PRESENTATION

Asymptomatic colonization is the most frequent outcome of host interaction with *S. aureus*. Among symptomatic patients, skin and soft tissue infections represent the majority of the disease burden due to CA-MRSA (48, 69). The Centers for Disease Control and Prevention (CDC) conducted population-based prospective surveillance and determined that 77% of 1,647 CA-MRSA infections in Baltimore and Atlanta were skin and soft tissue infections (48). Furuncles, carbuncles, and deep skin abscesses are most common. These skin infections are characterized by local warmth, induration, tenderness, and erythema with or without fluctuance. Dermonecrotic lesions are often initially thought to be brown recluse spider bites or other insect bites, causing delay in diagnosis and treatment. This history is often given by patients even in areas of the country outside the habitat of spiders whose bites can produce similar dermonecrosis. CA-MRSA skin lesions can rapidly progress in size and severity; fever and signs of systemic illness are variably present. In one prospective series of patients presenting to an urban medical center emergency department, half of all skin infections and 75% of all *S. aureus* skin infections were due to MRSA, nearly all of which carried SCC*mec* IV and the PVL genes (46).

The mainstay of treatment for skin abscesses is incision and drainage of the lesion (80). Before the epidemic CA-MRSA era, studies had supported the notion that adjunctive antibiotic therapy was unnecessary in uncomplicated cases of *S. aureus* abscesses, particularly small ones, but data regarding the precise rates of successful treatment, prevention of complications, and recurrence rates of CA-MRSA lesions have been inconclusive. One retrospective study suggested that incision and drainage alone of abscess-equivalent lesions <5 cm in diameter is adequate therapy, but this conclusion assumes the ineffectiveness of "inappropriate" antibiotics, with which many of the patients were also treated (75). Surrounding cellulitis, large lesions, fever, systemic illness, and comorbid conditions suggest the need for adjunctive antimicrobial therapy.

CA-MRSA can also cause more severe disease and has been implicated in several invasive-disease syndromes, including pneumonia with empyema, necrotizing pneumonia, necrotizing fasciitis, septic thrombophlebitis with pulmonary embolization, and severe sepsis syndrome (44, 91, 93). Although some of these invasive-disease syndromes had been previously described with MSSA (50, 78), they appear to be more frequently associated with CA-MRSA. In the CDC prospective surveillance mentioned previously, 6% of CA-MRSA cases were considered "invasive," including bacteremia, septic arthritis, osteomyelitis, and pneumonia (48).

CA-MRSA pneumonia characterized by rapidly progressing respiratory distress, hemoptysis, necrotizing features best viewed by computerized axial tomography (CT), and empyema requiring decortication has been described among children and adults with increased frequency. Patients with CA-MRSA necrotizing pneumonia/empyema present with a syndrome characterized by an influenza or influenza-like prodrome, high fever, leukopenia, respiratory failure, and shock (44). Infection with influenza virus or other viruses may predispose to invasion and infection by colonizing CA-MRSA strains. Chest radiography may reveal lobar or patchy consolidation with or without pneumatoceles. The pneumonia may be classified as "necrotizing" if the chest CT shows a consolidative infiltrate, destruction of normal lung architecture, and loss of tissue enhancement. Necrotizing pneumonia due to CA-MRSA (or CA-MSSA) carrying the genetic determinants for PVL is associated with increased morbidity and mortality compared with community-acquired pneumonia (CAP) due to *S. aureus* strains lacking PVL (50). Suspicion of CA-MRSA pneumonia should be raised when patients present with rapidly progressing respiratory distress, severe systemic illness, or the presence of pleural effusion by radiography or ultrasound. Early signs or predictors of CA-MRSA pneumonia as the etiology would be of clinical use but have yet to be identified (Fig. 1 and 2).

Empiric treatment of suspected CAP has been complicated by the emergence of CA-MRSA as an etiology. Guidelines for empirical therapy for CAP often do not include antimicrobials that successfully treat CA-MRSA, and determination of the etiologic agent of pneumonia is often unsuccessful or impractical. Addition of vancomycin is suggested for the empirical treatment regimen of ill patients with CAP. The presence of a pleural effusion necessitates thoracentesis and drainage, as well as evaluation of the pleural fluid in an effort to diagnose empyema.

Severe sepsis due to CA-MRSA has been increasingly recognized (2, 22, 73, 93). Our definition of severe sepsis includes isolation of *S. aureus* from a clinically important site, hypotension (systolic blood pressure below the fifth percentile for age for children or less than 90 mm Hg for adults), and respiratory distress syndrome or respiratory failure, plus

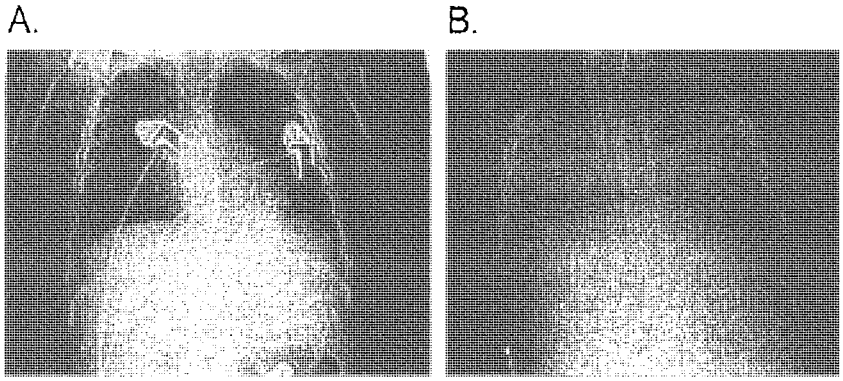


Figure 1. (A) A 2-year-old child with a history of asthma presented to the hospital with tachypnea and fever. The chest X-ray shown here showed patchy airspace disease in the left base, interpreted to be patchy atalectasis associated with asthma. (B) Less than 24 h later, the child's condition had rapidly deteriorated. This chest X-ray shows bilateral airspace opacification of both lungs. MRSA was isolated from the airway of this child and from the lungs at postmortem examination.

clinical or laboratory evidence of abnormal function of the central nervous system, liver, kidneys, muscles, or skin or hemostasis (or a combination thereof), usually in the presence of leukopenia or thrombocytopenia (2). Shock in the presence of pneumonia and purpura fulminans have also been documented. Severe sepsis may be rapidly progressive and result in death. Necrotizing pneumonia is always or nearly always present (Fig. 1). Initial treatment with antibiotics later found to be ineffective against the infecting MRSA strains may have contributed to the deaths of some patients, but death has resulted even when appropriate antibiotics were administered at presentation. The syndrome is often initially suspected to be meningococcemia or toxic shock syndrome. Autopsy results have revealed bilateral adrenal hemorrhage consistent with the Waterhouse-Friderichsen syndrome (2), most commonly associated with meningococcemia. *S. aureus* sepsis is a newly identified cause. Antibiotic therapy directed against MRSA should now be included in the empirical regimen for any patient presenting with sepsis and/or purpura fulminans.

Osteomyelitis, pyomyositis, septic arthritis, necrotizing fasciitis, septic thrombophlebitis, and orbital infections are other syndromes ascribed to CA-MRSA. Most reports have described disease in children, but adults have also been affected (44, 91). Empiric antibiotic coverage for any suspected *S. aureus* syndrome should now include agents active against CA-MRSA.

ASYMPTOMATIC COLONIZATION

When MRSA disease began to be recognized among previously healthy patients without risk for MRSA, it was presumed that asymptomatic MRSA colonization must also be occurring in the general population. Indeed, among healthy children visiting an outpatient health care center for routine care and children visiting a pediatric emergency room

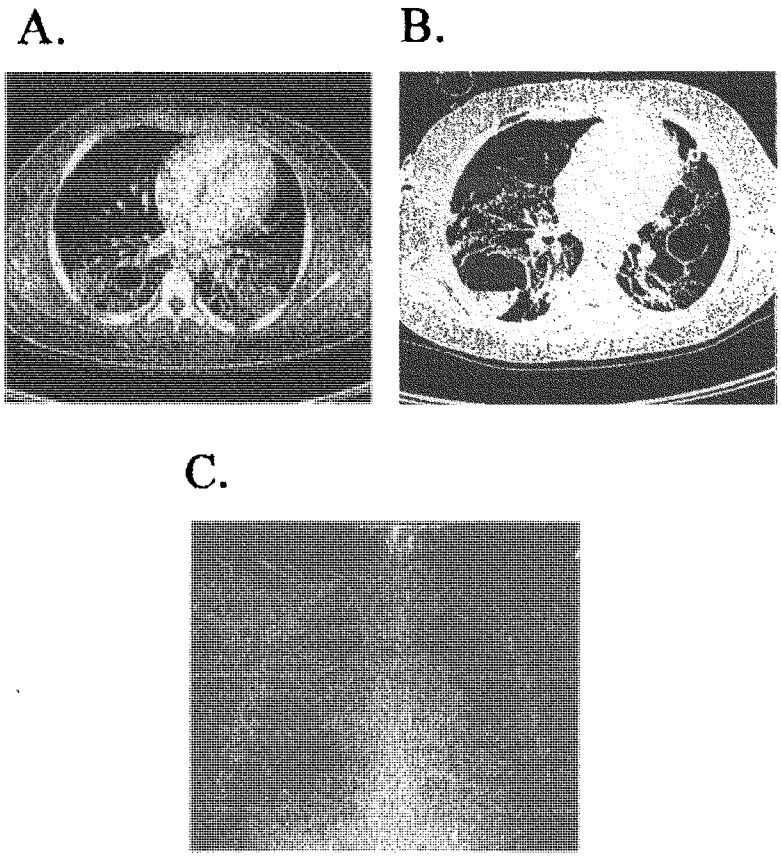


Figure 2. (A) Chest CT of an 8-year-old boy, 1 week after he presented to the hospital with MRSA necrotizing pneumonia. This CT shows extensive opacification and ground-glass appearance of both lungs and multiple pneumatoceles, all due to severe necrotizing pneumonia. (B) Chest CT of the same patient 6 weeks later, showing extensive destruction of normal lung architecture and an anterior pneumothorax. (C) Chest radiograph of the same patient 2 months after presentation, when the patient had recovered from his acute illness. This radiograph shows patchy airspace opacities and numerous pneumatoceles bilaterally.

for an urgent issue, the carrier rates of MRSA were about 1% (60, 125). The National Health and Nutrition Survey surveyed a cross-section of the general population in 2001 and 2002 and also found that about 1% of children and adults carried MRSA among their nasal flora (http://www.cdc.gov/nchs/nhanes.htm). About half of these strains contained SCC*mec* IV, and about half contained SCC*mec* II. Both studies were performed relatively early in the CA-MRSA epidemic, and colonization rates may have subsequently increased. Cultures taken from asymptomatic subjects without risk factors for MRSA colonization in Taiwan from 1997 to 2002 found a colonization rate of 5% (15). Interestingly,

a majority of those colonizing strains contained SCC*mec* IV and lacked the PVL loci, whereas a small subset contained SCC*mec* V_T carrying the PVL determinants. A 2004 Tennessee study of nasal colonization among 500 children presenting for well-child care found a startlingly high MRSA colonization rate of 9.2%, dramatically increased from the 0.8% found in 2001 (34).

Persons asymptomatically colonized with CA-MRSA seem to be at higher risk for *S. aureus* disease than those colonized with MSSA. Ellis et al. found that, among military recruits, those with CA-MRSA nasal colonization had a relative risk of 10.7 for developing clinical infection compared with those colonized with CA-MSSA ($P < 0.001$) (40). Of nine CA-MRSA-colonized participants who developed subsequent infection, eight were colonized with a PVL-positive strain and presented with abscesses, whereas the participant colonized with a PVL-negative strain presented with cellulitis. The MSSA isolates in this study were not characterized further to determine if they contained the PVL determinants.

The presence of the PVL genetic determinants among CA-MRSA isolates may be responsible for the differences in the risk of infection compared with PVL-negative HA-MRSA or PVL-negative MSSA. MSSA strains harboring the genes for PVL have also caused necrotizing pneumonia, sepsis, and skin and soft tissue infections. Further definition of the risk of infection among those colonized with PVL-positive CA-MRSA may have important prognostic and therapeutic implications.

THERAPY FOR CA-MRSA INFECTIONS

The CA-MRSA epidemic has complicated the selection of empirical antibiotic therapy for presumed *S. aureus* infections. The impossibility of clinically distinguishing between infections caused by CA-MSSA and CA-MRSA dictates that clinicians become familiar with the frequencies of CA-MRSA in their respective communities. In areas where the burden of CA-MRSA disease is significant (some have suggested that CA-MRSA strains are >10% of *S. aureus* strains [6]), empirical β-lactam therapy is no longer appropriate. Local resistance rates can be tracked by monitoring hospital clinical microbiology reports and outbreaks investigated by local public health departments. The recommended increased frequency of obtaining diagnostic cultures will also be of value in determining antibiotic susceptibilities.

Whereas treatment of often multiply resistant hospital-associated MRSA called vancomycin into heavy use, options for treatment of CA-MRSA are currently broader. Any antibiotic use has the potential to select for resistant strains, and CA-MRSA may not always remain susceptible to drugs currently available, as suggested by the presence of multidrug-resistant SCC*mec* type IV- and type V-containing CA-MRSA strains in Taiwan (15). The selection of empirical antibiotic therapy should reflect the local rate of methicillin resistance, the disease syndrome, the severity of illness, and the clinical implications of transiently choosing suboptimal therapy before culture and susceptibility results are known. Figure 2 illustrates an approach to the management of skin and soft tissue infections when CA-MRSA is among the likely etiologies. Empirical therapy for possible CA-MRSA invasive disease, including necrotizing pneumonia, septic arthritis, osteomyelitis, necrotizing fasciitis, and severe sepsis, can follow the Fig. 3 paradigms for moderate and severe illness.

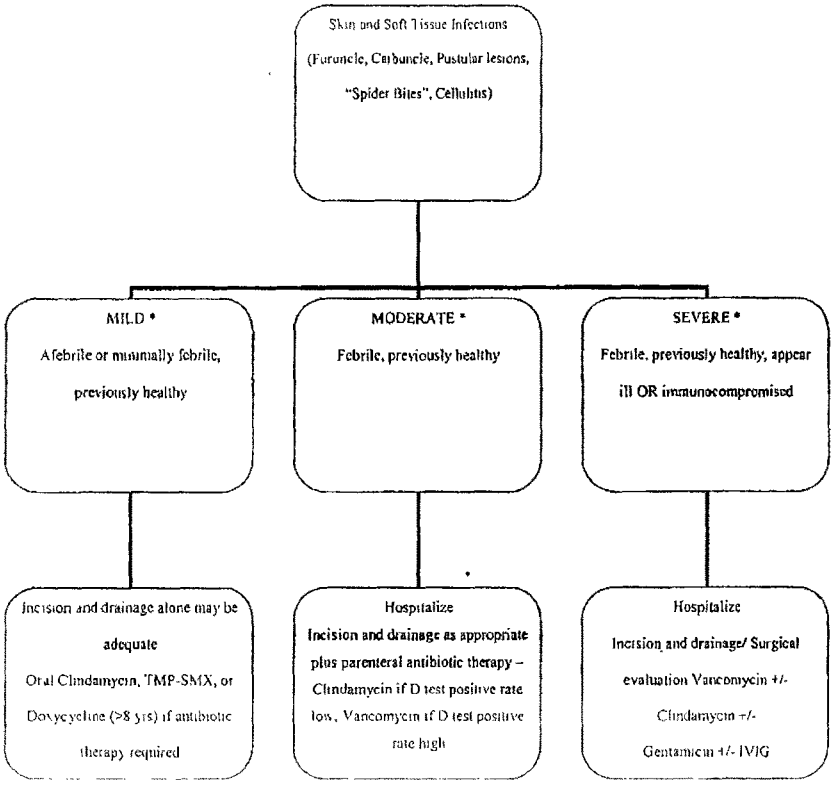


Figure 3. Paradigm for management of patients with CA-MRSA skin and soft tissue infections. The designations mild, moderate, and severe refer to the levels of clinical acuity.

The therapy for possible CA-MRSA disease involves the use of agents, many of which have not been in wide use for *S. aureus* infections prior to the CA-MRSA epidemic. Some relevant clinical properties of these agents are reviewed below.

Clindamycin

Clindamycin is a lincosamide antimicrobial that inhibits protein synthesis at the chain elongation step by interfering with transpeptidation by the 50S ribosomal subunit. It has activity against gram-positive organisms, including *S. aureus*, *Streptococcus pneumoniae*, *Streptococcus pyogenes*, and anaerobic organisms. While most HA-MRSA isolates are resistant to clindamycin, most CA-MRSA isolates are susceptible. A retrospective chart evaluation of patients treated for MRSA infection suggested that clindamycin was effective in treating invasive infections. Outcomes were comparable to those in patients with MSSA infections who were treated with β-lactams (87). Clindamycin is known for its

poor taste as an oral suspension and its potential for precipitating *Clostridium difficile* colitis, and some have remained reluctant to use it. Its advantages, however, include its availability in both oral and intravenous formulations; good tissue penetration, especially into skin and bone; and a lower cost than some alternative therapies.

Characterization of CA-MRSA strains obtained early in the epidemic found that many were resistant only to β-lactams, making clindamycin a reliable choice for therapy. However, reports of increasing erythromycin and clindamycin resistance among community strains have emerged (68).

