Int.J.Curr.Microbiol.App.Sci (2020) *9*(2): 1399-1408

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 9 Number 2 (2020)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2020.902.162

A Study of Hospital Acquired Bacterial Infections and its Antimicrobial Susceptibility Pattern in a Teaching Hospital of Gujarat, India

Dipak M. Panjwani[1,2*], Sucheta J. Lakhani[1], Sanjay J. Mehta[2], Kunjan M. Kikani[2] and KhushbooMadaan[2]

[1]Department of Microbiology, SBKS Medical Institute and Research Centre, Sumandeep Vidyapeeth, Piparia (Gujarat), India
[2]Deptartment of Microbiology, C. U. Shah Medical College, Surendranagar (Gujarat), India

**Corresponding author*

Keywords

Nosocomial infection, Hospital acquired infection, Prevalence and Antimicrobial susceptibility pattern

Article Info

Accepted:
08 January 2020
Available Online:
10 February 2020

A B S T R A C T

Hospital acquired infections (HAI) are counted as major reasons of mortality, morbidity and emotional stress in hospitalized patients. These infections has also enhanced burden on health care institutions. It has also been estimated that at any time over 1.4 million people worldwide suffer from nosocomial infections. The main reason for this alarming situation is resistant microorganisms of hospitals. The objective of this study was to isolate and identify the bacterial etiological agents responsible for nosocomial infection and to evaluate antimicrobial susceptibility pattern of these isolates. This study was conducted in the Department of Microbiology, C. U. Shah Medical College, Surendranagar; Gujarat. Various clinical specimens fulfilling the requisite criteria were included in the study. Specimens were collected and further processed for identification and antimicrobial susceptibility pattern through automated system (Vitek-2) as per standard guidelines. Out of total 1324 culture positive specimens, 187 were classified as HAI as per standard definition. The most frequent type of HAI was surgical site infection (45%) followed by Respiratory tract infection (25%). More than 80% of these types of infections were caused by the Gram-negative Bacteria (GNB). *Klebsiella* sp. (25%), *Acinetobacter baumannii* (19%), *Pseudomonas* sp. (16%), *E. coli* (13%) and *Staphylococcus aureus* (12%) were the common organisms. Among 24 *S. aureus* isolates, 18 (78%) were found to be Methicillin resistance *Staphylococcus aureus* (MRSA). Majority of Gram-negative isolates showed high resistant against amoxicillin, cefuroxime, cefotaxime and ceftriaxone. The present study reports 187 isolates with HAI. Hand washing practices, operational theater surveillances and periodic training of health care workers can reduce these incidences in

Introduction

Nosocomial infections also known as hospital-acquired infections are those infections acquired in hospital or healthcare service unit that first appear 48 hours or more after hospital admission within 30 days after discharge following in patient care. They are unrelated to the original illness that brings patients to the hospital and neither present nor incubating at the time of admission. There are some reasons why these infections are even

more alarming in this era. These include hospital related large number of people who are sick and whose immune system are often in a weak state are more prone to nosocomial infections. The routine use of anti-microbial agents in hospital creates selection pressure for the emergence of the resistant strains of microorganisms. (Revelas, 2012)

Nosocomial infections occur in patients while in hospital or other clinical care facility. Besides harming patients, hospital acquired infections can also affect nurses, doctors, laboratory persons, health care workers and visitors. According to CDC about 10% of all hospital patients acquire nosocomial infections.

Thus HAI represent a significant proportion of all infectious disease acquired by human. Nosocomial infections have proven to be the most common cause of increased morbidity, mortality, and the cost of the hospitalized patients more so in the intensive care units (ICUs). The increased length of stay for infected patients is the greatest contributor to cost (Willey *et al.*, 2011; Ducel *et al.*, 2012).

The most frequent nosocomial infections are infections of surgical wounds, urinary tract infections and lower respiratory tract infections. The WHO study, and others, has also shown that the highest prevalence of nosocomial infections occurs in intensive care units and in acute surgical and orthopaedic wards. Infection rates are higher among patients with increased susceptibility because of old age, underlying disease, or chemotherapy (Ducel *et al.*, 2012).

