

Cost Studies in cost-effective care-giving Controversies

Treatment of a Patient with Osteomyelitis

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We are beginning the slow process of developing a new standard of care that emphasizes cost-effective evaluation and treatment. To reduce the regulatory climate in medicine, physicians must comply with these new standards. One step toward accomplishing this goal is to ensure that resources are allocated appropriately.

This series aims to increase a physician's awareness of how economic realities can be combined with good medical care. Each article in the series contains a case report. Compare your clinical decisions and the cost of your proposed care package with those of a guest consultant.

Although you are encouraged to match your total costs with those of the consultant, do not assume that lower costs are necessarily the most important goal. The primary emphasis should be on using only those resources that directly contribute to the health of the patient. The case report is not intended to provide a standard of medical care, but rather to stimulate a dialogue about cost-effective ways to practice high-quality medicine.

Appropriate allocation of medical resources means physicians must know how much tests cost, so it is important to obtain this information in your own practice. The test charges listed are estimates from a local medical bureau. All charges are rounded to the nearest dollar. Regional variations are not taken into account.

—David J. Shulkin, MD

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Case History

A 35-year-old man presents with a 2-week history of intermittent fevers and swelling, tenderness, and pain in the left thigh. Although his health is generally excellent, he had fractured his femur in a motorcycle accident 2 months prior to presentation. A femoral rod was placed at that time.

Physical examination is normal, except for a temperature of 101° and a tender, warm, swollen, and reddish thigh. Initial screening laboratory values are average, except for a leukocyte count of 12,000.

Diagnostic and Therapeutic Options

1. Which of the following tests and/or consultations do you include in your evaluation?

Option	Cost
A. X-ray of femur	\$45
B. Blood culture	\$20
C. Bone scan	\$325
D. Infectious diseases consultation	\$70 to \$245
E. Erythrocyte sedimentation rate	\$7
F. Surgical consultation	\$70 to \$245
G. Gallium scan	\$450
H. Aspirate of thigh for Gram's stain (\$75) and culture (\$25)	\$100

2. Based on the initial evaluation, the patient appears to have a *Staphylococcus aureus* (sensitive to methicillin) infection of his femur. How do you proceed?

Option	Cost
A. Removal of the rod	\$400
B. Intravenous antibiotic therapy	\$150/d
C. Hospitalization	\$600/d
D. Oral antibiotic therapy	\$5/d

3. After testing is completed and a diagnosis of osteomyelitis confirmed, how do you approach treatment?

Option	Cost
A. Placement of peripherally inserted central catheter	\$300
B. Placement of central tunneled catheter	\$2000
C. Heparin lock for intravenous antibiotic therapy	\$10/d
D. Oral antibiotic therapy for 6 to 8 weeks	\$5/d

E. Intravenous antibiotic therapy for 4 to 6 weeks \$150/d

4. At the end of therapy, which of the following tests are in order?

Option	Cost
A. Blood culture	\$20
B. Computed tomography of thigh	\$375
C. Magnetic resonance imaging of thigh	\$700
D. X-ray of femur	\$45
E. Erythrocyte sedimentation rate	\$7
F. Repeat aspirate of thigh for Gram's stain (\$75) and culture (\$25)	\$100
G. Gallium scan	\$450

Total Cost of Care \$ _____

Dr. Tice Comments

This apparently healthy young man probably has an infection of his femur resulting from a fracture and subsequent surgery. The situation is complicated by a foreign body (ie, the rod placed in his femur). The differential diagnosis should include the possibility of further injury to his leg as well as thrombophlebitis, but these complications are less likely.

With the likelihood that this case is an infection, several questions should be answered before further diagnostic and therapeutic options are explored. Was the fracture compound with the potential for environmental organisms to have entered the wound? Were there problems with infection after surgery? Were there residual bone fragments that might not be viable and could themselves contribute to infection?^{1,2}

Knowledge of prophylactic antibiotics that were used with surgery can aid in selecting empiric antibiotic therapy in this situation. An awareness of other medical problems or diseases the patient has is also helpful in making therapeutic decisions. It is beneficial to know whether there are any remaining wounds from the motorcycle accident. These wounds may be infected and may have seeded his femur. Prior culture results of these wounds or the femur may also provide important clues as to the organisms that should be treated. Other possible sources of infection, such as tinea pedis, infected blisters, dental work, or even small boils or abscesses, can provide useful clues for understanding the infection.

The answers to question 1 are A (\$45), B (\$20), and E (\$7). A complete blood count, chemistry panel, erythro-

cyte sedimentation rate, and at least one blood culture (in case of bacteremia) should be ordered. Depending on the physical examination and the x-ray results, aspiration of the thigh should be considered because it would immediately confirm the infection and identify the organisms involved. The patient's surgeon should be alerted as to the problem and questioned about any difficulties encountered in prior management.³

An infectious diseases consultation is usually worthwhile and cost-effective, particularly if the specialist can help avoid or shorten the course of hospitalization.

An isotope scan at this point would not affect therapy and would likely be abnormal simply because of the recent injury and surgery. The cost of an isotope scan is also quite high compared with the other options listed, which can provide specific information for future decisions.

The answer to question 2 is B (\$150/d). Intravenous antibiotic therapy should be started immediately.⁴⁻⁶ An antibiotic should be selected to treat *S. aureus*, the organism most likely responsible for this infection. For *S. aureus*, a penicillinase-resistant penicillin is the best approach because these antibiotics have the greatest activity against this bacterium. If there is a penicillin allergy, vancomycin or a first-generation cephalosporin is also useful. Intravenous administration of antibiotics is preferred over oral administration because it provides higher concentrations of drug in the infected area. High doses of antibiotics should be used for several days before any surgery is performed.

Consideration should be given to removing the rod or plate, but only if the bone is healed well enough to keep the femur in good position. If surgery is performed, removing any sequestra around the fracture may be of benefit.

Hospitalization is common in this situation, although it may be possible to begin intravenous antibiotic therapy on an outpatient basis. The patient may then be admitted to the hospital for surgery after the microbiology is known and the acute phase of the infection is under control. The shorter the hospital stay, the less the expense of therapy.⁷

The answers to question 3 are A (\$300) and E (\$150/d). Although many cases of gram-negative osteomyelitis can be treated with oral antibiotic therapy using drugs such as the quinolones, the general consensus is that *S. aureus* should be treated with intravenous antibiotics for 4 to 6 weeks. The only exception to this regimen is in children, who may respond to a shorter

course of intravenous antibiotics followed by a prolonged course of oral antibiotics. Peripherally inserted central catheters (PICC lines) have been very useful with prolonged courses of intravenous antibiotic therapy. They are particularly suited to outpatient therapy, in which intravenous therapy nurses are not readily available and a pump may be beneficial. Heparin locks are less reliable than PICC lines and may be more expensive if home visits are needed to restart them. PICC lines are also considerably less expensive than a central tunneled catheter and may be used for periods of 1 year or more.

The answer to question 4 is D (\$45). At the end of therapy, an x-ray of the femur should be taken again. This test will show the extent of damage and will be helpful for follow-up. It may be worthwhile to assess the erythrocyte sedimentation rate to confirm that it has returned to normal. An aspirate of the femur is not necessary if there has been an adequate clinical response. Repeat blood culture might be useful if the prior culture was positive. A blood culture is probably not indicated at the end of therapy unless there is concern about continued bacteremia or endocarditis. Radiologic studies may not be cost-effective as long as the course is one of improvement.

Continued physician follow-up for a possible relapse is valuable, with additional blood tests and radiologic evaluations as indicated by symptoms and physical findings. **HP**

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