Clindamycin-susceptible, erythromycin-resistant *S. aureus* (clindamycin-erythromycin-discordant) isolates may reflect several molecular scenarios. Resistance to these antibiotics is commonly mediated by the *erm* gene, giving rise to the so-called macrolide, lincosamide, streptogramin B phenotype (3). These three structurally distinct compounds all interfere with protein synthesis by binding to a common target on the 23S rRNA. The *erm* gene product modifies the common binding target by methylating a critical adenine residue on ribosomal RNA. Expression of *erm* is normally repressed unless it is induced by a 14- or 15-member macrolide, e.g., erythromycin, via a translational attenuation mechanism. Because lincosamides (clindamycin) and streptogramin B do not induce the *erm* gene, isolates that express *erm* only after erythromycin induction are phenotypically resistant to macrolides but test susceptible to lincosamide (clindamycin) and streptogramin B antibiotics. In the presence of a mutation upstream of *erm*, the production of the methylase gene product proceeds without an inducer, and these mutants express a constitutive macrolide, lincosamide, streptogramin B phenotype. Even when inducible *erm* expression is present and clindamycin susceptibility is reported, clindamycin can select for constitutive *erm* expression. Clindamycin treatment failures have been reported under these circumstances (45, 76, 87). Although the frequency is not known, failure is likely to be infrequent.

The potential for clindamycin treatment failure can be assessed by performance of a tandem erythromycin-clindamycin disk diffusion test on all erythromycin-resistant, clindamycin-susceptible *S. aureus* isolates. Guidelines for performance of this "D test" have been published by the Clinical and Laboratory Standards Institute (formerly NCCLS) (99). The D test is performed by placing clindamycin and erythromycin disks at an edge-to-edge distance of 15 to 20 mm. The appearance of a D-shaped zone of clearing around the clindamycin disk indicates the presence of the *erm* gene and erythromycin-induced clindamycin resistance. If the D test is positive, clinicians should be aware that treatment with clindamycin may result in clinical treatment failure (Fig. 4). Clindamycin-susceptible, erythromycin-resistant isolates with a negative D test may contain an efflux pump specific to erythromycin, encoded by another gene called *msrA*. Clindamycin treatment is appropriate for these strains. The proportion of D-test-positive CA-MRSA isolates varies geographically (16, 45), although few data are available that directly address this issue.

Clindamycin has another potential advantage in the treatment of suspected toxin-mediated disease, such as necrotizing fasciitis, necrotizing pneumonia, toxic shock syndrome, and severe sepsis, due to its potent suppression of bacterial protein synthesis. Many experts have argued, therefore, for its hypothetical superiority in toxin-mediated syndromes, although explicit data are lacking. Advocates for clindamycin in this setting often combine it with oxacillin (in areas with low prevalence of MRSA) or vancomycin.

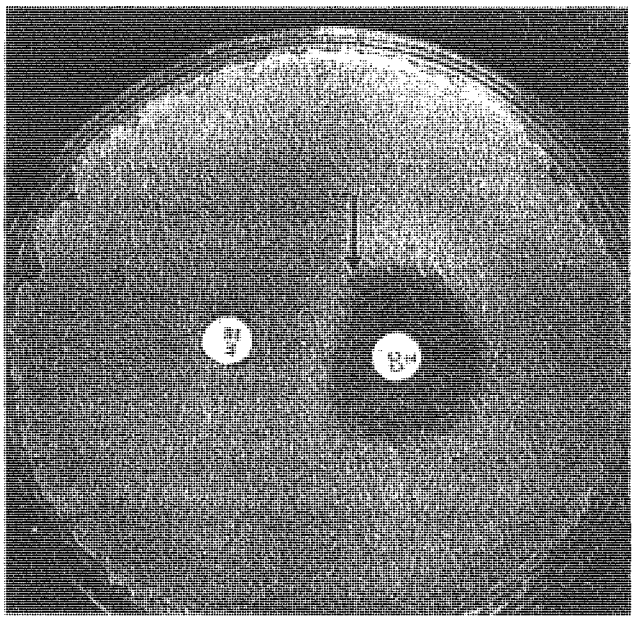


Figure 4. A "D test" is performed on isolates that are resistant to erythromycin but susceptible to clindamycin in order to evaluate the potential for treatment failure when using clindamycin. Blunting of the clindamycin zone of inhibition (marked by a vertical arrow) indicates the presence of an *erm* gene in the test isolate that is inducible by erythromycin.

Clindamycin is bacteriostatic and therefore probably should not be used in the treatment of endocarditis or other intravascular *S. aureus* infections.

Trimethoprim-Sulfamethoxazole

Trimethoprim-sulfamethoxazole (TMP-SMX) interferes with the biosynthesis of tetrahydrofolic acid, essential for microbial synthesis of proteins and nucleotides. Many experts believe that mild to moderate skin infections caused by CA-MRSA can be effectively managed by this fixed antibiotic combination. Lack of clinical experience in using TMP-SMX for *S. aureus* infections and lack of controlled trials supporting its use limit the confidence of some clinicians in this treatment regimen. A study conducted among intravenous-drug users suggested that TMP-SMX might be as effective as vancomycin for *S. aureus* infection, although vancomycin was superior for the treatment of endocarditis (86). A retrospective chart review of patients with cutaneous CA-MRSA infections concluded that a combination of TMP-SMX and rifampin was an effective treatment for cutaneous CA-MRSA infection (63), whereas use of TMP-SMX alone resulted in only a 50% clinical cure rate.

An important limitation of TMP-SMX as empirical therapy for a skin or soft tissue infection is its lack of activity against some strains of group A streptococci. Thus, if group A streptococcal infection is a consideration, e.g., in a patient with cellulitis, TMP-SMX may not be a good choice. Common side effects of TMP-SMX include rash and urticaria. More rarely, clinicians should be alert for the more serious Stevens-Johnson syndrome, hematologic abnormalities, and hepatotoxicity.

Tetracyclines

The long-acting tetracycline derivatives doxycycline, minocycline, and tigecycline have also been considered for the treatment of MRSA. Tigecycline is a novel tetracycline analogue approved by the U.S. Food and Drug Administration in 2005. Comparison of tigecycline with aztreonam plus vancomycin for the treatment of skin and skin structure infections showed equivalence between the two treatments (17). Case series report an 85% success rate in treatment of CA-MRSA infections with minocycline or doxycycline, but randomized trials have not been performed (116). These agents are generally not indicated for use in children younger than 8 years of age due to concern about discoloration of bones and teeth. Oral and intravenous formulations of tetracycline derivatives are available, but tigecycline is available only as an intravenous formulation.

Vancomycin and Related Glycopeptides

Vancomycin is a glycopeptide antimicrobial agent that inhibits the synthesis and assembly of cell wall peptidoglycan by binding to terminal D-Ala–D-Ala lipid II peptide precursors. Vancomycin underwent a marked increase in use when the spread of nosocomial MRSA occurred worldwide and for many years was called the "antibiotic of last resort." It is available only in an intravenous preparation. Adverse effects, including nephrotoxicity, require serum drug level monitoring, especially when other nephrotoxic agents are given concurrently. A histamine-like reaction, known as "red-man syndrome," associated with vancomycin infusion can be avoided by pretreatment with an antihistamine and slowed infusion. Vancomycin should be considered for children with serious suspected MRSA infections, including severe sepsis; toxic shock syndrome; necrotizing pneumonia; intravascular infections, such as septic thrombophlebitis or endocarditis; and necrotizing fasciitis.

Concern about vancomycin resistance is rising, since *S. aureus* isolates with so-called intermediate susceptibility to vancomycin (VISA) have been recovered (21, 124) in association with treatment failure. VISA isolates are believed to occur more frequently than is currently documented, because clinical microbiology laboratories often do not perform the necessary tests to detect intermediate susceptibility (47). Moreover, in 2002, the Centers for Disease Control and Prevention reported the first documented infection caused by high-level vancomycin-resistant *S. aureus* (VRSA) that contained the *vanA* vancomycin resistance genes from enterococci (23, 28, 128). Four additional VRSA isolates have been found subsequently. VRSA isolates are also unreliably detected by routine clinical microbiology laboratory methods.

Another glycopeptide antimicrobial, teicoplanin, is not licensed in the United States but appears to offer no advantage over vancomycin for treatment of staphylococcal infections.

Dalbavancin is a glycopeptide antibiotic with a long half-life currently under investigation for use in the treatment of infections with gram-positive aerobic and anaerobic bacte-

ria. Phase 3 trials in the treatment of skin and soft tissue infections in adults have been completed, but the results are not yet available.

BEYOND VANCOMYCIN

Linezolid

Linezolid is the first agent in a new class of antimicrobials called the oxazolidinones that act to inhibit the initiation step of protein synthesis. Linezolid has broad in vitro activity against β-lactam- and glycopeptide-susceptible and -resistant gram-positive bacteria, including MRSA, VISA, VRSA, and vancomycin-resistant enterococci. Treatment with linezolid has resulted in outcomes similar to those of treatment with vancomycin in patients with skin and soft tissue infections and pneumonia caused by resistant gram-positive organisms, including MRSA. Acquired resistance to linezolid in *S. aureus* has thus far been exceedingly rare. Linezolid is well tolerated in the pediatric population (37, 67, 131). It is available in intravenous and oral forms, and oral bioavailability is approximately 100%, allowing transition from intravenous to oral therapy. Unfortunately, linezolid is very expensive compared with alternative antibiotics. Because it is bacteriostatic against *S. aureus*, it is also not the preferred treatment option in endocarditis and meningitis, for which a bactericidal agent is preferred (30, 117).

Use of linezolid has been associated with reversible neutropenia, anemia, and thrombocytopenia. Monitoring of neutrophils, hemoglobin, and platelets should occur weekly in patients receiving linezolid, particularly if therapy extends beyond 2 weeks; in those with preexisting myelosuppression; or in those receiving other drugs that produce bone marrow suppression. Prolonged use of linezolid has also been associated with optic and peripheral neuropathies

Quinupristin-Dalfopristin (Synercid)

Quinupristin-dalfopristin is a fixed combination of group B and group A streptogramins. Both of these antibiotics bind to the 50S subunit of the bacterial ribosome and have a bactericidal effect resulting from inhibition of protein synthesis. Synercid has in vitro activity against staphylococci, streptococci, and enterococci, excluding *Enterococcus faecalis*. In two randomized open-label trials, the bacteriologic success rate for treatment of gram-positive skin and skin structure infections with quinupristin-dalfopristin was lower than with the standard therapy group (cefazolin, oxacillin, or vancomycin) (101).

ADJUNCTIVE THERAPIES

Intravenous immunoglobulin has been suggested for use in supportive treatment of toxin-mediated diseases, such as toxic shock syndrome (9, 121). The severe, rapidly progressive course in children and adults with necrotizing pneumonia, severe sepsis, and shock due to CA-MRSA may be due in part to toxin-mediated effects. One brand of commercially available intravenous immunoglobulin (IVIG) was found to contain antibody directed against recombinant PVL (49), and thus, IVIG may have a role in limiting toxin-mediated effects. IVIG neutralizes pore formation and the cytolytic effect of PVL in

vitro (49). Clinical trials evaluating the effectiveness of IVIG in CA-MRSA necrotizing pneumonia and severe sepsis are warranted.

PREVENTIVE MEASURES

S. aureus has its primary ecologic niche in the anterior nares. It has been assumed, but not proven, that the same is true for CA-MRSA. Skin-to-skin contact is likely the primary mechanism for transfer of a colonizing or skin and soft tissue infection isolate from one host to another, as evidenced by outbreaks among sports teams and those in close-contact quarters. Preventive measures have focused on decreasing transmission through improved hygiene, including strict wound care, proper disposal of contaminated items, covering unhealed wounds, and hand washing. Some sports teams have increased efforts to schedule equipment washing, discouraged towel sharing, restricted infected members from play until lesions are healed, and encouraged good hygiene among team members (24, 100). No single measure has proven successful, although outbreaks have been curtailed after the institution of multiple measures such as these. Several correctional facilities are also instituting increased access to soap and water and improved attention to skin lesions to prevent the spread of CA-MRSA, as recommended by the Federal Bureau of Prisons (25).

Eradication of colonization by MRSA has also been suggested as a strategy to prevent recurrent disease and possibly to control outbreaks. Many have attempted decolonization in outbreak situations, but few randomized controlled trials have evaluated the efficacies of various medications and washes in the eradication of *S. aureus* carriage (14, 81). Most eradication strategies proposed to eliminate MRSA carriage have been extrapolated from studies evaluating decolonization of MSSA. Some washes considered effective in decreasing MSSA colonization, such as chlorhexidine, may not have the same effectiveness against MRSA (65, 66).

Intranasal mupirocin ointment appears to have the most success in decreasing *S. aureus* nasal colonization, with a subsequent decrease in carriage at other body sites. A 5-day application of intranasal mupirocin showed good results in short-term eradication. However, recolonization occurred in at least half of subjects within months (38, 39, 43). Recolonization and concern about the development of resistance limit its widespread use at present (90).

Selective treatment of high-risk populations, including dialysis patients, surgical patients, and those with recurrent *S. aureus* infections, in order to prevent disease has also been attempted. Preoperative treatment of patients with intranasal mupirocin did not significantly reduce the overall rate of postoperative *S. aureus* surgical site infections compared with placebo (108). However, treatment did significantly decrease the rate of all nosocomial *S. aureus* infections among the patients who were *S. aureus* carriers. Implementation of this prophylaxis would necessitate screening patients for *S. aureus* nasal carriage prior to treatment.

Washing in dilute bleach (1 teaspoon per gallon of water) twice a week in conjunction with nasal mupirocin has also been suggested as a potentially effective means for decreasing colonization (68), but it has not yet been critically evaluated.

Simultaneous use of any proposed intervention to decrease colonization by all close contacts is likely to be necessary, as it is has been hypothesized that close contacts within a household have high transmission rates (58). Randomized trials evaluating the efficacy,

safety, and long-term results of various agents will be necessary before decolonization strategies can be routinely recommended.

DEFINING CA-MRSA

Definitions of CA-MRSA have varied and have been inconsistently used (118). Distinguishing HA-MRSA from CA-MRSA is useful in defining the changing epidemiology, identifying those at risk, and choosing empirical antibiotic therapy when required. The most commonly used definition has been based on time, with the designation of CA-MRSA assigned to an MRSA isolate obtained in the outpatient setting or in the first 48 to 72 hours of hospitalization. Because a substantial number of MRSA isolates actually have an epidemiologic link to the hospital setting, such a temporal definition may have limited use in predicting the clinical or microbiological characteristics of the organism. PFGE and MLST data suggest that some MRSA strains isolated in the community are of hospital origin, and furthermore, as the CA-MRSA epidemic has continued, movement of community strains into the hospital has likely occurred. For example, an outbreak in a neonatal intensive-care unit was promulgated by so-called CA-MRSA isolates containing SCC*mec* IV and resulted in severe illness characterized by pneumonia and sepsis (56). Additionally, in Western Australia, CA-MRSA isolates containing SCC*mec* IV were responsible for an outbreak of nosocomial infections (102), and at Harbor-UCLA Medical Center, CA-MRSA isolates have become the major clone accounting for nosocomial *S. aureus* infections (85). A decrease in multidrug resistance among hospital MRSA isolates has also been documented in the National Nosocomial Infections Surveillance System, consistent with the appearance of community MRSA strains in the hospital (72).

The presence or absence of traditional MRSA risk factors, including previous admission to a hospital, residence in a long-term care facility, recent surgery, history of MRSA colonization or infection, or presence of an indwelling device, has also been used to distinguish HA-MRSA from CA-MRSA. For example, some have defined a CA-MRSA isolate as one identified in the outpatient setting or within 72 h of hospitalization in the absence of traditional risk factors. This definition of CA-MRSA is the one currently used by the CDC (http://www.cdc.gov). Even using a combined temporal and risk factor definition, however, may not predict the molecular characteristics of the MRSA isolate. In MRSA surveillance at our institution, we have found that most patients with MRSA have some identifiable risk, whether the organism is obtained from a hospital or community origin (S. Crawford et al., unpublished data).

FUTURE DIRECTIONS

Many questions remain as CA-MRSA colonization and disease become more prevalent. Insight into the mechanism of transfer of resistance elements and toxin genomic islands may provide clues as to why the burden of CA-MRSA disease has increased so rapidly. Available preventive measures currently rely upon good hygiene and wound care and, although important, are unlikely to succeed in the community. Further investigation of decolonization methods is needed. *S. aureus* vaccine candidates are under investigation. New target candidates for vaccines and therapy, perhaps directed against important toxins, may provide hope for preventing and treating disease.

CONCLUSIONS

CA-MRSA disease is an emerging infectious disease responsible for a large disease burden. CA-MRSA isolates have different genetic elements and toxin genes than HA-MRSA, and these differences are considered to be responsible for the variations in epidemiology and disease. It is not understood what factors have led to the emergence of PVL-positive MRSA, nor why it appears that the disease burden has appeared so rapidly, as PVL is not a newly recognized virulence factor. Attention to hygiene and strict adherence to contact precautions in institutional settings are the current guidelines in place to prevent spread. Awareness of the increasing prevalence of CA-MRSA in relation to *S. aureus* disease is crucial. Culturing suspected *S. aureus* infections is now necessary to guide antibiotic therapy, and local prevalence rates and resistance patterns should guide clinicians in choosing empirical therapy. Early recognition of CA-MRSA disease is important but difficult; CA-MRSA must now be recognized as a possible cause of necrotizing pneumonia, sepsis, and other invasive life-threatening diseases.

