Original Article

Pathogenic bacteria in an orthopaedic hospital in India

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Abstract
Background: The problem of changes in pathogenic microbiological flora and the emergence of bacterial resistance has created major problems in the management of orthopaedic diseases and fractures. Due to the use of implants for open reduction and internal fixation, which are foreign bodies to the body, orthopaedic trauma surgery is at grave risk of microbiological contamination and infection.
Methodology: With new microbiological agents in vogue, we have conducted a retrospective study to determine the pattern of bacterial infection, sensitivity to various antimicrobial agents, and their relations to various orthopaedic illnesses and procedures. Results: Gram negative (*E. coli* and *Pseudomonas spp*.) infections have emerged as the major threat (74.37%) in orthopaedic cases in contrast to *Staphylococcus aureus* (23.31%). These bacteria infected patients with open fractures (34.3%), spinal instrumentation with bedsores (23.31%), osteomyelitis of bone (24.42%) and guillotine amputation stumps (14.43%). Conclusion:.Cefaperazone and ceftriaxone were found to be the most effective antibiotics against gram negative bacteria while cefaperazone was equally effective against *S. aureus*. Emerging resistance was found against amoxicillin, ampicillin and the aminoglycoside: amikacin.
Key Words: Microbiology, infection, sensitivity, pattern, causes, prevention.

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Introduction

During the past few years, there has been remarkable improvement in the field of diagnosis of infection due to newer techniques and sophisticated tools; better health care systems, particularly in urban areas; increasing awareness of patients; and invention of newer, more effective, and less toxic antimicrobials for combating osteoarticular infections.

The following factors influence the nature and frequency of infection: 1) low resistance of patients; 2) contact with infectious persons; 3) contaminated environmental sites; 4) drug resistance of endemic organisms. [1] The source of an infecting organism may be one of the following: 1) endogenous, from a patient's own flora which at the time of admission may include the organism brought into hospital at admission; 2) exogenous, from another patient or a member of the hospital staff or from the inanimate environment of the hospital; 3) environmental: a) air, water, food and medication, b) used equipment/instrumentation, c) soiled linen, d) Hospital waste (4) Contamination of wounds during the time of injury by dirt, soot, grease etc.

We have conducted this study to find out the frequency of bacterial flora in relation to the type of injury, type of surgery and antibiotic sensitivity pattern of various bacterial isolates.

Materials and Methods

This study was conducted in the department of orthopaedics from 1-1-03 to 31-3-04. From open fractures, bedsores and wounds clinically suspected to be infected, swabs were collected with all aseptic precautions to avoid contamination and were immediately transported to the microbiology department for culture and antibiotic sensitivity testing. Once the swab was taken then only further management of wound like debridement/irrigation with hydrogen peroxide or povidone iodine solution was done. From stitched wounds also material was collected with utmost precautions to avoid contaminations. The swabs were assayed for the predominant organisms found in culture and the microbial

sensitivity/resistance patterns in relation to the specific disease.

The pathogens were identified by standard laboratory procedures including Grams staining, motility, colony characters and biochemical reactions. Antibiotic susceptibility testing was done by Disc diffusion method and measuring diameter of zone of inhibition as described by Bauer-Kirby method on Mueller Hinton Agar (MHA) [2,11].

In cases of infected implants where there was colonization of bacteria in slimy glycocalyx covering the implant, this layer was curetted and sent for culture. Out of these 209 swabs sent for culture and antibiotic sensitivity, 88 specimens were reported as sterile and 111 specimens were reported as culture positive, of which 29 were resistant to the antibiotics they tested for. The orthopaedic illness and procedures infected by various bacteria with their sensitivity/resistance pattern are detailed in observation Tables 1 and 2. These reports were compared for disease and microbial sensitivity patterns with other published studies. Cultures were also taken from dressing materials and instruments of wards and operation theatres to differentiate between infection and contamination.

Results

Of the 111 positive culture cases out of 209 cultures reported in the above duration for orthopaedic patients, the incidence of various microbes in relation to orthopaedic illnesses and procedures, the antibiotic sensitivity pattern of infecting pathogenic bacteria and the antibiotic resistance pattern to infecting pathogenic bacteria are detailed in the following three self-explanatory tables.

Discussion

The common microbes found in orthopedics wounds, infections and fractures in our study are *E. coli*, *Pseudomonas Spp*, *S. aureus*, *Klebsiella*, *Proteus* and *Streptococcus* in the same sequence. *S. aureus* used to be the most common strain in the 1950s and 1960's. Harvey Bernard (1962) [3] opines that in the last several decades the pattern of infection has been changing and gram negative bacteria are becoming more and more common. E. Jack Benner (1967) [4] reports the incidence of gram negative bacteria to be 59% while Surange and Rai (1971-73) [5] report it as 35.25% *S. aureus,* 22.55% *E. coli* and 18.5% *B. pyocyancs.*

Table 1. Incidence of various microbes in relation to orthopaedic illnesses and procedures.

