

A Spectrum of Causative Organisms of Healthcare-associated Infections in a Tertiary Care Hospital of West Bengal: An Observational Study

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ABSTRACT

Background: Nosocomial infections are the foremost reasons for morbidity and mortality among hospitalized patients. Rampant use of antibiotics in infections has led to the emergence of multiresistant bacteria worldwide. Periodical review of sensitivity profiles is of utmost importance for optimal patient benefit.

Aims and objectives: To explore the spectrum of organisms responsible for intensive care unit (ICU) and inpatient hospital-acquired sepsis and evaluate the pattern of antibiotic sensitivity of the organisms.

Materials and methods: Samples were collected from all consecutive patients getting fever and satisfying the criteria for a nosocomial infection indoor as well as ICU, irrespective of etiology. They included sputum, blood, urine, and wound swabs. All samples were sent for a routine examination as well as a culture and sensitivity test. Descriptive statistical methods were used with the help of SPSS version 21.

Results: The most frequent organisms for nosocomial infections in the ICU were Enterobacteriaceae (45%), *Acinetobacter* (13.7%), and *Staphylococcus aureus* (12.3%). In the general wards, the most common isolates were Enterobacteriaceae (59.9%), *S. aureus* (14.5%), *Enterococcus* (9.8%), and *Pseudomonas* (9.3%). There was a high percentage of extended-spectrum beta-lactamase among the Enterobacteriaceae, methicillin-resistant *S. aureus*, and borderline oxacillin-resistant *S. aureus* among *S. aureus* and metallo- β -lactamase among the *Acinetobacter* and *Pseudomonas*. These indicate resistance to most beta-lactams, cephalosporins, and at times to carbapenems. There was also coresistance to fluoroquinolones and aminoglycosides.

Conclusion: An antibiotic policy should be improvised for each healthcare facility on the basis of that point of time.

Keywords: Infection, Multiresistant, Nosocomial, Sensitivity,
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INTRODUCTION

Antibiotics are essential components of modern therapeutic practices. But inappropriate and indiscriminate usage of antibiotics can result in resistance of organisms. Healthcare-associated infections (HAIs) lead to poor outcomes in hospitalized patients.¹ Thus, it is mandatory to abide by certain norms while prescribing antibiotics to minimize nosocomial infections which are defined as those that occur within 48 hours of admission or 3 days after discharge from a healthcare facility and it was absent during admission.² Empirical antibiotic therapy if not matched with suitable sensitivity profiles definitely leads to polyresistance in severe sepsis.³ So, it is essential for the institutions to have in-house up-to-date data to evaluate the likely causatives. This will assist in choosing empirical drugs from sensitivity patterns.

Studies concerning culture and sensitivity profiles of body fluids have been performed over the decades. There have been changes in the sensitivity profiles over time and more so due to the indiscriminate as well as illogical use of antibiotics. We endeavored to study the current trend of causative organisms and their antibiotic sensitivity and to compare it with the previous work done in this field. This study was done for 6 months to identify the pattern of organisms isolated from the intensive care unit (ICU) and inpatients of wards.

AIMS AND OBJECTIVES

- Primary objective is to explore the spectrum of organisms responsible for inpatient nosocomial sepsis.
- Secondary objective is to evaluate the pattern of antibiotic sensitivity in the organisms.

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MATERIALS AND METHODS

This is an observational study carried out in the ICU and the general wards of our hospital for a period of 6 months. Nonpurposive convenient sampling method was used to select patients. All patients with undiagnosed fever that developed 48 hours after admission to the hospital were included in the study fulfilling the criteria for a nosocomial infection. Immunocompromised and neutropenic patients and patients on steroids or immunosuppressive drugs

were excluded. After taking informed consent, detailed history and clinical examination were recorded in a prevalidated proforma.

Antimicrobial sensitivity tests were performed on bacteria considered significant. The antibiotics included in our study were Co-amoxiclav, ampicillin, trimethoprim/sulfamethoxazole (cotrimoxazole), norfloxacin, ciprofloxacin, levofloxacin, ofloxacin, nitrofurantoin, gentamicin, amikacin, doxycycline, cefuroxime, ceftazidime, cefotaxime, netilmicin, polymyxin B, Colistin, piperacillin/tazobactam, cefoperazone/sulbactam, meropenem, imipenem, vancomycin, tigecycline, and teicoplanin.