REFERENCES

1. **Adcock, P. M., P. Pastor, F. Medley, J. E. Patterson, and T. V. Murphy.** 1998. Methicillin-resistant *Staphylococcus aureus* in two child care centers *J. Infect. Dis.* **78**:577–580
2. **Adem, P. V., C. P. Montgomery, A. N. Husain, T. K. Koogler, V. Arangelovich, M. Humiller, S. Boyle-Vavra, and R. S. Daum.** 2005. *Staphylococcus aureus* sepsis and the Waterhouse-Friderichsen syndrome in children. *N. Engl. J. Med.* **353**:1245–1251.
3. **Arthur, M., A. Brisson-Noel, and P. Courvalin.** 1987. Origin and evolution of genes specifying resistance to macrolide, lincosamide and streptogramin antibiotics: data and hypotheses. *J. Antimicrob Chemother.* 20:783–802
4. Baggett, H. C., T. W. Hennessy, K. Rudolph, D. Bruden, A. Reasonover, A. Parkinson, R. Sparks, R. M. Donlan, P. Martinez, K. Mongkolrattanothai, and J. C. Butler. 2004. Community-onset methicillin-resistant *Staphylococcus aureus* associated with antibiotic use and the cytotoxin Panton-Valentine leukocidin during a furunculosis outbreak in rural Alaska *J. Infect Dis* 189:1565–1573.
5. **Baillargeon, J., M. F. Kelley, C. T. Leach, G. Baillargeon, and B. H. Pollock.** 2004. Methicillin-resistant *Staphylococcus aureus* infection in the Texas prison system *Clin. Infect. Dis.* **38**:e92–e95.
6. Baker, C. J., and R. W. Frenck. 2004. Change in management of skin/soft tissue infections needed. *AAP News* **25**:105.
7. **Barber, M.** 1961. Methicillin-resistant staphylococci *J. Clin. Pathol.* **14**:385.
8. **Barrett, F. F., R. F. McGehee, and M. Finland.** 1968. Methicillin-resistant *Staphylococcus aureus* at Boston City Hospital. *N. Engl J Med.* 279:441–448.
9. **Barry, W., L. Hudgins, S. T. Donta, and E. L. Pesanti.** 1992. Intravenous immunoglobulin therapy for toxic shock syndrome. *JAMA* **267**:3315–3316.
10. **Benner, E. J., and F. H. Kayser.** 1968. Growing clinical significance of methicillin-resistant *Staphylococcus aureus*. *Lancet* **ii**:741–744.
11. **Bondi, A., Jr., and C. C. Dietz.** 1945 Penicillin resistant staphylococci. *Proc. Soc. Exp. Biol. Med.* 60:55.
12. **Boyce, J. M., and W. A. Causey.** 1982. Increasing occurrence of methicillin-resistant *Staphylococcus aureus* in the United States. *Infect. Control* **3**:377–383.
13. Boyce, J. M. 1989. Methicillin-resistant *Staphylococcus aureus*: detection, epidemiology, and control measures. *Infect. Dis Clin. N. Am.* 3:901–913.
14. Boyce, J. M. 2001. MRSA patients proven methods to treat colonization and infection. *J. Hosp. Infect.* 48(Suppl. A):S9–S14.
15. Boyle-Vavra, S., B. Ereshefsky, C. C. Wang, and R. S. Daum. 2005. Successful multiresistant community-associated methicillin-resistant *Staphylococcus aureus* lineage from Taipei, Taiwan, that carries either the novel staphylococcal chromosome cassette *mec* (SCC*mec*) type VT or SCC*mec* type IV *J. Clin Microbiol* **43**:4719–4730.

16. Braun, L., D. Craft, R. Williams, F. Tuamokumo, and M. Ottolini. 2005. Increasing clindamycin resistance among methicillin-resistant *Staphylococcus aureus* in 57 northeast United States military treatment facilities. *Pediatr. Infect. Dis. J.* 24:622–626.

17. **Breedt, J., J. Teras, J. Gardovskis, F. J. Maritz, T. Vaasna, D. P. Ross, M. Gloud-Paquet, N. Dartois, E. J. Ellis-Grosse, E. Loh and the Tigecycline 305 cSSSI Study Group.** 2005. Safety and efficacy of tigecycline in treatment of skin and skin structure infections: results of a double-blind phase 3 comparison study with vancomycin-aztreonam *Antimicrob. Agents Chemother.* 49:4658–4666.

18. **Buckingham, S. C., L. K. McDougal, L. D. Cathey, K. Comeaux, A. S. Craig, S. K. Fridkin, and F. C. Tenover.** 2004. Emergence of community-associated methicillin-resistant *Staphylococcus aureus* at a Memphis, Tennessee children's hospital *Pediatr. Infect Dis. J.* 23:619–624.

19. **Campbell, K. M., A. F. Vaughn, K. L. Russell, B. Smith, D. L. Jimenez, C. P. Barrozo, J. R. Minarcik, N. F. Crum, and M. A. Ryan.** 2004. Risk factors for community-associated methicillin-resistant *Staphylococcus aureus* infections in an outbreak of disease among military trainees in San Diego, California, in 2002. *J. Clin. Microbiol.* 42:4050–4053.

20. **Carleton, H. A., B. A. Diep, E. D. Charlebois, G. F. Sensabaugh, and F. Perdreau-Remington.** 2004. Community-adapted methicillin-resistant *Staphylococcus aureus* (MRSA): population dynamics of an expanding community reservoir of MRSA. *J. Infect. Dis.* 190:1730–1738.

21 **Centers for Disease Control and Prevention.** 1997. *Staphylococcus aureus* with reduced susceptibility to vancomycin—United States, 1997 *Morb. Mortal. Wkly. Rep.* 46:765–766.

22. **Centers for Disease Control and Prevention.** 1999. Four pediatric deaths from community-acquired methicillin-resistant *Staphylococcus aureus*: Minnesota and North Dakota, 1997–1999. *Morb. Mortal. Wkly Rep.* 48:707–710.

23. **Centers for Disease Control and Prevention.** 2002. Vancomycin-resistant *Staphylococcus aureus*—Pennsylvania, 2002. *Morb. Mortal. Wkly. Rep.* 51:902.

24. **Centers for Disease Control and Prevention.** 2003. Methicillin-resistant *Staphylococcus aureus* infections among competitive sports participants—Colorado, Indiana, Pennsylvania, and Los Angeles County, 2000–2003. *Morb. Mortal. Wkly. Rep.* 52:793–795.

25. Centers for Disease Control and Prevention. 2003 Methicillin-resistant *Staphylococcus aureus* infections in correctional facilities—Georgia, California, and Texas, 2001–2003 *Morb Mortal. Wkly. Rep.* 52:992–996.

26. Chambers, H. F. 1988. Methicillin-resistant staphylococci. *Clin. Microbiol. Rev* 1:173–186

27. Chambers, H. F. 2001. The changing epidemiology of *Staphylococcus aureus*? *Emerg. Infect. Dis.* 7: 178–182

28. **Chang, S., D. M. Sievert, J. C. Hageman, et al.** 2003. Infection with vancomycin-resistant *Staphylococcus aureus* containing the *vanA* resistance gene. *N. Engl. J. Med.* 348:1342–1347.

29. Chavez-Bueno, S., B. Bozdogan, K. Katz, K. L. Bowlware, N. Cushion, D. Cavuoti, N. Ahmad, G. H. **McCracken, Jr., and P. C. Appelbaum.** 2005. Inducible clindamycin resistance and molecular epidemiologic trends of pediatric community-acquired methicillin-resistant *Staphylococcus aureus* in Dallas, Texas. *Antimicrob. Agents Chemother.* 49:2283–2288.

30. **Chiang, F. Y., and M. Climo.** 2003. Efficacy of linezolid alone or in combination with vancomycin for treatment of experimental endocarditis due to methicillin-resistant *Staphylococcus aureus*. *Antimicrob. Agents Chemother.* 47:3002–3004.

31 **Coombs, G. W., G. R. Nimmo, J. M. Bell, F. Huygens, F. G. O'Brien, M. J. Malkowski, J. C. Pearson, A. J. Stephens, P. M. Giffard, and the Australian Group for Antimicrobial Resistance.** 2004. Genetic diversity among community methicillin-resistant *Staphylococcus aureus* strains causing outpatient infections in Australia. *J Clin. Microbiol.* 42:4735–4743.

32. **Couppie, P., B. Cribier, G. Prevost, E. Grosshans, and Y. Peimont.** 1994. Leukocidin from *Staphylococcus aureus* and cutaneous infections: an epidemiologic study. *Arch. Dermatol.* 130:1208–1209.

33. **Craven, D. E., A. I. Rixinger, T. A. Goularte, and W. R. McCabe.** 1986. Methicillin-resistant *Staphylococcus aureus* bacteremia linked to intravenous drug abusers using a "shooting gallery." *Am J Med* 80:770–775

34 **Creech, C. B., D. S. Kernodle, A. Alsentzer, C. Wilson, and K. M. Edwards.** 2005. Increasing rates of nasal carriage of methicillin-resistant *Staphylococcus aureus* in healthy children. *Pediatr. Infect. Dis. J.* 24:617–621.

35 **Culpepper, R., R. Nolan, S. Chapman, A. Kennedy, and M. Currier.** 2001 Methicillin-resistant *Staphylococcus aureus* skin or soft tissue infections in a state prison—Mississippi, 2000. *Morb. Mortal. Wkly. Rep.* 50:919–922.

36. Daum, R. S., T. Ito, K. Hiramatsu, F. Hussain, K. Mongkolrattanothai, M. Jamklang, and S. Boyle-Vavra. 2002. A novel methicillin-resistance cassette in community-acquired methicillin-resistant *Staphylococcus aureus* isolates of diverse genetic backgrounds. *J. Infect. Dis.* **186**:1344–1347.
37. **Deville, J. G., S. Adler, P. H. Azimi, B. A. Jantausch, M. R. Morfin, S. Beltran, B. Edge-Padbury, S. Naberhuis-Stehouwer, and J. B. Bruss.** 2003. Linezolid versus vancomycin in the treatment of known or suspected resistant gram-positive infections in neonates. *Pediatr. Infect. Dis. J.* **22**(Suppl. 9):S158–S163.
38. **Doebbeling, B. N., D. L. Breneman, H. C. Neu, R. Aly, B. G. Yangco, H. P. Holley, Jr., R. J. Marsh, M. A. Pfaller, J. E. McGowan, Jr., B. E. Scully, et al.** 1993. Elimination of *Staphylococcus aureus* nasal carriage in health care workers: analysis of six clinical trials with calcium mupirocin ointment. *Clin. Infect. Dis.* **17**:466–474.
39. **Doebbeling, B. N., D. R. Reagan, M. A. Pfaller, A. K. Houston, R. J. Hollis, and R. P. Wenzel.** 1994. Long-term efficacy of intranasal mupirocin ointment. A prospective cohort study of *Staphylococcus aureus* carriage. *Arch. Intern. Med.* **154**:1505–1508.
40. **Ellis, M. W., D. R. Hospenthal, D. P. Dooley, P. J. Gray, and C. K. Murray.** 2004. Natural history of community-acquired methicillin-resistant *Staphylococcus aureus* colonization and infection in soldiers. *Clin. Infect. Dis.* **39**:971–979.
41. **Enright, M. C., N. P. Day, C. E. Davies, S. J. Peacock, and B. G. Spratt.** 2000. Multilocus sequence typing for characterization of methicillin-resistant and methicillin-susceptible clones of *Staphylococcus aureus*. *J. Clin. Microbiol.* **38**:1008–1015.
42. **Fergie, J. E., and K. Purcell.** 2001. Community-acquired methicillin-resistant *Staphylococcus aureus* infections in South Texas children. *Pediatr. Infect. Dis. J.* **20**:860–863.
43. Fernandez, C., C. Gaspar, A. Torrellas, A. Vindel, J. A. Saez-Nieto, F. Cruzet, and L. Aguilar. 1995. A double-blind, randomized, placebo-controlled clinical trial to evaluate the safety and efficacy of mupirocin calcium ointment for eliminating nasal carriage of *Staphylococcus aureus* among hospital personnel. *J. Antimicrob. Chemother.* **35**:399–408.
44. **Francis, J. S., M. C. Doherty, U. Lopatin, C. P. Johnston, G. Sinha, T. Ross, M. Cai, N. N. Hansel, T. Perl, J. R. Ticehurst, K. Carroll, D. L. Thomas, E. Nuermberger, and J. G. Bartlett.** 2005. Severe community-onset pneumonia in healthy adults caused by methicillin-resistant *Staphylococcus aureus* carrying the Panton-Valentine leukocidin genes. *Clin. Infect. Dis.* **40**:100–107.
45. Frank, A. L., J. F. Marcinak, P. D. Mangat, J. T. Tjhio, S. Kelkar, P. C. Schreckenberger, and J. P. Quinn. 2002. Clindamycin treatment of methicillin-resistant *Staphylococcus aureus* infections in children. *Pediatr. Infect. Dis. J.* **21**:530–534.
46. Frazee, B. W., J. Lynn, E. D. Charlebois, L. Lambert, D. Lowery, and F. Perdreau-Remington. 2005. High prevalence of methicillin-resistant *Staphylococcus aureus* in emergency department skin and soft tissue infections. *Ann. Emerg. Med.* **45**:311–320.
47. **Fridkin, S. K., J. Hageman, L. K. McDougal, J. Mohammed, W. R. Jarvis, T. M. Perl, F. C. Tenover, and the Vancomycin-Intermediate *Staphylococcus aureus* Epidemiology Study Group.** 2003. Epidemiological and microbiological characterization of infections caused by *Staphylococcus aureus* with reduced susceptibility to vancomycin, United States, 1997–2001. *Clin. Infect. Dis.* **36**:429–439.
48. **Fridkin, S. K., J. C. Hageman, M. Morrison, L. T. Sanza, K. Como-Sabetti, J. A. Jernigan, K. Harriman, L. H. Harrison, R. Lynfield, M. M. Farley, and the Active Bacterial Core Surveillance Program of the Emerging Infections Program Network.** 2005. Methicillin-resistant *Staphylococcus aureus* disease in three communities. *N. Engl. J. Med.* **352**:1436–1444.
49. **Gauduchon, V., G. Cozon, F. Vandenesch, A. L. Genestier, N. Eyssade, S. Peyrol, J. Etienne, and G. Lina.** 2004. Neutralization of *Staphylococcus aureus* Panton Valentine leukocidin by intravenous immunoglobulin in vitro. *J. Infect. Dis.* **189**:346–353.
50. **Gillet, Y., B. Issartel, P. Vanhems, J. C. Fournet, G. Lina, M. Bes, F. Vandenesch, Y. Piemont, N. Brousse, D. Floret, and J. Etienne.** 2002. Association between *Staphylococcus aureus* strains carrying the gene for Panton-Valentine leukocidin and highly lethal necrotising pneumonia in young immunocompetent patients. *Lancet* **359**:753–759.
51. Gladstone, G. P., and W. E. Van Heyningen. 1957. Staphylococcal leucocidins. *Br. J. Exp. Pathol.* **38**: 123–137.
52. **Gonzalez, B. E., K. G. Hulten, M. K. Dishop, L. B. Lamberth, W. A. Hammerman, E. O. Mason, Jr., and S. L. Kaplan.** 2005. Pulmonary manifestations in children with invasive community-acquired *Staphylococcus aureus* infection. *Clin. Infect. Dis.* **41**:583–590.