Hospitals, and particularly intensive care units, are an important breeding ground for the development and spread of antibiotic resistant bacteria. Increasing incidence of hospital acquired infections caused by antibiotic resistant pathogens is the selection of resistant mutant strains from the patient's own flora during antibiotic treatment. Strategies to control antibiotic resistance in hospitals include multidisciplinary cooperation in implementing local policies on use of antibiotics and infection control measures, timely detection and reporting of the antibiotic resistant strains, improved surveillance, and aggressive control of transmission of epidemic resistant bacteria. Despite of knowing these strategies to control HAI, these infections are still present and are big reason to worry (Struelens, 1998).

Materials and Methods

This study was conducted in Department of Microbiology, C. U. Shah Medical college, Surendranagar; Gujarat. Various clinical specimens were received in Department of Microbiology and were included in this study during January 2018 to March 2019. Specimens were collected and further processed for identification and antimicrobial susceptibility pattern as per standard guidelines (Ducel *et al.*, 2012).

Specimen were processed for gram stain, cultured on Blood agar and MacConkey agar and incubated at 35˚c for overnight as per standard guidelines.(Forbes *et al.*, 2007) For inoculation of blood and other sterile body fluids BacT/Alert automation blood culture system was used.

Pathogens were preliminary identified by colony characters and Gram staining. Further identification of organisms was carried out by Vitek 2 automated system. Antimicrobial susceptibility testing was performed by Vitek-2 automation system as per latest CLSI guidelines (Weinstein, 2018).

Results and Discussion

Total 1324 culture positive samples were collected from indoor patients during January 2018 to March 2019. A total of 187 were

identified as HAI as per standard definition. Out of 187 isolates, 85 (45%) were from surgical site infection, 46 (25%) were from respiratory site infection, 28 (15%) were from blood stream infection and 28 (15%) from urinary tract infection (Table – 1).

Maximum strains of HAI were isolated from Surgery ward 41 (22%). Out of 187 isolates 36 (19%) were from medicine ward, 35 (18%) from orthopedic ward, 29 (15%) were from MICU and 22 (12%) from Pediatric ward. Remaining 24 (14%) isolates obtained from other wards and ICUs. (Table – 2)

Organism wise distribution of the isolates was also studied. *Klebsiella* sp. was the most common isolate, having incidence of 51 (25 %), followed by *Acinetobacter baumannii* 40 (19%) and *Pseudomonas* sp. 33 (16 %). While E. coli and Staphylococcus aureus both having incidence of 26 (13%) and 24 (12%) respectively. (Table – 3)

According to antibiotic susceptibility of the Gram positive isolates, all the isolates were susceptible to Vancomycin. S. aureus showed maximum sensitivity against Linezolid 91%, Teicoplanin 91% and Gentamicin 83%. While S. aureus had low sensitivity rates against Amoxicillin 9%, Piperacillin/Tazobactam 17%, Erythromycin 17% and Imipenem 22%. Among 24 (100%) S. aureus isolates, 18 (78%) were found as MRSA. All Enterococcus sp. had shown completely resistance against Ciprofloxacin, Levofloxacin, Erythromycin, Clindamycin and Doxycycline. (Table – 4)

According to antibiotic susceptibility of Gram negative lactose fermenter isolates, *Klebsiella* sp. showed maximum sensitivity against Colistin 94%, Tigecycline 69% and Imipenem 57%. While it had low sensitivity rates against Amoxicillin 2%, Cefuroxime 12%, Amoxicillin/Clavulanic acid 18%, Cefotaxime 18% and Ceftriaxone 18%. E. coli isolates were shown 100% sensitivity against colistin. While it showed least sensitive rates against Amoxicillin 4%, Cefuroxime 12%, Cefotaxime 12% and Ceftriaxone 12%. (Table – 5)

According to antibiotic susceptibility of Gram negative lactose non fermenter isolates, *Acinetobacter baumannii* showed maximum sensitivity against colistin 95%, Tigecycline 68% and Minocycline 36%. While it showed low sensitivity rates against Imipenem 18%, Piperacilin/Tazobactam 18%, Cefepime 18% and Gentamicin 21%. *Pseudomonas* sp. showed maximum sensitivity rates against carbapenems group of antibiotics i.e. 55%. Remaining all *Pseudomonas* isolates showed less than 50% sensitivity rates against all antibiotics used in this panel. (Table – 6)