RESULTS

The study was conducted for 6 months in the general wards as well as ICU of a tertiary care hospital. The total number of samples collected was 1,046, of which 255 were from ICU. Seventy-three were positive isolates in the ICU (Table 1). Of 73 isolates, respiratory tract infection accounted for 33, urinary tract infection (UTI) 10, wound sepsis 7, bacteremia/septicemia 11, and intravenous (IV) catheter sepsis in 2 patients. Ten samples (15.4%) were due to probable colonization.

Table 1: Antibiotic sensitivity patterns of common isolates from inpatients location: intensive care units

Antibiotics	Isolates (% sensitive)				
	<i>Enterobacteriaceae</i> N = 34	<i>Pseudomonas</i> N = 9	<i>Acinetobacter</i> N = 10	<i>Staphylococci</i> N = 9	<i>Enterococci</i> N = 5
Amoxicillin	00	–	–	11	60
Cloxacillin/oxacillin	–	–	–	44	–
Carbenicillin	–	00	–	–	–
Piperacillin	–	00	–	–	–
Ampicillin-sulbactam	–	–	60	–	–
Amoxicillin-clavulanate	06	–	10	11	60
Piperacillin-tazobactam	62	44	80	56	100
Ticarcillin-clavulanate	35	00	20	56	–
Cefoperazone-sulbactam	65	56	100	56	–
Cephalexin	–	–	–	56	–
Cefuroxime	16	–	–	56	–
Cefotaxime	24	–	20	–	–
Ceftazidime	24	11	20	–	–
Cefoperazone	–	11	–	–	–
Cefpirome	–	–	–	56	–
Cefepime	24	11	20	–	–
Aztreonam	24	11	20	–	–
Imipenem	100	78	60	–	100
Meropenem	100	78	60	–	–
Azithromycin	–	–	–	33	40
Clindamycin	–	–	–	67	–
Vancomycin	–	–	–	100	100
Teicoplanin	–	–	–	100	100
Linezolid	–	–	–	100	100
Gentamicin	56	22	70	89	(High dose) 60
Tobramycin	47	22	80	–	–
Netilmicin	68	67	80	100	60
Amikacin	65	67	80	100	60
Ciprofloxacin	35	44	40	56	20
Ofloxacin	38	44	60	56	20
Levofloxacin	62	44	80	56	20
Moxifloxacin	56	44	80	78	60
Cotrimoxazole	21	00	40	33	–
Chloramphenicol	68	–	40	78	40
Tetracycline	44	–	50	89	20
Tigecycline	94	–	100	100	80
Polymyxin B	–	89	100	–	–
Colistin	–	89	100	–	–

Total no. of samples: 1464; no. of inpatient samples: 1046; no. of ICU samples: 255; total no. of ICU isolates: 73; polymicrobial growth: 8 samples (12.3%); NA, antibiotic disks not available