53. **Gorak, E. J., S. M. Yamada, and J. D. Brown.** 1999. Community-acquired methicillin-resistant *Staphylococcus aureus* in hospitalized adults and children without known risk factors *Clin. Infect. Dis.* **29**:797–800.
54. Gottlieb, R. D., M. K. Shah, D. C. Perlman, and C. P. Kimmelman. 1992. Community-acquired methicillin-resistant *Staphylococcus aureus* infections in otolaryngology. *Otolaryngol. Head Neck Surg.* **107**:434–437.
55. **Groom, A. V., D. H. Wolsey, T. S. Naimi, K. Smith, S. Johnson, D. Boxrud, K. A. Moore, and J. E.** Cheek. 2001. Community-acquired methicillin-resistant *Staphylococcus aureus* in a rural American Indian community. *JAMA* **286**:1201–1205.
56. Healy, C. M., K. G. Hulten, D. L. Palazzi, J. R. Campbell, and C. J. Baker. 2004. Emergence of new strains of methicillin-resistant *Staphylococcus aureus* in a neonatal intensive care unit. *Clin. Infect. Dis.* **39**:1460–1466
57. **Herold, B. C., L. C. Immergluck, M. C. Maranan, D. S. Lauderdale, R. E. Gaskin, S., Boyle-Vavra, C. D. Leitch, and R. S. Daum.** 1998. Community-acquired methicillin-resistant *Staphylococcus aureus* in children with no identified predisposing risk. *JAMA* **279**:593–598.
58. **Hollis, R. J., J. L. Barr, B. N. Doebbeling, M. A. Pfaller, and R. P. Wenzel.** 1995. Familial carriage of methicillin-resistant *Staphylococcus aureus* and subsequent infection in a premature neonate. *Clin. Infect. Dis* **21**:328–332.
59. **Hussain, F. M., S. Boyle-Vavra, C. D. Bethel, and R. S. Daum.** 2000. Current trends in community-acquired methicillin-resistant *Staphylococcus aureus* at a tertiary care pediatric facility. *Pediatr. Infect. Dis. J.* **19**:1163–1166.
60. **Hussain, F. M., S. Boyle-Vavra, and R. S. Daum.** 2001 Community-acquired methicillin-resistant *Staphylococcus aureus* colonization in healthy children attending an outpatient pediatric clinic. *Pediatr. Infect. Dis. J.* **20**:763–767.
61. Ito, T., Y. Katayama, K. Asada, N. Mori, K. Tsutsumimoto, C. Tiensasitorn, and K. Hiramatsu. 2001 Structural comparison of three types of staphylococcal cassette chromosome *mec* integrated in the chromosome in methicillin-resistant *Staphylococcus aureus*. *Antimicrob. Agents Chemother.* **45**:1323–1336.
62. **Ito, T., K. Okuma, X. X. Ma, H. Yuzawa, and K. Hiramatsu.** 2003. Insights on antibiotic resistance of *Staphylococcus aureus* from its whole genome: genomic island SCC. *Drug Resist. Updates* **6**:41–52.
63. **Iyer, S., and D. H. Jones.** 2004. Community-acquired methicillin-resistant *Staphylococcus aureus* skin infection: a retrospective analysis of clinical presentation and treatment of a local outbreak *J. Am. Acad. Dermatol* **50**:854–858
64. Jevons, M. P. 1961. "Celbenin"-resistant staphylococci. *Br. Med. J.* **i**:124.
65. Kampf, G., R. Jarosch, and H. Ruden. 1998 Limited effectiveness of chlorhexidine based hand disinfectants against methicillin-resistant *Staphylococcus aureus* (MRSA). *J. Hosp. Infect.* 38:297–303.
66. Kampf, G. 2004 The value of using chlorhexidine soap in a controlled trial to eradicate MRSA in colonized patients. *J. Hosp. Infect.* **58**:86–87.
67. **Kaplan, S. L., S. L. Deville Kaplan, J. G. Deville, R. Yogev, M. R. Morfin, E. Wu, S. Adler, B. Edge-Padbury, S. Naberhuis-Stehouwer, J. B. Bruss, and the Linezolid Pediatric Study Group.** 2003. Linezolid versus vancomycin for treatment of resistant Gram-positive infections in children. *Pediatr. Infect. Dis. J* **22**:677–686.
68. **Kaplan, S. L.** 2005. Personal communication.
69. Kaplan, S. L.; K. G. Hulten, B. E. Gonzalez, W. A. Hammerman, L. Lamberth, J. Versalovic, and **E. O. Mason, Jr.** 2005. Three-year surveillance of community-acquired *Staphylococcus aureus* infections in children. *Clin. Infect. Dis.***40**:1785–1791.
70. **Katayama, Y., F. Takeuchi, T. Ito, X. X. Ma, Y. Ui-Mizutani, I. Kobayashi, and K. Hiramatsu.** 2003. Identification in methicillin-susceptible *Staphylococcus hominis* of an active primordial mobile genetic element for the staphylococcal cassette chromosome *mec* of methicillin-resistant *Staphylococcus aureus*. *J. Bacteriol.* **185**:2711–2722.
71. Kazakova, S. V., J. C. Hageman, M. Matava, A. Srinivasan, L. Phelan, B. Garfinkel, T. Boo, S. McAllister, J. Anderson, B. Jensen, D. Dodson, D. Lonsway, L. K. McDougal, M. Arduino, V. J. Fraser, G. Killgore, F. C. Tenover, S. Cody, and D. B. Jernigan. 2005. A clone of methicillin-resistant *Staphylococcus aureus* among professional football players. *N. Engl. J. Med.* **352**:468–475.
72. **Klevens, R. M., J. R. Edwards, F. C. Tenover, L. C. McDonald, T. Horan, R. Gaynes, and the National Nosocomial Infections Surveillance System.** 2006. Changes in the epidemiology of methicillin-resistant *Staphylococcus aureus* in intensive care units in US hospitals, 1992–2003. *Clin. Infect. Dis.* **42**: 389–391.

73. **Kravitz, G. R., D. J. Dries, M. L. Peterson, and P. M. Schlievert.** 2005. Purpura fulminans due to *Staphylococcus aureus*. *Clin. Infect. Dis.* **40**:941–947.

74. **Kwon, N. H., D. T. Park, J. S. Moon, W. K. Jung, S. H. Kim, J. M. Kim, S. K. Hong, H. C. Koo, Y. S. Joo, and Y. H. Park.** 2005. Staphylococcal cassette chromosome *mec* (SCC*mec*) characterization and molecular analysis for methicillin-resistant *Staphylococcus aureus* and novel SCC*mec* subtype IVg isolated from bovine milk in Korea. *J. Antimicrob. Chemother.* 56:624–632.

75. **Lee, M. C., A. M. Rios, M. F. Aten, A. Mejias, D. Cavuoti, G. B. McCracken, Jr., and R. D. Hardy.** 2004. Management and outcome of children with skin and soft tissue abscesses caused by community-acquired methicillin-resistant *Staphylococcus aureus*. *Pediatr. Infect. Dis. J.* **23**:123–127.

76. **Levin, T. P., B. Suh, P. Axelrod, A. L. Truant, and T. Fekete.** 2005. Potential clindamycin resistance in clindamycin-susceptible, erythromycin-resistant *Staphylococcus aureus*: report of a clinical failure. *Antimicrob. Agents Chemother.* 49:1222–1224.

77. **Levine, D. P., R. D. Cushing, J. Jui, and W. J. Brown.** 1982. Community-acquired MRSA endocarditis in the Detroit Medical Center. *Ann. Intern. Med.* **97**:330–338.

78. **Lina, G., Y. Peimont, F. Godail-Gamot, M. Bes, M. O. Peter, V. Gauduchon, F. Vandenesch, and J. Etienne.** 1999. Involvement of Panton-Valentine leukocidin-producing *Staphylococcus aureus* in primary skin infection and pneumonia. *Clin. Infect. Dis.* **29**:1128–1132.

79. **Lindenmayer, J. M., S. Schoenfeld, R. O'Grady, and J. K. Carney.** 1998. Methicillin-resistant *Staphylococcus aureus* in a high school wrestling team and the surrounding community. *Arch. Intern. Med.* **158**:895–899.

80. **Llera, J. L., and R. C. Levy.** 1985. Treatment of cutaneous abscess: a double-blind clinical study. *Ann. Emerg. Med.* **14**:15–19.

81. Loeb, M., C. Main, C. Walker-Dilks, and A. Eady. 2003. Antimicrobial drugs for treating methicillin-resistant *Staphylococcus aureus* colonization. *Cochrane Database Syst. Rev.* **2003**(4):CD003340.

82. **Lowy, F. D.** 1998. *Staphylococcus aureus* infections. *N. Engl. J. Med.* **339**:520–532.

83. **Ma, X. X., T. Ito, C. Tiensasitorn, M. Jamklang, P. Chongtrakool, S. Boyle-Vavra, R. S. Daum, and K. Hiramatsu.** 2002. Novel type of staphylococcal cassette chromosome *mec* identified in community-acquired methicillin-resistant *Staphylococcus aureus* strains. *Antimicrob. Agents Chemother.* **46**:1147–1152.

84. Maguire, G. P., A. D. Arthur, P. J. Boustead, B. Dwyer, and B. J. Currie. 1996. Emerging epidemic of community-acquired methicillin resistant *Staphylococcus aureus* infection in the Northern Territory. *Med. J. Aust.* **164**:721–723.

85. Maree, C. M., R. S. Daum, S. Boyle-Vavra, K. Matayoshi, and L. G. Miller. 2005. Rapid temporal increase in community-acquired methicillin-resistant *S. aureus* strains causing nosocomial infections. Presented at the Interscience Conference on Antimicrobial Agents and Chemotherapy, Washington, D.C., December 2005.

86. **Markowitz, N., E. L. Quinn, and L. D. Saravolatz.** 1992. Trimethoprim-sulfamethoxazole compared with vancomycin for the treatment of *Staphylococcus aureus* infection. *Ann. Intern. Med.* **117**:390–398.

87. **Martinez-Aguilar, G., W. A. Hammerman, E. O. Mason, Jr., and S. L. Kaplan.** 2003. Clindamycin treatment of invasive infections caused by community-acquired, methicillin-resistant, and methicillin-susceptible *Staphylococcus aureus* in children. *Pediatr. Infect. Dis. J.* **22**:593–598.

88. **McDougal, L. K., C. D. Steward, G. E. Killgore, J. M. Chaitram, S. K. McAllister, and F. C. Tenover.** 2003. Pulsed-field gel electrophoresis typing of oxacillin-resistant *Staphylococcus aureus* isolates from the United States: establishing a national database. *J. Clin. Microbiol.* **41**:5113–5120.

89. **Melles, D. C., R. F. Gorkink, H. A. Boelens, S. D. Snijders, J. K. Peeters, M. J. Moorhouse, P. J. van der Spek, W. B. van Leeuwen, G. Simons, H. A. Verbrugh, and A. van Belkum.** 2004. Natural population dynamics and expansion of pathogenic clones of *Staphylococcus aureus*. *J. Clin. Investig.* **114**:1732–1740.

90. **Miller, M. A., A. Dascal, J. Portnoy, and J. Mendelson.** 1996. Development of mupirocin resistance among methicillin-resistant *Staphylococcus aureus* after widespread use of nasal mupirocin ointment. *Infect. Control Hosp. Epidemiol.* **17**:811–813.

91. **Miller, L. G., F. Perdreau-Remington, G. Rieg, S. Mehdi, J. Perlroth, A. S. Bayer, A. W. Tang, T. O. Phung, and B. Spellberg.** 2005. Necrotizing fasciitis caused by community-associated methicillin-resistant *Staphylococcus aureus* in Los Angeles. *N. Engl. J. Med.* **352**:1445–1453.

92. Mishaan, A. M., E. O. Mason, Jr., G. Martinez-Aguilar, W. Hammerman, J. J. Propst, J. R. Lupski, P. Stankiewicz, S. L. Kaplan, and K. Hulten. 2005. Emergence of a predominant clone of community-acquired *Staphylococcus aureus* among children in Houston, Texas. *Pediatr. Infect. Dis. J.* 24:201–206.

93 **Mongkolrattanothai, K., S. Boyle, M. D. Kahana, and R. S. Daum.** 2003. Severe *Staphylococcus aureus* infections caused by clonally related community-acquired methicillin-susceptible and methicillin-resistant isolates. *Clin Infect. Dis* 37:1050–1058.

94. **Mongkolrattanothai, K., S. Boyle, T. V. Murphy, and R. S. Daum.** 2004. Novel non-*mecA*-containing staphylococcal chromosomal cassette composite island containing *pbp4* and *tagF* genes in a commensal staphylococcal species: a possible reservoir for antibiotic resistance islands in *Staphylococcus aureus*. *Antimicrob Agents Chemother* 48:1823–1836.

95. **Moreno, F., C. Crisp, J. H. Jorgensen, and J. E. Patterson.** 1995. Methicillin-resistant *Staphylococcus aureus* as a community organism. *Clin. Infect. Dis.* **21:**1308–1312.

96. **Naimi, T. S., K. H. LeDell, D. J. Boxrud, A. V. Groom, C. D. Steward, S. K. Johnson, J. M. Besse, C. O'Boyle, R. N. Danila, J. E. Cheek, M. T. Osterholm, K. A. Moore, and K. E. Smith.** 2001. Epidemiology and clonality of community-acquired methicillin-resistant *Staphylococcus aureus* in Minnesota, 1996–1998. *Clin. Infect. Dis.* **33:**990–996.

97. **Naimi, T. S., K. H. LeDell, K. Como-Sabetti, S. M. Borchardt, D. J. Boxrud, J. Etienne, S. K. Johnson, F. Vandenesch, S. Fridkin, C. O'Boyle, R. N. Danila, and R. Lynfield.** 2003 Comparison of community- and health care-associated methicillin-resistant *Staphylococcus aureus* infection. *JAMA* **290:**2976–2984.

98. **Narita, S., J. Kaneko, J. Chiba, Y. Piemont, S. Jarraud, J. Etienne, and Y. Kamio.** 2001. Phage conversion of Panton-Valentine leukocidin in *Staphylococcus aureus*: molecular analysis of a PVL-converting phage, phiSLT. *Gene* 268:195–206.

99 NCCLS. 2004. *Performance Standards for Antimicrobial Susceptibility Testing: 12th Informational Supplement.* NCCLS document M100-S14. NCCLS, Wayne, Pa.

100 Nguyen, D. M., L. Mascola, and E. Brancoft. 2005 Recurring methicillin-resistant *Staphylococcus aureus* infections in a football team. *Emerg. Infect. Dis.* **11:**526–532.

101. **Nichols, R. L., D. R. Graham, S. L. Barriere, A. Rodgers, S. E. Wilson, M. Zervos, D. L. Dunn, B. Kreter, et al.** 1999. Treatment of hospitalized patients with complicated gram-positive skin and skin structure infections: two randomized, multicentre studies of quinupristin/dalfopristin versus cefazolin, oxacillin or vancomycin. *J. Antimicrob. Chemother.* **44:**263–273.

102 **O'Brien, F. G., J. W. Pearman, M. Gracey, T. V. Riley, and W. B. Grubb.** 1999. Community strain of methicillin-resistant *Staphylococcus aureus* involved in a hospital outbreak. *J. Clin Microbiol.* 37: 2858–2862

103 Okuma, K., K. Iwakawa, J. D. Turnidge, W. B. Grubb, J. M. Bell, F. G. O'Brien, G. W. Coombs, J. W. Pearman, F. C. Tenover, M. Kapi, C. Tiensasitorn, T. Ito, and K. Hiramatsu. 2002. Dissemination of new methicillin-resistant *Staphylococcus aureus* clones in the community. *J. Clin Microbiol* 40: 4289–4294.

104. **Oliveira, D. C., A. Tomasz, and H. de Lencastre.** 2001. The evolution of pandemic clones of methicillin-resistant *Staphylococcus aureus*. identification of two ancestral genetic backgrounds and the associated *mec* elements. *Microb Drug Resist.* 7:349–361.

105. **Pan, E. S., B. A. Diep, H. A. Carleton, E. D. Charlebois, G. F. Sensabaugh, B. L. Haller, and F. Perdreau-Remington.** 2003. Increasing prevalence of methicillin-resistant *Staphylococcus aureus* infection in California jails *Clin Infect. Dis.* 37:1384–1388.

106. **Panton, P. N., and F. C. O. Valentine.** 1932. Staphylococcal toxin. *Lancet* **i:**506–508.

107. **Peacock, J. E., Jr., F. J. Marsik, and R. P. Wenzel.** 1980. Methicillin-resistant *Staphylococcus aureus*: introduction and spread within a hospital. *Ann. Intern. Med.* **93:**526–532.

108. **Perl, T. M., J. J. Cullen, R. P. Wenzel, M. B. Zimmerman, M. A. Pfaller, D. Sheppard, J. Twombley, P. P. French, L. A. Herwaldt, and the Mupirocin and the Risk of *Staphylococcus aureus* Study Team.** 2002. Intranasal mupirocin to prevent postoperative *Staphylococcus aureus* infections. *N. Engl J. Med* 346:1871–1877.

109. **Pinho, M. G., H. de Lencastre, and A. Tomasz.** 2001. An acquired and a native penicillin-binding protein cooperate in building the cell wall of drug-resistant staphylococci. *Proc. Natl. Acad. Sci. USA* **98:** 10886–10891.

110 **Prevost, G., P. Couppie, P. Prevost, S. Gayet, P. Petiau, B. Cribier, H. Monteil, and Y. Piemont.** 1995. Epidemiological data on *Staphylococcus aureus* strains producing synergohymenotropic toxins. *J. Med. Microbiol.* **42:**237–245

111. **Purcell, K., and J. E. Fergie.** 2002. Exponential increase in community-acquired methicillin-resistant *Staphylococcus aureus* infections in South Texas children. *Pediatr. Infect. Dis. J.* **21:**988–999.

112. **Purcell, K., and J. Fergie.** Epidemic of community-acquired MRSA infections: a 13-year study at Driscoll Children's Hospital, abstr. 484. Presented at the annual meeting of the Infectious Diseases Society of America, 2004.

113. **Rammelkamp, C. H., and T. Maxon.** 1942. Resistance of *Staphylococcus aureus* to the action of penicillin. *Proc. Soc Exp Biol. Med.* **51**:386.

114 Riley, T. V., and I. L. Rouse. 1995. Methicillin-resistant *Staphylococcus aureus* in Western Australia, 1983–1992 *J Hosp Infect.* **29**:177–188.

115. **Robinson, D. A., and M. C. Enright.** 2003 Evolutionary models of the emergence of methicillin-resistant *Staphylococccus aureus. Antimicrob. Agents Chemother.* **47**:3926–3934.

116 **Ruhe, J. J., T. Monson, R. W. Bradsher, and A. Menon.** 2005 Use of long-acting tetracyclines for methicillin-resistant *Staphylococcus aureus* infections: case series and review of the literature. *Clin. Infect. Dis.* **40**:1429–1434.

117. **Ruiz, M. E., I. C. Guerrero, and C. U. Tuazon.** 2002. Endocarditis caused by methicillin-resistant *Staphylococcus aureus*: treatment failure with linezolid. *Clin. Infect. Dis.* **35**:1018–1020.

118. **Salgado, C. D., B. M. Farr, and D. P. Calfee.** 2003. Community-acquired methicillin-resistant *Staphylococcus aureus*: a meta-analysis of prevalence and risk factors. *Clin. Infect Dis.* **36**:131–139.

119. **Saravolatz, L. D., N. Markowitz, L. Arking, D. Pohlod, and E. Fisher.** 1982. MRSA: epidemiologic observations during a community-acquired outbreak. *Ann. Intern. Med.* **96**:11–16.

120. **Saravolatz, L. D., D. J. Pohlod, and L. M. Arking.** 1982 Community-acquired methicillin-resistant *Staphylococcus aureus* infections: a new source for nosocomial outbreaks. *Ann. Intern. Med.* **97**:325–329

121. **Schlievert, P. M.** 2001. Use of intravenous immunoglobulin in the treatment of staphylococcal and streptococcal toxic shock syndromes and related illnesses. *J. Allergy Clin. Immunol.* **108**:S107–S110.

122. **Shahin, R., I. L. Johnson, F. Jamieson, A. McGeer, J. Tolkin, E. L. Ford-Jones, et al.** 1999. Methicillin-resistant *Staphylococcus aureus* carriage in a child care center following a case of disease. *Arch. Pediatr. Adolesc. Med.* **153**:864–868.

