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INFECTIOUS DISEASES BOARD REVIEW MANUAL

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Microbiology of Resistant Bacteria

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Microbiology of Resistant Bacteria

INTRODUCTION

Many physicians who are still practicing medicine today can remember thinking that infectious diseases had been conquered. As diseases fell to the onslaught of new and more potent antibiotics, some began to believe that medicine was only a science and not also an art form. Then, to paraphrase H.G. Wells, defeat came at the hands of the humblest organism found on the earth. Perhaps it was ultimate egotism to believe that a limited number of chemists and biologists, with only a few years' effort, could defeat a life form that constitutes most of the living material on this planet and has been combating antimicrobial toxins for an estimated 3.5 billion years.

If medicine is to regain supremacy against bacterial organisms, we must understand the enemy and mount attacks on several fronts. We previously underestimated the ability of bacteria to outwit the drugs that we used so confidently against them. Now we need to husband our still effective weapons, isolate and control resistant organisms, and above all study these organisms to identify their weaknesses.

This article will examine the major bacterial organisms that have exhibited antimicrobial resistance. The history, epidemiology, resistance mechanism, resultant changes in antibiotic selection, and future trends of each will be discussed in detail.

CASE PRESENTATION

A 72-year-old man is admitted to the hospital with clinical and radiographic evidence of pneumonia. His recent medical history includes emergency surgery to repair multiple broken bones sustained in an automobile accident and a subsequent lengthy stay in the surgical intensive care unit. While in the surgical intensive care unit, the patient was treated for nosocomial pneumonia. Since discharge from the hospital 6 months ago, the patient has been living in a nursing home.

A sputum Gram's stain obtained on admission shows a uniform field of gram-positive cocci consistent with *Staphylococcus aureus*. Laboratory results show that the *S. aureus* is resistant to methicillin, so the empiric antibiotic is changed to vancomycin. The patient is recovering from his pneumonia when he develops diarrhea.

Results of a test to identify *Clostridium difficile* toxin are negative, but results of a routinely performed screen for vancomycin-resistant enterococci (VRE) are positive.

- **What risk factors does this patient have that suggest the presence of antibiotic-resistant bacteria?**
- **What resistant organism(s) should be suspected?**
- **What steps are necessary to prevent the spread of the organism(s)?**

METHICILLIN-RESISTANT STAPHYLOCOCCUS AUREUS

HISTORY

S. aureus has been recognized as a major pathogen since it was first identified.¹ One of the great advantages of the drug penicillin when it was first introduced was its ability to treat *S. aureus* infections. Unfortunately, this control lasted only a few years. By the 1950s, many strains of *S. aureus* had developed the ability to destroy the penicillin molecule by means of the enzyme penicillinase (one of the β -lactamases). In response to this challenge, pharmaceutical companies created modified penicillin molecules that were resistant to the enzymatic action of penicillinase. This step, which led to the development of the semisynthetic penicillins methicillin, nafcillin, and oxacillin, returned control over *S. aureus* to the medical profession. Yet within a few years of the introduction of the semisynthetic penicillins, strains of *S. aureus* resistant to them were identified² and collectively labeled as methicillin-resistant *S. aureus* (MRSA). The first outbreaks of MRSA infections occurred in Europe but soon spread to the United States.³ Like their penicillinase-producing predecessors, these resistant strains were referred to as "hospital staph" because they were identified only in hospitalized patients. Today, it is common for 50% to 60% of all nosocomial *S. aureus* isolates to be MRSA.

DEDICATION

Volume 7, Part 1, of the *Infectious Diseases Board Review Manual* is dedicated to the memory of J. Boyd Francis, MD.