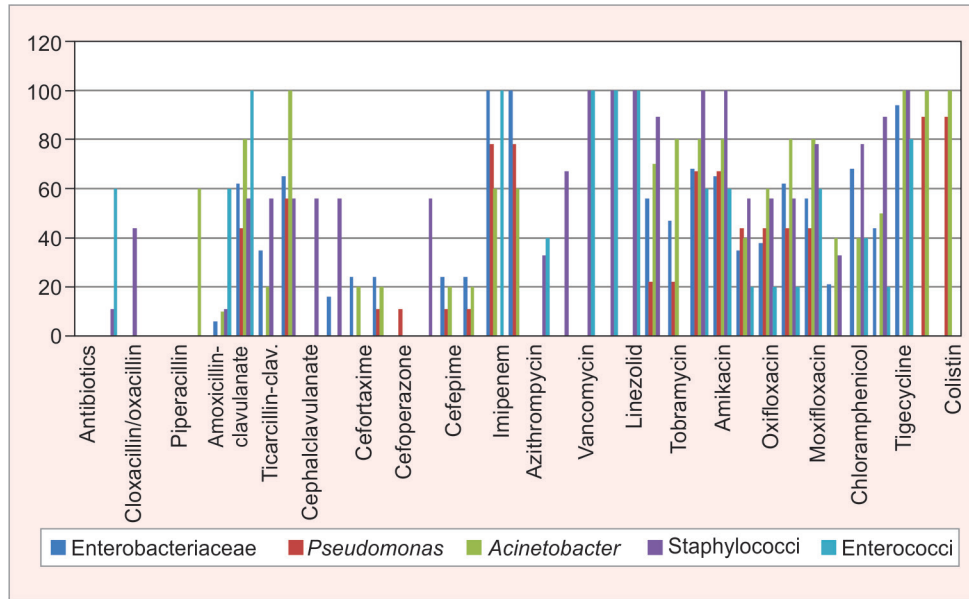


Fig. 1: Sensitivity patterns of organisms in ICU

The most common organisms isolated were Enterobacteriaceae (34 isolates, i.e., 45%). Of which 15 (44%) were extended-spectrum beta-lactamase (ESBL) producers; 11 (32%) probable coproducers of ESBLs and AmpC beta-lactamases. All isolates were sensitive to imipenem and meropenem.

Among the *Acinetobacter* sp., the next most common organism (10 isolates, i.e., 13.7%), 4 (40%) were carbapenem resistant and 3 (75%) of those were metallo-β-lactamase (MBL) producers. Polymyxins, cefoperazone/sulbactam and tigecycline covered 100% of the isolates.

Other organisms isolated were:

- *Staphylococci*: 9 isolates (12.3%), of which 3 were (33%) methicillin-resistant *S. aureus* (MRSA), 1 (11%) borderline oxacillin-resistant *S. aureus* (BORSA), 4 methicillin-sensitive *S. aureus* (MSSA), 1 methicillin-resistant coagulase-negative *S. aureus* (MR-CNSA).
- *Pseudomonas*: 9 isolates (12.3%), of which 2 (22%) were carbapenem-resistant MBL producers. All *Pseudomonas aeruginosa* isolates were sensitive to polymyxins.
- *Enterococci*: 5 isolates (6.8%): all *Enterococcus faecalis*: all were sensitive to vancomycin, linezolid, imipenem, and piperacillin/tazobactam (Fig. 1).
- *Fungi*: 6 isolates (8.2%): all *Candida* sp.: 4 (67%) *albicans*; 2 (33%) non-*albicans* spp.

The results from inpatients revealed the following (Table 2): there were 791 samples collected, of which 172 were positive. Of 172 isolates, respiratory tract infection accounted for 10, UTI 70, wound sepsis 60, bacteremia/septicemia 15, IV catheter infection in 3; 14 samples (9%) were due to probable colonization.

Here also the most frequent isolate was Enterobacteriaceae: 103 isolates (59.9%). Fifty-four (52%) ESBL producers; 11 (11%) probable coproducers of ESBLs and AmpC beta-lactamases. All were carbapenem sensitive. They were poorly responsive to cephalosporins and quinolones.

Next were *Staphylococci*: 25 isolates (14.5%): 10 (40%) MRSA, 2 (8%) BORSA, 13 MSSA. Well responsive to vancomycin, clindamycin, and linezolid.

Enterococci: Of the 17 isolates (9.8%), all were sensitive to vancomycin, linezolid, and tigecycline.

Pseudomonas: 16 isolates (9.3%): all *P. aeruginosa*: 6 (38%) carbapenem resistant: all were MBL producers. All were polymyxin sensitive.

Acinetobacter sp.: 3 isolates (1.7%): 1 (33%) carbapenem resistant and MBL producer. All sensitive to polymyxins, cefoperazone/sulbactam, and piperacillin/tazobactam (Fig. 2).

Fungi: 8 isolates (4.6%), all *Candida* sp.: 4 (50%) *albicans*; 4 (50%) non-*albicans* spp.