123. **Shore, A., A. S. Rossney, C. T. Keane, M. C. Enright, and D. C. Coleman.** 2005. Seven novel variants of the staphylococcal chromosomal cassette *mec* in methicillin-resistant *Staphylococcus aureus* isolates from Ireland. *Antimicrob. Agents Chemother.* **49**:2070–2083.

124 Smith, T. L., M. L. Pearson, K. R. Wilcox, C. Cruz, M. V. Lancaster, B. Robinson-Dunn, F. C. Tenover, M. J. Zervos, J. D. Band, E. White, W. R. Jarvis, et al. 1999. Emergence of vancomycin resistance in *Staphylococcus aureus. N Engl. J. Med.* **340**:493–501.

125. **Suggs, A. H., M. C. Maranan, S. Boyle-Vavra, and R. S. Daum.** 1999 Methicillin-resistant and borderline methicillin-resistant asymptomatic *Staphylococcus aureus* colonization in children without identifiable risk factors. *Pediatr. Infect. Dis. J.* **18**:410–414.

126. **Thompson, R. L., I. Cabezudo, and R. P. Wenzel.** 1982 Epidemiology of nosocomial infections caused by methicillin-resistant *Staphylococcus aureus. Ann Intern. Med.* **97**:309–317.

127. **Vandenesch, F., T. Naimi, M. C. Enright, G. Lina, G. R. Nimmo, H. Heffernan, N. Liassine, M. Bes, T. Greenland, M. E. Reverdy, and J. Etienne.** 2003. Community-acquired methicillin-resistant *Staphylococcus aureus* carrying Panton-Valentine leukocidin genes: worldwide emergence. *Emerg. Infect. Dis.* **9**: 978–984.

128. **Whitener, C. J., S. Y. Park, F. A. Browne, L. J. Parent, K. Julian, B. Bozdogan, P. C. Appelbaum, J. Chaitram, L. M. Weigel, J. Jernigan, L. K. McDougal, F. C. Tenover, and S. K. Fridkin.** 2004. Vancomycin-resistant *Staphylococcus aureus* in the absence of vancomycin exposure. *Clin. Infect. Dis.* **38**: 1049–1055.

129 **Williams, R. E. O.** 1963. Healthy carriage of *Staphylococcus aureus* its prevalence and importance. *Bacteriol. Rev.* **27**:56–71.

130. **Wisplinghoff, H., A. E. Rosato, M. C. Enright, M. Noto, W. Craig, and G. L. Archer.** 2003. Related clones containing SCC*mec* type IV predominate among clinically significant *Staphylococcus epidermidis* isolates. *Antimicrob. Agents Chemother.* **47**:3574–3579.

131 **Yogev, R., L. E. Patterson, S. L. Kaplan, S. Adler, M. R. Morfin, A. Martin, B. Edge-Padbury, S. Naberhuis-Stehouwer, and J. B. Bruss.** 2003. Linezolid for the treatment of complicated skin and skin structure infections in children. *Pediatr. Infect. Dis. J.* **22**(Suppl. 9):S172–S177.

132. **Yoshida, R., K. Kuwahara-Arai, T. Baba, L. C. Cui, J. F. Richardson, and K. Hiramatsu.** 2003. Physiological and molecular analysis of a *mecA*-negative *Staphylococcus aureus* clinical strain that expresses heterogeneous methicillin resistance. *J. Antimicrob Chemother.* **51**:247–255.

133. **Young, D. M., H. W. Harris, E. D. Charlebois, H. Chambers, A. Campbell, F. Pedreau-Remington, C. Lee, M. Mankani, R. Mackersie, and W. P. Schecter.** 2004. An epidemic of methicillin-resistant *Staphylococcus aureus* soft tissue infections among medically underserved patients. *Arch. Surg.* **139:**947–953.

134. **Zhang, H. Z., C. J. Hackbarth, K. M. Chansky, and H. F. Chambers.** 2001. A proteolytic transmembrane signaling pathway and resistance to beta-lactams in staphylococci. *Science* **291:**1962–1965

135. **Zinderman, C. E., B. Conner, M. A. Malakooti, J. E. LaMar, A. Armstrong, and B. K. Bohnker.** 2004. Community-acquired methicillin-resistant *Staphylococcus aureus* among military recruits. *Emerg. Infect. Dis.* **10:**941–944.

Mr. TOWNS. All right. Thank you.
Dr. Walts.

STATEMENT OF STEVEN L. WALTS, ED.D.

Mr. WALTS. On behalf of Prince William County's 72,654 students and their families, our 10,000 employees, our school board and our community, I thank the members of the House of Representatives Committee on Oversight and Government Reform, and in particular Ranking Minority Member Tom Davis, for inviting me to speak with you today.

I am going to give you a firsthand account from the perspective of a school system and a school superintendent on dealing with the drug-resistant MRSA, which has affected us as the second largest school division in the State of Virginia. I am sure that I speak for every public school superintendent when I say that safety and security of our students is of the utmost importance. Without a safe learning environment, teaching and learning cannot happen.

When most of us grew up, safety and school were synonymous. That has changed a little bit over the last 10 years, and we can take nothing for granted. Talking about safety, from senseless and desperate acts of violence to infectious diseases, school personnel have had to renew their diligence in keeping their environments safe. This is obviously a challenge, as most of our employees are teachers and are in roles that directly support instruction. We are not in the law enforcement business, nor are we of the medical profession, although we do have a number of school nurses who quietly perform heroic tasks each and every day. So we have to lean heavily on our partnerships that we have established with other agencies. And for the most part, those partnerships are working well. And then there is the challenge of making sure we are keeping our parents and our school communities and our larger public informed about what is going on in the school division. Of course, this ranges from many positive recognitions and awards to urgent communications, such as we have faced with the increase of MRSA cases.

As I know you are aware, in addition to the legal implications, there is a delicate balance that we are required to walk from communications, privacy issues and the creation of public hysteria, which is pretty easy to happen with medical matters. In Prince William County Schools, as of Friday, November 2nd, we had 21 documented cases of MRSA, with 7 cases still considered open, meaning the student or employee has not received clearance from their doctor to return to school. And although we weren't required to do this, we began voluntarily reporting these statistics as a public service. While we feel this is our responsibility to our public, unfortunately there are some negative consequences to this. We do not know that any of these cases were actually contracted at our schools. But because we are reporting that people have the infection, the public may naturally make assumptions like, these were caught at school, and inadequate cleaning was a source of the infection. Like the flu, it is virtually impossible to know exactly where someone picked up the infection. But I can assure you, we are very diligent with our cleaning practices, and I am confident

we are doing everything we can to keep our schools and facilities free of MRSA.

The challenge and response, there is an excellent summary on our Web site, www.pwcs.edu, under announcements. There is a lot of information there, and you can see exactly what we have been communicating to our public. Initially, two athletic-related cases of MRSA showed up within about a week of each other in mid-September at one of our 10 high schools. It is not uncommon for one or two cases to show up in a school environment each year. So this did not seem to be out of the ordinary. In fact, our athletic trainers have been on the leading edge of preventing and treating MRSA, since the athletic community was an area where this topic first became an issue. The school nurse and the athletic trainers sent a letter home to parents of the sports team involved, informing them of the case, and providing tips and precautions they should take.

We also had an employee at a different school report a case of MRSA during the same timeframe. About 2 weeks went by, and then a student in another school reported a case of MRSA. And it just went on and on and on. The following week, a student in Virginia, not in our school division, actually died of MRSA, which greatly increased the public awareness of this. And then there were other cases that were generated, and a school, again not in Prince William County, closed.

So, around October 17th through 19th, we had five more reported cases in Prince William County, and it was all over the national news media. So issues began to surface rapidly. We triggered a comprehensive division communication plan, and we have had countless staff members and departments basically working on this 7 days a week for the past 3 weeks. I am pleased to say that we are diligently communicating with our public, and we daily update on our Web site each afternoon all the established cases.

We also have standards and protocols for each of our 86 schools. So if a case arises, the principal can quickly put on a telephone recording automated message, send home a letter to students, post the information on their school Web site and work with us centrally to update our school division Web site.

We have a lot of cleaning protocols that we use. We are paying particular attention to areas, such as gyms, showers, locker rooms, desktops, water fountains, door knobs and panic bars. We are following the procedures, and our schools are being disinfected as they are being cleaned nightly. Buses at schools with known MRSA cases have also been disinfected.

Talking a little bit about the health issues, the Virginia Department of State Health has been in close contact with us, and we are working with our own medical consultant every step of the way. Our division communication plan focused on good hand washing, and included a parent tip sheet and other health-related precautions.

Unless our school personnel observe an unusual skin lesion firsthand, we are dependent upon the students or their families to inform us of an infection. And in some cases, we were not made aware of this until after the fact. Based on the inquiries of our own health service staff, we discovered that, initially, some of the students diagnosed with MRSA did not actually have that strain of

the disease, but they were being prescribed with the antibiotics anyway. And of course, this strain of staph infection is already resistant to antibiotics, so to be assured that we can confidently communicate to the parents, we need to be confident that the medical community is treating these cases using best medical practice. Because staph in general and the MRSA strain included can be found anywhere at any time, in fact most of us most likely are carrying it on us today, the medical community cannot say definitely that the person infected is MRSA free without reculturing. And from what we know, that is not always being done. However, doctors are clearing students for school because it is not contagious if a sore is not open and since it is not an airborne infection. Since we know that MRSA can spread by contact with an infected open, oozing wound, we did decide not to let any students diagnosed with a confirmed case of MRSA participate in sports or physical activity if they had any wound whatsoever.

A few final observations. I have asked what could be done to help school divisions in the future to better respond to our communities on such health-related issues, and I would respond with the following: The government, Federal, State, local, could help us to serve as a calming force with the public by alleviating unfounded fears, possibly through public safety announcements. Local, State or Federal health agencies could be out in front of the media so the media does not end up driving the message without the proper professional guidance and perhaps create a public hysteria in the process. A good example is our working relationship with law enforcement agencies and the media. If a criminal incident occurs at a school, the media asks us school-related questions and the law enforcement agencies questions pertaining to the criminal nature of the incident. The medical community, CDC, State and county health departments could quickly speak to the facts.

Mr. TOWNS. Could you sum up, Dr. Walts? Could you sum up?

Mr. WALTS. Yes. In the case of MRSA, reinforcing with the public how it is contracted, and even when a student is diagnosed does not mean the infection was actually contracted at school. So we feel we have communicated our issues well, but we have those suggestions as other ways we could collaborate to work through these kinds of issues in the future. Thank you.

[The prepared statement of Mr. Walts follows:]

Prince William County
PUBLIC SCHOOLS
Providing A World-Class Education

November 7, 2007

Congress of the United States
House of Representatives
The Committee on Oversight and Government Reform
Hearing on "Drug Resistant Infections in the Community: Consequences for Public Health"

Introduction

On behalf of Prince William County's 72,654, students and their families, our 10,000 employees, our School Board, and our community, I thank you Chairman Waxman and members of the House of Representative's Committee on Oversight and Government Reform, and in particular, Ranking Minority Member, Representative Tom Davis, for inviting me to speak to you today.

I will give you a first-hand account of how the issue of staph infections, in particular the methicillin-resistant Staphylococcus aureus (MRSA), has affected us as the second largest school division in Virginia. I am sure I speak for every public school superintendent when I say that the safety and security of our students and employees is of the utmost importance. Without a safe learning environment, teaching and learning cannot happen. The issue of safety and security in schools has always been important, but we have gone from a time when the words "school" and "safety" were virtually synonymous when most of us were growing up, to a real awakening and keen awareness in the past 10 years that nothing can be taken for granted.

Safety is Paramount

From senseless and desperate acts of violence to infectious diseases, school personnel have had to renew their diligence to keeping their environments safe. This is obviously a challenge as most of our employees are teachers or are in roles that directly support instruction. We are not in the law enforcement business, nor are we in the medical profession — although we do have a number of school nurses who quietly perform heroic tasks each and every day — so we have to lean heavily on our partnerships that we have established with other agencies. And for the most part, those partnerships are working well.

And then there is the challenge of making sure we are keeping our parents and school communities adequately informed about all that is going on in our School Division. Of course this ranges from the many positive recognitions and awards to urgent communications such as what we have faced with the increase in the number of cases of MRSA. As I know you are aware, in addition to legal implications, there is a delicate balance between communications, privacy, and the creation of public hysteria when it comes to medical matters.

DR. STEVEN L. WALTS
Superintendent of Schools

P.O. BOX 389, MANASSAS, VA 20108 • WWW.PWCS.EDU

In Prince William County Public Schools, as of Friday, November 2, we have documented 21 cases of MRSA, with seven cases still considered "open," meaning the student or employee has not received clearance from their doctor to return to the school. While not required to, we began voluntarily reporting these statistics as a public service. While we feel this is our responsibility to our public, unfortunately, there are some negative ramifications. We do not know that any of these cases were actually contracted at our schools, but because we are reporting that people have the infection, the public may naturally make assumptions like:

1. It was caught at the school; and
2. Inadequate cleaning is the source of the infection.

Like the flu, it's virtually impossible to know exactly where someone actually picked up the infection, but I can assure you we are very diligent with our cleaning practices, and I am confident we are doing everything we can to keep our schools and facilities free of MRSA.

Challenge and Response

An excellent summary of how we have responded to these cases of MRSA is contained on our Web site, www.pwcs.edu under "Announcements," and I hope that each of you will have a chance to review that at some point but I will provide you a little background as to how this issue came to light in Prince William County Public Schools and how we addressed it. Two athletic-related cases of MRSA showed up within about a week of each other in mid-September at one of our high schools. Since it is not uncommon for one or two cases to show up in a school environment each year, this did not seem to be out of the ordinary. In fact, our athletic trainers have been on the leading edge of preventing and treating MRSA, since the athletic community was an area where this topic first became an issue. The school nurse and the athletic trainer sent a letter home to parents of the sports team involved, informing them of the case and providing tips and precautions they could take. We also had an employee at a different school report a case of MRSA during this same time frame.

About two weeks went by and then a student at another high school reported a case of MRSA. Four days later, a student at yet another high school contracted the infection. By this time, the Central Office staff was working with the schools, helping them craft their messages, still at the school level.

The following week, a student in another part of Virginia tragically died as a result of MRSA, which obviously greatly increased awareness among the public. I think it stands to reason that the public awareness generated by this student's death also caused people to be more diligent in getting possible symptoms diagnosed and consequently reporting confirmed cases. It was at this same time, specifically October 17-19, that we had five more cases reported and it quickly became evident we needed to trigger our comprehensive Divisionwide communications plan.

So issues began to surface very rapidly as these cases came to light rather suddenly. Since then, my entire Senior Staff, and several other departments and offices, not to mention untold school-based officials, have worked almost exclusively on all aspects of this issue for the better part of the past three weeks.

I am pleased to say that we are diligently communicating with our public with a daily update posted to our Web site each afternoon. We also have established standard communications protocols for each of our 86 schools so if a case arises at any school, the principal is quickly on the telephone recording an automated message, sending a letter home with students, posting the information to their school Web site, and working with centrally based community relations staff to update our School Division Web site.

Cleaning

We continue to clean and disinfect our buildings on a daily basis. It is not necessary to close our schools to disinfect them. I don't want to speak for other school divisions but my understanding is that one possible reason why some school divisions may have needed to close would be if they were using plain detergents. We have been using disinfecting detergents (approved by the EPA) in Prince William County Schools, and so our schools were, and continue to be, disinfected when they are cleaned each day. This practice is supported by the County Health Department. However, in response to the increased cases of MRSA, we have reinforced with the entire custodial staff the importance of ensuring that our disinfectant detergents are utilized for all cleaning purposes, which, again, is already our standard procedure. We are paying extra attention to areas such as gyms, showers, locker rooms, desk tops, water fountains, door knobs and panic bars. By following these procedures, our schools are being disinfected as they are being cleaned nightly. Buses at schools with known cases of MRSA have also been disinfected.

The custodial staff has ensured that each of our schools is stocked with disinfectant detergents and extra training has been given to custodial staffs that have requested it. Other meetings with all of our custodial managers are also taking place to review our cleaning and disinfecting methods and to address any questions they may have.

Health Issues

As advised by the Virginia Department of Health, we have been in close contact with the Prince William County Health Department, as well as our own medical consultant every step of the way. Our Divisionwide communication plan focused on good hand washing and included a parent tip sheet of other health-related precautions.

Unless our school personnel observe an unusual skin lesion first-hand, we are dependent upon the students or their families to inform us of an infection, and in some cases, we were not made aware until after-the-fact.

Based on the inquiries of our own health services staff, we discovered that initially some of the students diagnosed with MRSA did not have culture tests done, but were prescribed antibiotics anyway. And, of course, this strain of staph infection is already resistant to antibiotics, so, to be assured that we can confidently communicate to our parents, we need to be confident that the medical community is treating these cases using best medical practices.

Because staph in general, and the MRSA strain included, can be found anywhere at anytime – in fact most of us are most likely carrying it on us today – the medical community can't say definitively that the person infected is MRSA-free without reculturing, and from what we know, that is not always being done. However, doctors are clearing students for school because it is not contagious if a sore is not "open," and since it is not an airborne infection.

Since we do know that MRSA can be spread by contact with an infected open, oozing wound we did decide to not let any students diagnosed with a confirmed case of MRSA participate in sports or physical activity, if they had any wound at all.