	S. aureus	*Streptococcus*	*Klebsiella*	*Proteus*	*E. coli*	*Pseudomonas*	Total
Open fractures	6	1	4	1	9	9	30
Bedsores	3	1	2	1	5		12
Spinal instrumentation	2				7		9
Chronic Osteomyelitis	5	1	1		8	7	22
Interlocking nailing for femur and tibia	2	1		3	2	1	9
Cobrahood plating for subtrochanteric fracture femur	1		1			2	4
Arthrotomy for septic arthritis of the knee	1				1	1	3
Guillotene Amputation	1		1	1	3	7	13
Kirschner's wire fixation for supracondylar fracture humerus		1					1
Dynamic condylar screw fixation for distal femoral fractures.		1			1		2
Hemiarthro-plasty for fracture neck of femur in elderly.		1		1	2		4
Tension band wiring for fracture patella						2	2
Total	21	7	9	7	38	29	111

Our study shows that gram negative infections continue to be a major threat and were isolated from 74.7 cases. *E. coli* remains the most common pathogen (34.4% cases), especially in open fractures, chronic osteomyelitis, bedsores and patients with spinal instrumentation. *E. coli* is a commensal of gut and as many orthopedic patients are bedridden for prolonged periods, contamination of wounds, dressing, linen, clothes and even hands during perineal hygiene plays a major role in increasing chances of transmission of infection.

The second most common microbe found was *Pseudomonas spp*. (26.1%) found commonly in chronic osteomyelitis and amputation stumps. Sussaman (1959) [6], Agrawal (1985) [7], and Dade and Hall (1964) [8] have documented that *Pseudomonas* can multiply on common objects in a hospital environment such as buckets used for soaking Plaster of Paris bandages, wood wool paddings, and Cheatle forceps.

Table 2. Antibiotic sensitivity/resistance pattern of infecting pathogenic bacteria.

#	Microbe	No. of cases	%	Cases with Multiple Drug Resistance	Frequency of Antibiotics Showing Sensitivity	Frequency of Antibiotics Showing Resistance
1	*S. aureus*	21	19	02	Cefoperazone (5), ticarcillin (3), tobramycin (3), ciprofloxacin (3), cloxacillin (2), cefotaxime (2) ceftriaxone (1)	Amoxicillin (5), Ampicillin (3), Amikacin (3), Penicillin (2), Methicillin (2), Nalidixic acid (2), Azithromycin (2), Nitrofurantoin (NFT) (2) Clindamycin (1)
2	*Klebsiella*	09	8.1	03	Cefoperazone (3), ceftriaxone (3), cefepime (2), ticarcillin (2), amikacin (1), clindamycin (1) ceftazidime(1).	Cloxacillin (3), Ciprofloxacin (2), Ampicillin (2), Gentamycin (2), Tobramycin (1), Cefotaxime (1) Carbenicillin (1)
3	*E.coli**	38	34.4	09	Ceftriaxone (4), cefoperazone (4), nitrofurantoin (4), cefepime (3), amikacin (3), ticarcillin (3) and piperacillin (3). It was intermediately sensitive to cloxacillin (2), neomycin (2), ciprofloxacin (2), ofloxacin (2) and cefotaxime (1).	Ampicillin (4), Amoxicillin (3), Penicillin (3) Methicillin (2)
4	*Pseudomonas**	29	26.1	12	Ceftriaxone (4), cefoperazone (4), nitrofurantoin (4), cefepime (3), amikacin (3), ticarcillin (3), piperacillin (3), carbenicillin (2), and ceftazidime (2).	Ampicillin (4), Amoxicillin (3), Penicillin (3) Methicillin (2)
5	*Proteus*	07	6.3	02	Ceftriaxone (3), cefotaxime (1) and cefoperazone (1). Less effective drugs include nalidixic acid (1), tobramycin (1) and ciprofloxacin (1).	Ampicillin (2), Amoxicillin (1), Gentamycin (1) Cefixime (1).
6	*Streptococcus*	07	6.3	01	amikacin (2), neomycin (2), nalidixic acid (2), cephalothin (1) and cefepime (1)	Ampicillin (3), Amoxicillin (3) Carbenicillin (1).

*These were the Bacteria most difficult to treat due to Multiple Drug Resistance.

S. aureus (21.62%) is the third most common organism. About 10% to 30% of healthy people carry this organism, particularly in the nose. These organisms can also be carried by patients themselves. Bed sheets, instruments and dressings have also been found to act as reservoirs. Agrawal (1972) [9] and Datta (1976) [10] found that 45.2% of hospitalized patients and 6.6% of hospital staff are carriers.

In our study, isolates were also tested for antimicrobial susceptibility. *Pseudomonas* (12 cases), *E. coli* (9 cases), *Klebsiella* (3 cases), *Proteus* (2 cases) and *Streptococcus* (1 case) were found to be resistant to all antibiotics.

Our study clearly shows that *Pseudomonas spp.* is still resistant to most antibiotics (12 cases out of 29) and was sensitive only to ceftriaxone, cefoperazone, and piperacillin. A higher infection rate as compared with developed countries may be related to overcrowding in wards, poor socioeconomic status, and lack of hygiene and education. In contrast to the routine use of cefotaxime and amikacin for all orthopaedic patients with open fractures or implant surgery, and amoxicillin/ampicillin and amikacin for other orthopaedic illnesses in our hospital, cefoperazone followed by ceftriaxone has emerged as the drug of choice for *E. coli* and *Pseudomonas spp*. infection while cefoperazone was also the drug of choice in *S. aureus* infections. All these bacteria developed resistance to amoxicillin, ampicillin and amikacin, perhaps due to the routine use of these antibiotics in wards. We recommend the use of cefaperozone as the first drug of choice in orthopaedic patients with open fractures, wounds, bedsores and osteomyelitis of bones.

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