To summarize, the pattern of infection reveals a spectrum of multiresistant bacteria both in ICU and general wards responsive to the highest grade of antibiotics. However, *Acinetobacter* was much more frequently found in ICU than wards, though Enterobacteriaceae and *S. aureus* were omnipresent.⁴

DISCUSSION

HAIs comprise catheter-associated UTI, pneumonia including ventilator-associated pneumonia, bloodstream infection, gastroenteritis, and surgical site and wound sepsis.⁵ Nosocomial infections are most frequently bacterial.⁶ Some may be commensals of the patient taking the upper hand when immunity becomes weak. In the ICU, almost 70% of the organisms constitute *Staphylococci*, Enterobacteriaceae, *Pseudomonas*, and *Acinetobacter* species. Enterobacteriaceae include *Escherichia coli*, *Proteus mirabilis*, *Klebsiella pneumoniae*, and *Serratia marcescens*.⁷⁻⁹

Our study revealed that group of Enterobacteriaceae, *Acinetobacter*, *S. aureus*, and *Pseudomonas* were most isolated in the ICU. In the wards, Enterobacteriaceae, *S. aureus*, and *Pseudomonas* were most frequent. This spectrum is similar to the studies in the United Kingdom, Canada, Uganda, etc.¹⁰⁻¹² Of the Enterobacteriaceae 103 isolates: 54 (52%) ESBL producers; 11 (11%) probable coproducers of ESBLs and AmpC beta-lactamases. Among the *Staphylococci* 25 isolates: 10 (40%) MRSA; 2 (8%) BORSA; 13 MSSA. For *Acinetobacter* sp. 3 isolates: 1 (33%) carbapenem resistant and MBL producer and

Table 2: Antibiotic sensitivity patterns of common isolates from inpatients, location: general wards (non-ICU)

Antibiotics	Isolates (% sensitive)				
	<i>Enterobacteriaceae</i> N = 103	<i>Pseudomonads</i> N = 16	<i>Acinetobacter</i> N = 3	<i>Staphylococci</i> N = 25	<i>Enterococci</i> N = 17
Amoxicillin	06	–	–	16	65
Cloxacillin/oxacillin	–	–	–	52	–
Carbenicillin	–	13	–	–	–
Piperacillin	–	13	–	–	–
Ampicillin-sulbactam	–	–	67	–	–
Amoxicillin-clavulanate	17	–	00	24	65
Piperacillin-tazobactam	87	50	100	60	82
Ticarcillin-clavulanate	41	31	00	60	–
Cefoperazone-sulbactam	88	50	100	60	–
Cephalexin	–	–	–	60	–
Cefuroxime	20	–	–	60	–
Cefotaxime	32	–	00	–	–
Ceftazidime	32	19	00	–	–
Cefoperazone	–	19	–	–	–
Cefpirome	–	–	–	–	–
Cefepime	32	25	00	–	–
Aztreonam	32	38	00	–	–
Imipenem	100	63	67	–	82
Meropenem	100	63	67	–	–
Azithromycin	–	–	–	56	47
Clindamycin	–	–	–	68	–
Vancomycin	–	–	–	100	100
Teicoplanin	–	–	–	100	100
Linezolid	–	–	–	100	100
Gentamicin	61	50	33	92	(High dose) 59
Tobramycin	59	50	33	–	–
Netilmicin	71	50	67	92	65
Amikacin	70	69	33	92	59
Ciprofloxacin	41	50	33	68	35
Ofloxacin	47	50	33	76	47
Levofloxacin	69	50	67	88	59
Moxifloxacin	83	50	67	92	76
Cotrimoxazole	34	19	33	44	–
Chloramphenicol	68	–	–	88	53
Tetracycline	54	–	33	92	47
Tigecycline	95	–	67	100	100
Polymyxin B	–	100	100	–	–
Colistin	–	100	100	–	–

No. of inpatient samples: 1046; no. of non-ICU samples: 791; total no. of non-ICU isolates: 172; polymicrobial growth: 15 samples (9.6%); NA, antibiotic discs not available

for *Pseudomonas* 6 isolates (38%) carbapenem resistant: all were MBL producers. A study from Punjab revealed production of ESBL, AmpC beta-lactamase, and MBL by *E. coli* and *K. pneumoniae*.

Of all isolates, ESBL was detected in 35.16% and MBL producers in 10.98%.¹³

Thus, they manifested multidrug resistance and propensity to respond only to higher antibiotics like carbapenems, polymyxin, Colistin, vancomycin, tigecycline, etc. The initial choice of drugs like cephalosporins and beta-lactams is useless in this setting.

Coreistance to quinolones and aminoglycosides was seen maybe due to plasmid transfer, which is of grave concern.