Observations

If asked as to what could be done to help school divisions in the future to better respond to our communities on such health related issues, I would respond with the following:

- Government (federal, state, and local) could help to serve as the calming force with the public by alleviating unfounded fears, possibly through public safety announcements;
- Local, state, and/or federal health agencies should be out in front of the media so they don't end up driving the message without the proper professional guidance, and perhaps create a public hysteria in the process;
- A good example is our working relationship with law-enforcement agencies and the media. If a criminal incident occurs at a school, the media asks us school-related questions but then asks the law enforcement agency questions pertaining to the criminal nature of the incident.
- The medical community (e.g., Centers for Disease Control, state and county health departments) could quickly speak to the facts. In the case of MRSA, reinforcing with the public how it is contracted, that even when a student is diagnosed it doesn't mean that the infection was actually contracted at school, and that schools don't necessarily need to close down to disinfect; and
- The medical community could take the lead role (of course in collaboration with the schools) in very proactive ways to communicate with the public on such issues. School officials are not the medical experts.

Closing Remarks

While Prince William County Public Schools had excellent communications protocols in place prior to this recent MRSA event, this experience has allowed us to fine tune our communications planning, making improvements where needed, so that we are even better prepared for any future similar events.

Thank you for allowing me this opportunity to share with this distinguished body of legislators my perspective on this issue.

Steven L. Walts
Superintendent of Schools

Mr. TOWNS. Thank you very much, Dr. Walts.
Dr. Gayle.

STATEMENT OF ERIC GAYLE, M.D.

Dr. GAYLE. Thank you for the opportunity to address the critical subject of methicillin-resistant staph aureus [MRSA], particularly in the context of how this affects vulnerable communities like the Bronx and the role that community health centers can play in this regard. I am a family physician who has practiced primary care in the Bronx, New York for the past 9 years, and the Bronx Regional Medical Director for the Institute For Family Health, an organization that provides over 75,000 people in New York State, most of them ethnic minorities, and the majority on Medicaid or uninsured.

I am here today to provide testimony that speaks to the specific needs of my community in respect to MRSA and the critical role that community health centers play in the management of contagious diseases such as this. My most recent contact with community acquired MRSA was June 2007. Let me reassure you, as I reassure my patients, that MRSA has been in the community for many years and has been successfully treated well by community health center physicians for the most part without much fanfare. MRSA is significant to the health of the individual and to the community, mainly if it goes unrecognized and thus is improperly treated. The problem for community health center physicians is that oftentimes we are called upon to evaluate a patient only after the infection has significantly progressed and the patient is already ill and possibly toxic.

This is because community health centers are known as places where people can seek care, even if they are uninsured or if they need care in their own language or even if they become ill in a crisis. We are truly a major part of what has been termed the community's health care safety net. Community health centers do their best work when they are involved in the prevention of illnesses. One can never do enough in the education of our patients and the public so that once there is a question about any illness or malady that they know that they need to contact their primary care provider immediately.

This is the role that community health centers play and play so well. We are often the first contact for our patients for whatever their health concerns are. But tragically many families do not have a medical home, do not have a community health center such as ours to go to. We need to continue to grow and develop these vital community resources so that they are available everywhere. Where else will patients be educated to take care in their personal health, particularly as it relates to communicable diseases?

We advise them that if they have open sores or rashes that they ought not to participate in contact sports activities, advise the kids not to share towels in gym or not to go to school or to work with any contagious illness.

With MRSA now seemingly more prevalent, community health centers with electronic health record capabilities can closely monitor the patients they are seeing for possible outbreaks within a particular community and similarly alert community providers of any clusters of infections being seen. With the dramatic media cov-

erage of this infection, MRSA, there is no better place for the community and for patients to receive important information about this disease and the necessary precautions that one must take than their local community health center. Emergency rooms and hospitals have neither the time nor the opportunity to spend in the education of the patients about properly hygiene techniques. Most of which we have heard already today. I would caution all that we need to remember that we are living in time where our communities are constantly being reminded of the many other serious and contagious illnesses that are out there.

In communities where there are immigrants from multiple nations and where international travel is common these include West Nile virus, Avian flu, tuberculosis and the risk for both epidemics and pandemics. Community health centers are the medical home for millions of patients nationally. And our patients are provided not only high quality accessible and affordable health care, but extensive health education. In the case of MRSA, a major role has been the dispersal of large quantities of reassurance.

I want to mention one other point in closing. The Institute for Family Health where I work has installed a state-of-the-art electronic medical record system which is integrated into the central surveillance system of the New York City Health Department. Every night, all the patient encounter information from the day's visits stripped of any identifying information is downloaded to the Health Department for analysis. The Health Department looks for any symptoms like rash or boils that might be appearing at the higher than normal frequency that day.

This kind of network gives the Health Department and thus all physicians in the community a jump-start on containing an outbreak of infection illness. My patients, your constituents, deserve this type of investment in their health. This can only occur if there is funding provided for electronic medical records in the community health centers allowing for integration of health center systems with public health departments to get more accurate and more timely information out to the public.

Thank you for listening and for the opportunity to address the committee. Continued support to provide a community health center home for all vulnerable people and to provide information technology and support of the providers who work there will ultimately work to contain any spread of communicable disease in the community and any spread of the panic that may accompany it. Thank you.

[The prepared statement of Dr. Gayle follows:]

"MRSA: A Community Health Center Perspective"

Committee on Oversight and Government Reform
U.S House of Representatives

THE INSTITUTE FOR FAMILY HEALTH

Testimony of

Eric Gayle MD
Bronx Regional Medical Director
Institute for Family Health
16 East 16th Street
New York, NY 10003

November 7, 2007

"MRSA: A Community Health Center Perspective"

Committee on Oversight and Government Reform

U.S House of Representatives

Testimony of

Eric Gayle MD
Bronx Regional Medical Director
Institute for Family Health
16 East 16th Street
New York, NY 10003
egayle@institute2000.org

Mr. Chairman, esteemed members of the Committee:

Thank you for the opportunity to address the critical subject of Methicillin Resistant Staph Aureus, or MRSA as it is commonly called, specifically in the context of how this effects vulnerable communities like the Bronx and the role that Community Health Centers can play in this regard.

My name is Eric Gayle, I am a Family Physician who has practiced primary care in the Bronx, New York for the past 9 years. I am the Bronx Regional Medical Director for the Institute for Family Health, an organization that provides care to over 75,000 people in New York State – most of them ethnic minorities and the majority on Medicaid or uninsured. I am here today to provide testimony that speaks to the specific needs of my community in respect to MRSA and the critical role that Community health Centers play in the management of contagious diseases such as this.

Let me reassure you, as I reassure my patients, that MRSA has been in the community for many years and has been successfully treated well by Community Health Center physicians for the most part without much fanfare. MRSA is significant to the health of the individual and to the community mainly if it goes unrecognized and thus is improperly treated.

When encountered in a community health center, the emergency room or in the hospital, MRSA may not be diagnosed for several days due to the time needed to do the appropriate laboratory testing. Therefore, what is most

important is the education to of the clinical community about the best agents for treating skin and soft tissue infections (SSTI) of which MRSA is the agent of most concern today.

The problem for Community Health Center physicians is that often times we are called upon to evaluate a patient only after the infection has significantly progressed and the patient is already ill and possibly toxic. This is because Community Health Centers are know as places where people can seek care even if they are uninsured – or if they need care in their language – or even if they come in for the first time in a crisis. We are truly a major part of what has been termed the community's health care safety net.

Community Health Centers do their best work when they are involved in the prevention of illnesses. One can never do enough in the education of our patients and the public so that once there is a question about any illness or malady that they know how to contact their primary care provider immediately. Only through early diagnosis and treatment can the patient be kept from the potentially serious outcomes of MRSA infection. The Community Health Center and their respective primary care providers need to be the first contact for any ailments our patients experience. The emergency rooms have a distinct disadvantage in the treatment of a condition like MRSA. Only the primary care provider has the advantage of knowing the individual and their history and can appropriately manage the patient and their family as well as share information pertinent to their illness and to their health.

Just this past June, I had an experience with a patient of mine who had MRSA - an experience which illustrates the importance of community based primary care. The patient was a child of 5 years old whom I had been managing since her mother was pregnant with her. This child has eczema as severe as I have ever known it to be in any individual. She came in with her mother one day with sores on her body that her mother attributed either to bites from an infestation of bugs in her building or from her scratching her skin from the itching resulting from her eczema. My knowledge of this child and her family – a relationship that has lasted many years - allowed me to be available to her at her first sign of concern and also to be able to provide the care she needed to combat her infection. On culture result she indeed had MRSA. I was able to not only treat the child but also again educate the family about good hygiene techniques in infection control and also to reassure them. This is the role that Community Health Centers play

so well: we are often the first contact for our patients for whatever their health concerns are.

But, tragically, many families do not have a medical home, do not have a Community Health Center such as ours to go to. We need to continue to grow and develop these vital community resources so they are available everywhere.

Where else will patients be educated to take care in their personal health particularly as it relates to communicable diseases? We advise them that if they have open sores or rashes that they ought not to participate in contact sports activities, advise the kids not to share towels in gym, and not to go to school or to work with any contagious illness.

Community Health Centers perform thousands of preparticipation physicals and part of this examination includes the education of athletes about those health problems for which he or she should seek medical attention before participating. These include education about rashes such as fungal infections, boils, sores and cuts for which he or she must take precautions.

With MRSA now seemingly more prevalent, Community Health Centers with electronic health record capabilities can closely monitor the patients they are seeing for possible outbreaks within a particular community and similarly alert community providers of any clusters of infections being seen.

A few years ago media coverage was about "the flesh eating bacteria" and the hysteria it provided in our communities was unimaginable. Our Community Health Center was approached by the local media to share information with the public about this infection. In a few minutes of televised information about this ailment we were able to calm our neighborhood of the fears and concerns they had regarding this disease. They were further calmed when they could identify with the physician discussing the issue on television. It was their family physician providing the information, not some media star with whom they could not identify.

With the dramatic media coverage of this infection, MRSA, there is no better place for the community and for patients to receive important information about this disease and the necessary precautions that one must take than their local community health center. Emergency rooms and

hospitals have neither the time nor the opportunity to spend in the education of the patients about proper hygiene techniques.

Let me share some basics with you that I share with my patients:

- Practice good hygiene in general
- Keep your hands clean by washing thoroughly with soap and water or using an alcohol-based hand sanitizer.
- Keep cuts and scrapes clean and covered with a bandage until healed.
- Avoid contact with other people's wounds or bandages.
- Avoid sharing personal items such as towels or razors.

I would caution all that we need to remember that we are living in times where our communities are constantly being reminded of the many other serious and contagious illnesses that are out there. In communities where there are immigrants from multiple nations and where international travel is common these include West Nile virus, Avian flu (which still presents an international concern), and the risk for both epidemics and pandemics.

While the media has dramatized the MRSA outbreaks, what we really need them to do is to dramatize the need for general preventive care. We need media coverage to urge our elderly and chronically ill patients to get their flu vaccine to prevent Influenza. We need to remind our asthmatic children that they ought to get their influenza vaccine and tell them that this is as critical to them as a possible outbreak of MRSA in their school. We also need education to dispel some of the myths associated with flu vaccine so that they can understand that it is impossible to get the flu from taking the vaccination. These salient information needs can and do come from the Community Health Centers and their primary care physicians.

Community Health Centers are the medical home for millions of patients Nationally and our patients are provided not only high quality, accessible and affordable healthcare but extensive health education. In the case of MRSA a major role has been the dispersal of large quantities of reassurance.

I want to mention one other point in closing. The Institute for Family Health where I work has installed a state-of-the art electronic medical record system which is integrated into the Syndromic surveillance system of the New York City Health Department. Every night, all the patient encounter information from the day's visits, stripped of any identifying information, is downloaded

to the health department for analysis. The health department looks for any symptoms (like rash or boils) that might be appearing at a higher than normal frequency that day. This kind of sentinel network gives the health department, and thus, all physicians in the community, a jump start on containing an outbreak of infectious illness. My patients - your constituents - deserve this type of investment in their health.

This can only occur if there is funding provided for electronic medical records in the Community Health Centers allowing for integration of health center systems with public health departments to get more accurate and more timely information out to the public.

Thank you for listening and for the opportunity to address the committee. Continued support to provide a community health center home for all vulnerable people and to provide information technology in support of the providers who work there will ultimately work to contain any spread of communicable disease in the community and any spread of the panic that may accompany it.

XXX

Mr. TOWNS. Thank you very much, Dr. Gayle. Let me thank all of you for your excellent testimony. Now we move into the question and answer period. And let me start with you, Dr. Walts.

You know, when a situation occurs in a school, parents get up in arms. And they will say, well, I'm not taking my son or my daughter back to that school. And of course, others will get involved and say you should not. And then somebody from the school will indicate the fact that the school is now safe. And then they will say to you, you are not a medical doctor, you're not in a position to evaluate whether or not the school is safe. How do you handle a situation like that? Because we always look at things legislatively and want to know if you need any help in terms of legislation.

Mr. WALTS. Well, we use a variety of strategies. We communicate with people in different ways because different ways of communication people can relate to. For example, we have an auto-dialer system. Again, it is up to the parent if they choose to be a part of that. But we'll put out a message using that auto-dialer system. We've got a very good Web site where we have a link. In fact, this was our lead story.

If you pulled up the Prince William County Web site during the height of this, that's the leading link. And there again, it would talk about facts related to MRSA. Preventive things, like the washing of the hands with soap and water, because you almost have to barrage people with a variety of communication methodologies talking about the facts, because otherwise they jump to conclusions that are just simply not helpful. And thinking, for example, that you have to close the school down, we were already using the chemicals that schools that have closed to disinfect were using because they weren't using that beforehand, so there was no reason to close schools. But when you see something on the news that some other school division is doing, then you're right, it really gets to almost a public hysteria point of view.

We work a lot with the press through this also to help us get the messages out. Of course, some of the issues with that is you never get them enough information fast enough. So that's why we would like to have more help from health departments and that sort of thing in terms of getting on the front lines of these kinds of issues.

Mr. TOWNS. Thank you very much. Thank you. Dr. Daum, I understand you've done a significant amount of research in this area. I wanted to learn more about why these infections are becoming resistant. I also want to understand if this is a situation that is actually getting worse or it is a situation where we have better reporting at the present time.

Dr. DAUM. Thank you for the question. I'll take the first part of the question, first question first. It turns out that what the community MRSA epidemic represents in my mind is a convergence of antibiotic resistance and virulence so that the resistance happens by means of a small piece of DNA, which we call a cassette, which actually can move from strain to strain. And when it moves from strain to strain, the sensitive strain it lands in becomes a resistant one. So the organism is obviously looking to acquire these cassettes because there's lots of antibiotics in our environment and it is better able to survive.

But it also turns out that virulence is a factor as well. And so that a strain that receives a cassette becomes a more fit pathogen, better able to survive on our bodies and in our environment if it also has virulence genes that allow it to do so. So what you have here is really two forces working against us humans. And that is that it is both antibiotic resistant and more virulent. The second part of your question I think had to do with—can you remind me? I'm sorry.

Mr. TOWNS. Actually, in terms of a better record reporting, better reporting now. Do we have a better reporting, period?

Dr. DAUM. I think it was related to how I know it is increasing. We did a study at our institution where, in a period of 3 years in the late 1990's, we showed that it had increased 25fold at our institution. And that's not as good as population based data to be sure, but it does give you a sense of what's going on. At Texas Children's Hospital, Dr. Kaplan and his colleagues have reported a similar very dramatic increase. At Driscoll Children's Hospital in Corpus Christi, they have also counted MRSA infections and it is a dramatic increase. And these are all healthy people or, for the most part, healthy people coming in from the community.

So I think there's at least three institution-based data that I can summon quickly to mind that suggest that it is increasing dramatically. I'll toss in my own clinical experience, if you would. And that is before this started in the late 1990's I never saw anything like this. I didn't see these severe syndromes I showed you, and I also didn't see children coming by the flocks to have their abscesses drained or getting admitted to the hospital at the rate that they are now.

Mr. TOWNS. Thank you very much. I yield to the ranking member, Mr. Davis.

Mr. DAVIS OF VIRGINIA. Thank you, Mr. Towns. Dr. Burns, let me ask you, with regard to the MRSA case in Bedford, it is unclear from your testimony whether the young man succumbed to CA MRSA or HA MRSA. Do you have any definitive answer on that?

Dr. BURNS. I don't have a definitive answer. And as you appreciate, I'm sure better than I, that talking about an individual case creates some HIPA issues. However, the mother did hold up the death certificate on television, so I think she's kind of provided that document in the public. And that document lists the cause of death as staph aureus sepsis.

In an individual case, as we heard this morning, it's virtually impossible to determine where this strain came from; whether it originated in the community and was acquired in the community, whether it originated at a hospital and was acquired in the community and the various combinations. I'm not sure this individual case would inform our decisionmaking. Certainly, we would be more comfortable using a series of cases. I think that's all I can tell about this case.

Mr. DAVIS OF VIRGINIA. The question is if you identify a MRSA case, but you don't know exactly what kind of strain it is or what antibiotic it is going to respond to, isn't that correct, isn't that one of the difficulties in this?

Dr. BURNS. Well, you're asking kind of two questions.

Mr. DAVIS OF VIRGINIA. I'm asking anybody who can answer two.

Dr. BURNS. You're asking the genetic question and the antibiotic resistant question. By definition, MRSA has been going to the laboratory and antibiotic sensitivity has been determined, so you know it is resistant to methicillin. And usually, if you've made that determination, you've done a complete sensitivity on it, so you know other antibiotics that it is both sensitive to and resistant to.

And that would virtually always be the case when you're culturing staph that you would be doing a sensitivity on it, especially in this day and age. Doing the genetic testing is a completely different issue. That wouldn't routinely be done for community strains.

Mr. DAVIS OF VIRGINIA. But early diagnosis is important and treatment in some of these cases, is that fair to say? Does anybody want to take a shot at that? Dr. Gayle.