The fungal isolate in this study, i.e., *Candida* species is another fixture in all HAI spectrum of organisms. It is isolated mostly in patients with diabetes, renal failure, and cancer and in immunocompromised patients. It is said to be the sixth common cause of nosocomial infection worldwide.¹⁴

World Health Organization documents around 15% of all hospitalized patients develop nosocomial infections.¹⁵ Susceptibility

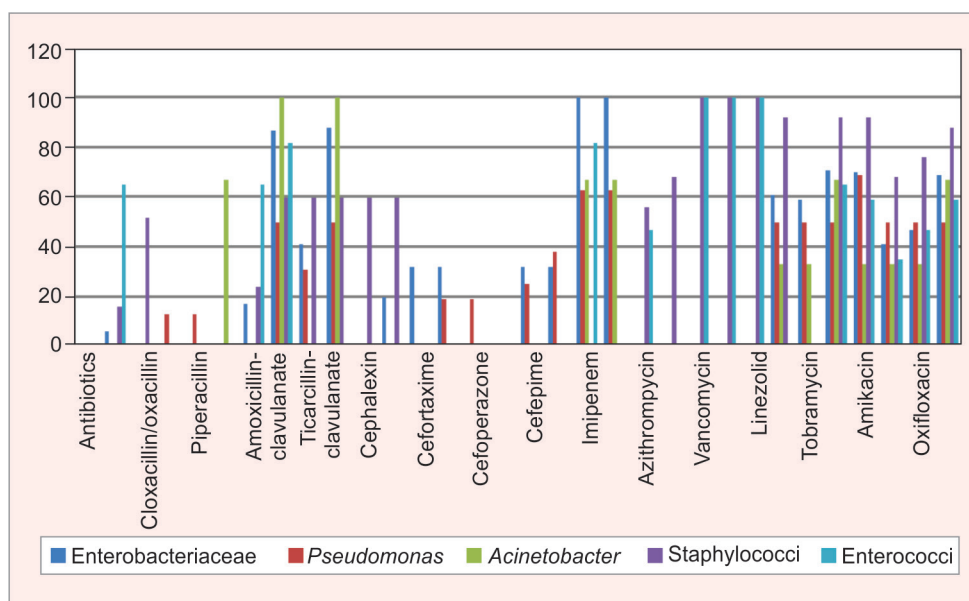


Fig. 2: Sensitivity patterns of organisms in wards

to HAI increases due to unhygienic environment, improper waste disposal, and ignorance among healthcare personnel.¹⁶

Patient factors include immunosuppression, increased duration of ICU admission, and continued antibiotic therapy. Improper techniques of use of invasive devices (cannula and catheters) and absence of control policies are all incriminated as predisposing factors.¹⁷

In low-income countries, the above factors are linked to poor economic status, inadequate staff, and infrastructure.¹⁸

It is important to devise ways of prevention of nosocomial infections by practicing well-monitored healthcare delivery, maintenance of hygiene, and specifically targeted antimicrobial prescription policy.

Proper waste disposal, cleanliness in the environment, proper food handling, and hand hygiene should be practiced. Foremost is also to take measures for the prevention of drug resistance to develop.^{19,20}

It is important that every hospital should have an infection control group who would devise an antibiotic policy for that particular healthcare facility. Our study is a typical microbiological surveillance report on the current pathogen spectrum and their sensitivity pattern.

An antibiotic policy provides guidelines for use in specific infections for that institution at a point in time. It is reviewed by a microbiologist and devised based on the latest surveillance data.^{21,22}

The following are the measures to be undertaken:

- Training on antibiotic usage.
- Monthly data surveillance and feedback to be reviewed periodically.
- Hospital infection control group will formulate guidelines to ensure restricted antibiotic use.

LIMITATIONS OF OUR STUDY

Viral identification was not possible in our setup. The total number of samples was limited and stool samples were not done.

CONCLUSION

Superbugs are emerging day by day in healthcare setups where traditional antibiotics are becoming useless. The importance of periodical sampling and culture and sensitivity tests cannot be undermined as the bacterial spectrum and the sensitivity change over time. Moreover, it helps to lay down an antibiotic policy for a particular institution that goes a long way in the prevention of multidrug resistance in the future.

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