Dr. GAYLE. I want to say that it is going to take a couple of days at least. Because you can look at the presentation of the case and still not be certain whether or not you're dealing with community acquired MRSA. You have to do the culture. And you may presumptively begin treatment. But then, once the culture and sensitivity comes back and identifies the strain and what medications are—the bacteria sensitive to that, then you can make changes in the management. But I don't think you're going to be able to look at the case and say specifically that it is MRSA.

Mr. DAVIS OF VIRGINIA. Dr. Walts, let me just ask on your Prince William cases. You mention in your testimony you've had a strong working relationship in place with local law enforcement. That kind of goes with the job out there. I've seen that work. Not the same relationship with the public health community and in the relationship with the media. Could you try to describe each of those? With the public health community, what was preexisting, how we are changing that and then managing the media is a difficult issue in a time like this.

Mr. WALTS. I would say with the health community, what I would like to see is them stepping up and taking more of a proactive role in helping the community to understand it from a medical perspective. The preventive care, the realities and the factual information around what this is to prevent hysteria. Because again, as you pointed out, I'm not a medical expert. So when I'm out there delivering all the information from the school division, I think it would be helpful to parents and certainly helpful to us to have the medical experts out there in the same way that we've carved that kind of a relationship with law enforcement.

Any time we have a criminal type of matter, we will talk about it from the education perspective, but then the police cover the criminal perspective. A lot of times we'll even do joint interviews with the press, that sort of thing. So that would be really helpful. Right now there hasn't been a lot of that.

Mr. DAVIS OF VIRGINIA. Dr. Gerberding talked about school nurses and how important they are. Can you give me, from a school superintendent's perspective, where they fit into this?

Mr. WALTS. Well, I will say absolutely they're critically important. And with the complexities of health care these days and the issues that have occurred in schools, the complexities of medications and that sort of thing, I have a lot more confidence when I know that I have a full-time nurse in every school. I wish I could

say that we did in Prince William County, but I'm glad to say that we have 69 nurses covering 86 schools. And we've increased the numbers of nurses every year pretty dramatically. I'm going to tell you, I'll say before I've even told my own school board, I'm going to be asking for more next year, because simply managing these issues over the last few weeks has just put the system on absolute overload.

Mr. DAVIS OF VIRGINIA. I'll be happy to join in a letter in support of that with the new school board. Could I just ask one last question. Dr. Daum, you talked about in your testimony that MRSA really has not invaded all the regions of the country. Which regions are the lucky ones who have been spared at this point?

Dr. DAUM. That's a great question, and I don't know every little one. But I can tell you that most people believe that we in the Midwest were the first to notice it in the late 1990's. And you heard from Dr. Gerberding that the four children that died in Minnesota and North Dakota, we actually had described it in the Journal of the American Medical Association a year before that. So the Midwest, I think, is blamed or credited with being the first place to really observe this rapid upswing. Next, reports became clear from many centers in Texas and the gulf coast that they were having the same kind of problem with a greatly increased volume of skin and soft tissue infections with the occasional severe infection and death.

The west coast appeared to come up to speed next, along with Alaska. And the California centers almost up and down the west coast have had trouble with community MRSA. And curiously, the east coast, the Northeast in particular, have been the last to sort of come up to speed. But Atlanta now is reporting a huge problem. And we didn't get to see Dr. Gerberding's data this morning, but in her JAMA paper, the city of Baltimore was such an outlier in terms of having higher rates than every other region in her network that they actually didn't include them in the mean calculations because they were so high.

So I think the important thing with regard to your question is that every place where it comes it hasn't gone away and it is coming to new places every day.

Mr. TOWNS. Thank you very much. Congresswoman Norton.

Ms. NORTON. Thank you, Mr. Chairman. I'm troubled by, indeed, what you just said about how the disease just seemed to emerge first in the Midwest and then you said the west coast came up to speed. And I know we in the east coast had this great knowledge to come forward only recently. And you mentioned in the 1990's when it was first noted. Of course, we're not talking about the new disease. This isn't like AIDS. This isn't that kind of new thing that everybody ought to believe is the end of the world. And that, therefore, is something that we would have thought we would have known of as a nation. That's really my question.

These statistics, which apparently have emerged for the first time, and I'm pleased that professionals of CDC did the JAMA article that told us about the 90-some thousand cases. 18,000 deaths, that's very troublesome. A disease that's been known for a long time, known to be drug resistant for a long time. My interest is in how the public health system works so that, yes, it is very

workmanlike, very professional. And I commend CDC for going to a peer review journal, informing the profession. But again, this is not—basically what they told us about was the incident of the disease. The reason I'm particularly concerned, frankly, is that this committee and one of my other committees, the Homeland Security Committee, have been very concerned about how people get to know that they should take precautions in a period when all kinds of deliberate carrying of germs could occur.

After 9/11 everybody is alert for that possibility. Even have had testimony here about what began as some attempt by the administration to control—to vaccinate some professionals ahead of time, and that stalled. But what I'm trying to find out is whether you believe that the present system of monitoring and informing the public is sufficient. When we hear—we do get everybody's attention once someone sits down and does the statistical work. But one is left to wonder whether we are now waiting for the next JAMA article to find whether there is a disease in our midst.

Should the CDC have told us about what was beginning, maybe this is for Dr. Bancroft, in the midwest. What, is it Dr. Daum's testimony, then became very visible in the midwest. Well, I'm sitting over here in the east coast with a lot of folks and it has become a real issue here only recently.

One would wonder why once you begin to see a trend in one part of the country, whether there is a mechanism for alerting people throughout the country, especially when some of what can be done washing hands and the rest of it, might have prevented some of these 18,000 deaths or the spread from wherever they occur, in hospitals, prisons, wherever they are. So I'm really concerned about the early warning capability of the CDC and whether it is working.

Dr. BANCROFT. Well, speaking as a local public health official, I will say that this entity of community MRSA has been written up in medical journals and public health journals since the 1990's. And we've been working with CDC since early 2002 when it was first identified in Los Angeles County, as had many other groups. In fact, the CDC has sponsored quite a bit of research on this. Dr. Daum is a recipient of CDC grants researching and looking at the prevalence of this.

I think one of the reasons it came to such public attention now where it has been otherwise quite vigorously described in the medical and public health literature, but why it has come to media attention now, was it was almost a perfect maelstrom of information of the JAMA article coming out the same week that a child died of MRSA, of community, or what we assume to be, but don't know to be community MRSA in that same week. I think for the public——

Ms. NORTON. How might it have happened? How might the entire country have become alert before somebody died and we had a kind of crisis atmosphere, at least created here for a while?

Dr. BANCROFT. You know, it's a great question, because we've been trying to work with the media in Los Angeles County, the school districts, for example, for many years on this. We sent out our guidelines for the prevention of how to prevent spreading this bug back in 2004 to the school districts, and have been giving lectures to doctors in school districts.

Ms. NORTON. Well, did CDC send anything out that time? Did CDC send out anything in the 1990's for example when it began to develop in the Midwest?

Dr. BANCROFT. It did have that MMWR, which is basically a public health notification, it is an official CDC notification, in 2000, about the deaths that occurred in 1999 in the Midwest. And subsequently there have been multiple MMWRs and multiple articles in the CDC journal emerging infectious disease about this.

Ms. NORTON. I'm trying to find out whether or not your school superintendent, your Congresswoman, your mayors, your laypeople who do not have access and do not want access to the professional literature were alerted, should have been alerted, whether or not our system in the post 9/11 period has a way to say nationally, look everybody, there's something out there, it is not a crisis, but this is what is occurring in some parts of our country. The reason I ask this from the point of view of the layman is we aren't talking about something only doctors can deal with.

You tell me that there are precautions that children can take in school, that people can take in restaurants, God help us people can take in hospitals that I don't think they understood they could take because you were left to deal in LA County to hear your testimony, and others of course dealt as they should have where they were located. This is a Nation. We're not dealing with how this hops from one country to another as in Europe.

So I'm just trying to find out if you have a national public health network, is it working here and what can this committee do to make sure that before there is an outbreak, before there's something sensationalized in the papers that now we got to go into our neighborhoods and say, just a moment, this is not like AIDS, this 18,000 people dying. So then you leave it to laypeople like us to have to put it back in perspective, because there's been no national understanding of what has happened.

That is my complaint. Not that they didn't do the professional job. That was excellent what they did. But they didn't tell me, they didn't tell my constituents, they didn't tell the people who come in contact with the very people who may be spreading it.

Dr. Daum, did you have something you wanted to say?

Dr. DAUM. Yes. I think the most important message I would like to give at this point is that to be constructive about this. And that is to say that if you believe the perspective that I've tried to provide, that the epicenter of MRSA is not now in the hospitals, but it is actually in the community. I think you've heard threads of that over and over again.

Ms. NORTON. We have a school, a whole school, and those kids haven't been in the hospital.

Dr. DAUM. I understand. We have our jail facilities, we have the households of patients, we have a lot of evidence of spread to new people, new kinds of folks that weren't really MRSA high-risk people before this began.

Mr. TOWNS. The gentlewoman's time is expired. I would be delighted to give her second round.

Ms. NORTON. Thank you very much Mr. Chairman.

Mr. TOWNS. Definitely. Let me move forward. Congressman Matheson.

Mr. MATHESON. Well, thank you, Mr. Chairman. Again, I appreciate the opportunity to participate in this hearing as not a regular member of the committee, and I'm pleased to have a chance to participate today. Dr. Daum, you're probably aware, my wife is a pediatric infectious disease doctor in Salt Lake City.

Dr. DAUM. She's probably unsupported.

Mr. MATHESON. Well, that's a discussion I hear a lot at the family dinner table. I appreciate your being here today, and wanted to ask you a couple questions. First, it is my understanding that Illinois is the only State in the country that's passed legislation that requires active surveillance of MRSA in hospitals. Do you think that's a model that other States and other countries should be following? What do you see the strengths and weaknesses of the Illinois model.

Dr. DAUM. First of all, let me begin by saying thank you for being one of the sponsors of the Star legislation. I think that's an important step to really getting the resources that this community, MRSA and other infectious disease antibiotic resistant infections really requires of us. I'm not pleased with our law in Illinois. What's happened, for those that don't know, in the last couple of years is a screening test is now available where you can take a swab of someone's nose and determine whether they have a MRSA DNA in their nose secretions. And while on the one hand one could conjure of some valuable things to investigate with that test, knowing that the germ or the DNA more properly is in someone's nose, does not really inform about the risk for subsequent infection. And so, first of all, it is a very expensive intervention. It costs several hundred dollars a test. The bill in Illinois, the price of it is being charged to the patients.

Second of all, our law is on admission only to ICUs. And I've already begun to field phone calls from people who are well, had a positive test and don't know what to do. They've been to doctors. They can't get rid of it. We don't know what the intervention is to tell someone about with a positive test. There's one. And now a new university hospital in our State is contemplating screening of everyone standing at the door of the hospital and screening everyone who comes in. And again, you can imagine a healthy woman coming to deliver a baby gets screened, finds out she's positive, she's perfectly well and goes crazy with anxiety about what she should do now and there's no intervention we have.

So although at first glance it sounds like it is a good thing to do. And in intensive care units it may have some use in decreasing spread in that high-charged environment. The epicenter of the problem is in the community now. And screening at the entrance to the hospital is not going to do anything but spend a lot of money and create a lot of anxiety.

Mr. MATHESON. That's helpful. You mentioned the Star Act that I've introduced, along with Congressman Waxman. I was wondering if you could just describe what you see as the strengths in the bill and can you speak in particular about the antimicrobial resistance, clinical research and public health network.

Dr. DAUM. So I think that MRSA, community MRSA, the epidemic we're having, coupled with other ongoing problems, most of which are at this moment based in hospitals, such as extended-

spectrum beta-lactamases and organisms like klebsiella, which are nosocomial infections, are health care problems that we've approached in a piecemeal way. And what excites me about the Star Act is the idea that we as a society will take a proactive approach and create centers around the country with a central focused office and bureau here that will start to proactively look at the magnitude of these issues so that we're not getting a paper like the one that came out in JAMA well into the epidemic and saying, wow, these numbers are really high. We'll know all along.

They also provide for novel interventions to try and contain the spread of antimicrobial resistance infections. That part of it excites me as well. And the part that excites me the most, and is also part of this, is to create novel research strategies in the lab and at the bedside to understand why resistant organisms are so successful making their way in our community and intensive care units with the goal to try to prevent that from happening. I see this bill as potentially resulting in new therapeutic strategies, new infection control strategies and ultimately perhaps even new prevention strategies. So I'm very excited about its scope and the idea that it creates a diverse effort from investigators and public health people around the country.

Mr. MATHESON. That's very helpful. I need to take you around with me when I'm trying to get people to co-sponsor the bill.

Dr. DAUM. Let's talk.

Mr. MATHESON. One last quick question. My time is expired. Can I just get one quick one in? Do you feel right now the Federal Government has, in place, an adequate—has the capability to adequately—is able to respond to antimicrobial resistant germs when they manifest itself somewhere? Do you think the Federal Government is set up to deal with that right now?

Dr. DAUM. I think that the JAMA paper for me was very exciting in that it gave numbers to what I believe I've been seeing clinically for the last 10 years. And the numbers are incredibly high. And I believe that this declares what I've been saying, is that this is an epidemic. It is an epidemic in our communities of MRSA infections, and they're novel infections. They're not the hospital germs that have moved out into the community. They're new germs. And I think that it gives us a real chance to immobilize. I think the mechanisms, to answer your question, are in place. NIH knows how to put out notices that were interested in research in a certain problem. CDC has begun to more aggressively fund extramural programs, and needs to continue to do that to look for better ways to deal with this.

So I think that if the agencies that are in place respond and say this is an epidemic, this is not about the hospitals, this is not about disinfecting a school or two, this is a major epidemic and we need to understand why and intervene, that yes the mechanisms are in place. But they need to be resourced. The Star bill is a mechanism of doing that. There are probably others. And they need to be mandated. And I hope that's something that comes out of this hearing today. That we've convinced you that there is an epidemic on, that the epicenter is in the community and that some of our public institutions, like the jails and the military and the athletic facilities are clearly involved in this, but we need to understand exactly how.

Mr. MATHESON. Thank you, Mr. Chairman. I yield back.

Dr. BANCROFT. May I add something to what Dr. Daum said, which is I think it is important to have the Federal Government have the resources to respond to this epidemic, but also to support the local and State public health resources. Because we're really the front lines of this epidemic. The first calls come to us when there's a problem. And what we look forward to CDC is to help set up the science behind the recommendations that then we will be applying on a regular daily basis. So I appreciate that there needs to be support for the Federal Government, but also for local and State health centers.

Mr. TOWNS. Thank you very much. On that note, Dr. Bancroft, do we really have the mechanism in place to determine how many cases?

Dr. BANCROFT. That's a great question. As Dr. Gerberding said earlier today, in those areas where they did the surveillance that the JAMA article is based on, yes they had a great mechanism for determining every case of invasive MRSA. But that particular mechanism took a lot of resources. Most of us at local and States don't have that resources to follow every case of MRSA.

Mr. TOWNS. Thank you. Dr. Gayle, isn't there a short window for treating invasive MRSA? You talk about administering a culture. How long will that take?

Dr. GAYLE. Well, the culture and identification and sensitivity of any bacteria generally takes about 3 days. And any clinician, if they're suspicious of something that's going on, something that doesn't look quite normal, will begin treatment. Whether the treatment is adequate is going to be determined by the sensitivity of the bug.

So you basically have 3 days in which you can start treatment, which could probably quiet the infection but not get at it to kill it. And then after you've identified the strain and the sensitivity, change the antibiotic that will effectively kill the bacteria.

Mr. TOWNS. Thank you.

Dr. DAUM. I think that Dr. Gayle's points are right on the money, but they apply to the common manifestation of community MRSA, which is the skin and soft tissue infection. Unfortunately, that is the commonest manifestation, as I showed you on the slide. I just want to remind everybody that fortunately uncommon, but there is a manifestation of this disease that does not present as a skin and soft tissue infection, but presents as an overwhelming body-wide infection and has the potential to cause death in previously healthy people in 12 to 24 hours.

I showed you a picture of one of the children who died. I showed you the skin rash and the adrenal glands and the lungs of such a child. We work with some of the parents who this has happened to. Because as you might imagine, they're kind of overwhelmed. But there's no quick test to do, which is what your question goes to, I think, to diagnose those children. Our emergency room is on very high alert, as are probably most other ERs now in our country for these severely ill folks. We have the antibiotics ready to go, the fluids ready to go. The supportive care evidence based or not ready to go. But the mortality is still high. And that's one of the reasons people have called repeatedly today, and I among them, for a vac-

cine. Because the tip of the iceberg of this epidemic, fortunately less common, I don't want to be an alarmist here, kills faster than we can treat it.

And it is not just a question about better antibiotics. And I just wanted to emphasize that because it goes to your question. It also has changed, to come back to Dr. Gayle's point one more time, this epidemic has also changed how we practice medicine. It used to be we had a skin and soft tissue infection or an abscess and we could take a penicillin or cephalosporin compound and reliably treat, didn't need to do a culture. The MRSA epidemic has changed that.

We now recommend a culture. Incision and drainage, as Dr. Bancroft said. But that the antibiotic has to be guessed at, and it takes several days to know whether it is the right choice or not. And it is not a penicillin or a cephalosporin. It is one of these old-timey drugs that we don't even know how well they work. So it isn't about antibiotic resistance in that sense. That it has changed how clinicians must respond to a skin and soft tissue infection now as compared with 10 years ago. I hope that's helpful.

Mr. TOWNS. Very helpful. A couple of you indicated that the government should do certain things. And I think you were talking about government agencies. But you know we're government too. So what specific suggestions do you have to us? And I know you might have some concerns about Members of Congress getting their nose under the tent. Are there any specific recommendations or suggestions?

Congressman Matheson, of course, and Congressman Waxman have a piece of legislation, I think, that you're looking at. But are there any other suggestions or recommendations that you feel that Congress should be involved in or should get involved in legislation of any sort? So let's go right down the line. I know, Dr. Walts, you have already made your request.

Mr. WALTS. I've got one more.

Mr. TOWNS. You have one more? Dr. Burns. Let me just go right down the line. And I know your situation is a little different.

Dr. BURNS. Not surprisingly, my first request would be continued support for health departments at the local level, because that is where the rubber meets the road. I thought it was almost breathtaking that the centers for Medicaid and Medicare services did what they did for nosocomial acquired infection. So basically they're saying if your practices are such that you're creating a nosocomial infection in the hospital, again, focus on the hospital. But if that happens in the hospital, you're not going to get paid for that patient. I think that's an incredibly powerful tool. I think it sends a great message.

And I think that and 100,000 Lives Campaign are two very effective methods to get the attention of the hospital system. I think it is not as obvious how such a kind of simple idea could affect community acquired infections, because it is kind of everybody doing what we do that creates the risk. It is back to the issue about what kind of resources do we have to get the public's attention. And I think that's the issue. It is not the fact that people at the Federal level, the State level and the local level aren't trying to get these messages out. But we have an almost unlimited number of public health messages that we want to get out, and we're competing with

a very noisy and effective advertising world where they're trying to get their message out too.

So there's a limited capacity for people to hear messages. And it tends to happen around something like this. Where for reasons that I still don't understand something gets the public's attention and then they start paying attention. And if we could figure out how we could get people to pay attention I think we could be much more effective in getting our messages out. You obviously can't legislate that.

Mr. TOWNS. Dr. Daum, and I'm on Congressman Davis' time now. Go ahead.

Dr. DAUM. Does that mean I shouldn't talk or I should talk fast?

Mr. DAVIS OF VIRGINIA. No, take your time.

Dr. DAUM. I think there's a number of things that you can do. The first thing, as you've heard from the different vantage points seated at this table, and I think we all have slightly different stakeholders in this problem, that education and the ability to cope with the need for education by the public is a major problem and needs to be resourced and expanded. So that we need to understand better how to react to hearing that a case came from the school or that this screening program is being proposed for the hospital and educate the public about what's going on. I know that's easy to say. But I think that we've heard this morning and this afternoon that we haven't done a very good job of it despite our best intentions.

More importantly—sorry. A larger scale of the problem, I think, is really accepting. And I heard all day long that we're having trouble accepting this. Really accepting that what's new about this is that it is not about dirtier hospitals, it is not about better recognition of infections in hospitals. It is a community-based epidemic. The hospital problem has always been there. It needs attention, it needs work, it needs to be enhanced. But the community problem is new. And we have—we're a very wealthy country and we have the ability to resource these things and create programs to ask the research questions to find out what we need to know and then the interventions to act.

What's happened is we don't have the knowledge base. And so when a case comes from the school that close it and disinfect it, well, people are angry and upset, those are natural kinds of impulses, but they won't help control MRSA epidemics in the community to appreciable extent.

So what can you do? I think that you can say there is an epidemic on, it is in the community and we need resources to deal with it. We need the CDC to mobilize and say this is a problem now; new programs, new money directed at this, and other antibiotic resistance infections as well. We need the NIH to ask what are the science questions that we need to know. Someone asked this afternoon how are these strains causing this trouble in the community, what do they have? Those are basic science questions. But we need to know them. Perhaps they're vaccine targets when we find out the answers.

So NIH also needs to create problems that says there's a community MRSA epidemic on, antibiotic resistance is a problem, we need expanded programs to deal with it. The Star bill is one way to do

it, it's a good way to do it, but there's other ways. And so what can you do? I think that you can say this is an epidemic and it needs attention and it needs it now.

Mr. TOWNS. Thank you very much. Dr. Walts.

Mr. WALTS. In addition to the ones I already gave, I know that you had distributed this morning a card, and it was a sample of something that had been distributed to hospitals throughout the country. And someone raised the question, do you have something similar that's been developed for schools, a tip sheet? And the doctor said, well, that's a good idea, we could see if we can try to locate resources for that.

So again, from my perspective as a school person, that to me would be an outstanding thing to have and probably fairly easy thing to do if there was just the money to put it together and distribute it. So sometimes simple things can really help tremendously inform the public, especially from a school perspective.

Mr. TOWNS. Thank you. Thank you very much. Dr. Gayle, and very quickly.

Dr. GAYLE. I would say that you need to be able to identify the community-based centers. And the only way to do it is if its through central surveillance. And I'll give you an example. I work in the Port Chester section of the Bronx. And this past summer, there was at least three cases of Legionnaire's disease that were identified. Because we are hooked into the New York City Department of Health, once they were notified that there was a cluster of that particular infection in that particular community, they sent out a bulletin immediately to my two medical centers in that community and said this is what we're seeing, look for these signs for Legionnaire's disease.

So each time a patient presented with symptoms that looked like Legionnaire's disease, there was a best practice alert that popped up on the computer screen that says think of this as a possibility for this particular patient. And so the doctor had it right there in front of his mind while he's seeing the patient whether or not this particular case could have been a Legionnaire's case. So central surveillance right at the point of care where you get information from the community as to what's happening now and then sending out the information to the respective centers in that particular community could be a great deal of help in identifying cases early.

Dr. BANCROFT. Quickly two areas. One, CDC does have money for some surveillance given to local and State health departments for surveillance in teaching about antibiotic resistance. But frankly it is not enough. There are limited funding for those positions in the State and local health departments. And I think it is extremely important to better delineate the epidemiology who is getting this disease. But not just the basic demographics of who is getting the disease, but being able to interview the patients themselves and ask about the risk factors, their practices, their behaviors that may be underlying why they're getting that disease.

So CDC needs additional funds to be able to distribute out to better do those studies, and also to support surveillance. And the second area really comes down to hospital MRSA. Dr. Daum has talked about the new epicenter of this disease being in the community. But still, as of this point, 85 percent of MRSA, at least the

invasive MRSA is hospitals. Right now in the local health departments, we inspect restaurants far more regularly than we inspect hospitals. That's true on a national level as well. We'll inspect restaurants one to four times a year. We inspect hospitals once every 3 years. I think more resources to inspect hospitals in order to help them have better oversight that they meet those inspection control standards that we know if applied will decrease MRSA and other infections.

Mr. TOWNS. Thank you. I yield to the ranking member. It is all yours.

Mr. DAVIS OF VIRGINIA. Thank you. I'll try to be brief, but I very much appreciate what the panel has had to offer. Dr. Burns, the emergency reporting requirements that were issued a few weeks ago required labs do the reporting. How did Virginia officials settle on that as being the best means for tracking?

Dr. BURNS. As you could imagine, it did take a lot of debate and discussion to decide on the most efficient method to do it. But it came down to the fact that to diagnose MRSA you had to have a laboratory test. So it is not a clinical diagnosis, it is a laboratory diagnosis. So since it is a laboratory diagnosis, why make the doctor report it when the laboratory already has the data, and the laboratories are generally much more oriented toward just adding another disease to the list of diseases they report, and then it happens automatically. There's not a one at a time kind of situation. So it is cheap, it is exactly the data we want, it is effective, the system is already in place, it was easy.

Mr. DAVIS OF VIRGINIA. What do we do with the data reported? Are school districts made aware of the reported cases.

Dr. BURNS. What we're asking the labs to report is MRSA from a normally sterile part of the body. So it doesn't include all the skin and superficial infections. So we're looking at bone, bloodstream, things like that. We don't anticipate that this will be a tool that will be useful at the school level. But we do think that it will be useful in helping us keep track of the tip of the iceberg. And by understanding what the tip of the iceberg is doing, both over time and by location, we can better target our deeper investigations to see what's actually going on.

And the thing I forgot to mention earlier about the other reason why it is real attractive to do the laboratory data is in public health we always like to know the denominator, we like to know something about the population that the number of diseases comes from.

So if you just take the number of diseases coming into the emergency room and you haven't thought about what part of the community they represent, you really kind of just have a popularity contest about who goes to that hospital. So by doing this laboratory-based reporting we know that we have the entire universe and so we will have valid data for us to make conclusions on over time.

Mr. DAVIS OF VIRGINIA. Thank you. Dr. Daum, you mentioned in your testimony that the skin and the soft tissue infections associated with MRSA often resemble spider bites. Now, if a physician were to look at this, this skin infection as a spider bite and treat it that way, is that a potentially fatal misstep for the patient.

Dr. DAUM. It is true that spider bites are commonly the story that patients will tell who come in with a community MRSA skin and soft tissue infection. I had a slide but not enough time to show it today that shows the mismatch of where epidemic diseases occurring and where those kinds of spiders live in our country. And it is amusing to hear in Chicago where the spiders do not live how often patients will nevertheless tell you that this started with a spider bite. And what I've learned to do then is say, have you seen the spider, and the answer is no.

So I guess it is recognition of something that looks like a spider bite in a place where they don't live is helpful. It is a bit of a conundrum here, because when anything that breaks the skin, including an insect bite, can actually predispose the staphylococcal infection. Staph lovesbroken skin. So that it is possible that a spider bite in sections of the country where they do live, could, in fact, set off a community MRSA infection as well.

So I think a physician has to be concerned when he or she sees something that looks like a spider bite that this could be a community MRSA infection. I think that your question though goes to an issue of progression. And in the skin and soft tissue infection, a very, very small percentage of them progress to more severe disease. So that I think that physicians need to be thoughtful about what they're seeing, but that an abscess today does not mean you're going to have a severe sepsis tomorrow.

Mr. DAVIS OF VIRGINIA. I'm just confused on—this is going to be my last question. Dr. Gerberding, in the first panel, talked about how these staph, these germs are everywhere. They're in people's noses and all over. And you're talking about how they're more regional in their manifestations.

Dr. DAUM. So we're both right.

Mr. DAVIS OF VIRGINIA. I knew that. I was just trying to get it together and understand how you were both right.

Dr. DAUM. So staphylococcus aureus, which is what we are really talking about today, and MRSA is a subset of those, is a very well adapted human pathogen. My guess is if the history book could be open, it has been living in us and on us for centuries. And a well-adapted pathogen doesn't want to kill everybody. That's the last thing in the world it would want to do, because then it has no place to live. So what staph really are happiest doing is living in your nose usually, but could be on your skin or even somewhere else rarely, and just sit there. Eat what you eat, breathe what you breathe, and its ultimate goal, divide. It really doesn't want to cause disease.

Disease is an unfortunate result of breakdown between our body's defenses and a germ's ability to live on us in peace. Dr. Gerberding is absolutely right. Staphylococcus aureus is everywhere. About a third of us right now have it on our bodies, even though presumably none of us have kind and soft tissue infections. And that's true. That's changed a little bit because now there's sometimes MRSA, a methicillin-resistant staph aureus. But it is the same staph aureus. Any disease is an uncommon outcome of interaction between this bug and one of us. It likes to just live peacefully among us.

So I think that goes to your question that she sort of posed. The difference is as if they perceive that they don't have enough food, they perceive that the conditions where they're living aren't the right ones, then they begin to secrete their toxins and begin to destroy tissues. The body then begins to respond to it and you get something that a doctor would call an infection.

Mr. DAVIS OF VIRGINIA. Thank you. That's it. Thank you all very much.

Mr. TOWNS. Thank you very much. Let me just say that the chairman has indicated we will have another hearing in the spring on hospital acquired MRSA and resistant strains. I also would like to thank all the witnesses for their testimony. And I hope that this hearing has provided some comfort to the public that while MRSA is a genuine concern, there are some practical simple steps that people can take to protect themselves and their children. At the same time the witnesses have made a very compelling case that we have to do more to combat infections in the community and in the health care setting. And also that we need to take the issue of antibiotic resistance very seriously. I look forward to pursuing these issues in the coming months. And as I've said that there will be another hearing in the spring. Without objection the committee stands adjourned.

[Whereupon, at 1:35 p.m., the committee was adjourned.]

[The prepared statements of Hon. Edolphus Towns and Hon. Diane E. Watson follow:]

U.S. HOUSE OF REPRESENTATIVES OVERSIGHT AND GOVERNMENT REFORM COMMITTEE HEARING, REGARDING "RESISTANT INFECTIONS IN THE COMMUNITY: CONSEQUENCES FOR PUBLIC HEALTH"

WENDESDAY, NOVEMBER 7, 2007 AT 9:15 A.M.
ROOM 2154 RAYBURN HOUSE OFFICE BUILDING
STATEMENT OF THE HON. EDOLPHUS TOWNS (D NY-10TH)

THANK YOU, MR. CHAIRMAN AND RANKING MEMBER FOR HOLDING THIS HEARING ON, **"RESISTANT INFECTIONS IN THE COMMUNITY: CONSEQUENCES FOR PUBLIC HEALTH".** BECAUSE OF AN INCIDENT IN MY BROOKLYN DISTRICT INVOLVING A TWELVE-YEAR OLD CHILD, OMAR RIVERA, WHO WAS INFECTED BY MRSA, I DIDN'T HESITATE TO ASK YOU FOR THIS HEARING, AND AM VERY GRATEFUL TO YOU FOR CONVENING THIS VERY TIMELY AND IMPORTANT HEARING. I THANK ALL OF YOU FOR APPEARING HERE, TODAY, ESPECIALLY OUR DISTINGUISHED FIRST PANLELIST, THE HON. **DR. JULIE LOUISE GERBERDING OF THE CDC; AND DR. ERIC G. GAYLE, THE BRONX REGIONAL MEDICAL DIRECTOR OF THE INSTITUTE FOR FAMILY HEALTH, WHO IS ON OUR SECOND PANEL.**

IN MY BROOKLYN DISTRICT, WE, RECENTLY, SUFFERED LOSS OF A CHILD'S LIFE, DUE TO WHAT MAY BE COMMUNITY-ASSOCIATED MRSA, ALSO COMMONLY CALLED, "STAPH." I BELIEVE THAT NEW YORK CITY'S MEDICAL EXAMINER IS STILL TRYING TO DECIDE WHETHER THE CHILD'S DEATH WAS ACTUALLY DUE TO STAP. CERTAINLY, MY WELL WISHES GO OUT TO THE RIVERA FAMILY FOR THEIR TRAGIC LOSS.

WE NEED TO BE ALARMED. THESE OUTBREAKS AND ANY LOSS FROM COMMUNITY-ASSOCIATED DRUG RESISTENT STRAINS OF MRSA, TUBERCULOSIS AND OTHER INFECTIOUS DISEASES, SUCH AS THOSE INFECTING OUR SERVICEMEN RETURNING FROM IRAQ, ARE INCREASING AND MUST BE STOPPED. DRUG RESISTANCE TO CERTAIN STRAINS IS SCARY. IT POSES AN EVER-INCREASING THREAT TO YOUNG AND OLD, REGARDLESS OF WHETHER INDIVIDUALS ARE HEALTHY, OR ARE IMMUNE COMPROMISED. AS PUBLIC OFFICIALS, WE MUST ASSURE THE PUBLIC. WE OWE A SPECIAL DUTY TO OUR CHILDREN, TO ENSURE THAT ALL SAFEGUARDS ARE IN PLACE. WE MUST FOCUS ON REPORTING, RESEARCH, PREVENTION, COMMUNITY EDUCATION AND OUTREACH, AND THE DEVELOPMENT OF EFFECTIVE ANTIBIOTICS.

THAT'S WHY I'M IN SUPPORT OF H.R. 3697 - THE MATHESON-WAXMAN BILL; AND I WILL SEPARATELY INTRODUCE A BILL TO APPROPRIATE FUNDS TO PROVIDE ASSISTANCE TO PUBLIC SCHOOLS FOR THE PREVENTION AND TREATMENT OF MRSA. I AM ALSO WORKING WITH SENATOR SCHUMER OF NEW YORK ON A BILL THAT WILL ENCOURAGE PRIVATE ENTITIES TO CONDUCT RESEARCH ON THE PREVENTION AND TREATMENT OF MRSA AND OTHER INFECTIOUS DISEASES.

I URGE MY COLLEAGUES TO JOIN ME IN CO-SPONSORING AND PASSING THIS CRITICAL LEGISLATION THIS YEAR. THANK YOU, MR. CHAIRMAN. # # #

Opening Statement
Congresswoman Diane E. Watson
Oversight & Government Reform
Hearing: "Drug-Resistant Infections in the Community: Consequences for Public Health"
November 7, 2007

Thank you Mr. Chairman for holding today's hearing concerning protecting public health from the spread of community-associated M.R.S.A. (Methicillin-Resistant *Staphylococcus Aureus*) infections. Even though most cases are related to health care settings, there may be a rise in infections affecting the general public.

Staphylococcus Aureus is a common bacteria found on the skin and usually causes no need for concern. However, there may be a possibility that infections may be able to spread to a much larger

portion of the general public if precautionary measures are not taken to reduce risk.

One of my concerns is the lack of data in relation to the spread of community-associated M.R.S.A. A Centers for Disease Control and Prevention (CDC) study found that community-associated M.R.S.A. made up 13.7 percent of all M.R.S.A. infections, but because the data only represented a snapshot and did not cover a period of years there is not enough information to determine how widespread the issue is.

I look forward to hearing both panels' testimony and I hope we can find out more about what can be done to increase Congress' awareness on how widespread community-associated M.R.S.A. really is,

and what can be done to educate the general public about preventing the spread of the infections.

I also look forward to the testimony given by Dr. Elizabeth Bancroft on the second panel, who is the Medical Epidemiologist for Los Angeles County Department of Health Services. I represent a large portion of Los Angeles, and I would like to know what demographic of the Los Angeles community is most susceptible to community-associated M.R.S.A.

Mr. Chairman, thank you for holding today's hearing and I yield back the remainder of my time.

○