Hospital acquired infections are considered as major causes of mortality, enhanced morbidity and emotional stress in hospitalized patients. They also account for significant economic loss and additional burden on health care institutions. It has been estimated that at any time over 1.4 million people worldwide suffer from infectious complications acquired in hospital. The infections acquired in the hospitals may be due to resistant organisms that further accentuate the problem. (Ducel *et al.,* 2002)

In present study maximum numbers of isolates obtained from surgical site infection i.e. 47% which is different from other studies reported. However high prevalence of hospital acquired urinary infection has reported about 24% in both S Habibi *et al.,* (2008) and US Kamat *et al.,* (2008). In this study more than 80% of these types of infections were caused by the Gram-negative Bacteria (GNB). *Klebsiella* sp. *Pseudomonas* sp., E. coli, and *Acinetobacter baumannii* together counted more than 70% of the

isolates. *Klebsiella* sp. was the most common isolate in present study. Similar findings were also reported by US Kamat *et al.*, (2008). Such alarming numbers of GNB in hospital acquired infections has been commented by many investigators.

According to study of N. Akhtar(2010) sensitivity of various gram negative lactose fermenter isolates was tested, *Klebsiella* showed 79.2% sensitive against Imipenem, 70.8% sensitive against Amikacin, 37.5% sensitive against Ceftriaxone and 16.7% sensitive against Amoxicillin/Clavulanic acid.

However present study reported sensitivity of *Klebsiella*, 57% sensitive against Imipenem, 53% sensitive against Amikacin, 18% sensitive against Ceftriaxone and Amoxicillin/ Clavulanic acid each.

Colistin sensitivity rate for *Acinetobacter baumannii* was maximum among the panel. Apart from Tigecycline all Acinetobacter isolates showed less than 50% sensitivity against all antibiotics used in this panel. According to Shalini *et al.*, (2010) *Pseudomonas* showed maximum sensitivity against Imipenem which was similar to the present study.

In present study 17% of isolates were Gram positive cocci. All the gram positive isolates were susceptible to Vancomycin which is also lined up by studies of Shalini *et al.*, (2010) and N. Akhtar. (2010) In present study S. aureus showed 78% methicillin-resistant Staphylococcus aureus (MRSA). According to study of US Kamat *et al.*, (2008) the MRSA is 71% which is reported similar to present study. However Shalini S. *et al.*, (2010) showed 41% MRSA which is quite lower than present study.

In the study of N. Akhtar (2010) sensitivity of S. aureus was tested, 68.4% sensitive against Imipenem, 15.8% sensitive against Gentamicin, 10.5% sensitive against Ciprofloxacin and 42% sensitive against Amoxicillin/Clavulanic acid.

However present study reported sensitivity of S. aureus, 22% sensitive against Imipenem, 83% sensitive against Gentamicin, 39% sensitive against Ciprofloxacin and 17% sensitive against Amoxicillin/Clavulanic acid.

Table.1 Type of HAI and specimen wise distribution of isolates

Type of HAI	Specimens	No. of isolates (n=187)	No. of isolates (n=187)	Percentage
Surgical site infection	Pus	50	85	45%
	Swab	35		
Respiratory infection	ET	29	46	25%
	Sputum	16		
	BAL	1		
Septicemia	Blood	28	28	15%
Urinary tract infection	Urine	28	28	15%
Total	-	**187**	**187**	**100%**

Table.2 Ward wise distributions of isolates

Hospital Location	No. of isolates (n=187)	Percentage
Surgery Ward	41	22%
Medicine Ward	36	19%
Orthopedic ward	35	18%
MICU	29	15%
Pediatric ward	22	12%
NICU	7	4%
ENT ward	5	3%
SICU	4	2%
OBG ward	3	2%
Pulmonary ward	2	1%
Casualty	2	1%
PICU	1	1%
Total	**187**	**100%**

Table.3 Organism wise distributions of isolates

Organism	No. of organisms (n=207)	Percentage
Klebsiella sp.	51	25%
Acinetobacter baumannii	40	19%
Pseudomonas sp.	33	16%
E. coli	26	13%
Staphylococcus aureus	24	12%
Pseudomonas aeruginosa	9	4%
CONS	5	2%
Acinetobacter lwoffii	5	2%
Enterococcus faecium	3	1%
Enterococcus faecalis	3	1%
Proteus vulgaris	2	1%
Pseudomonas putida	2	1%
Acinetobacter junnii	2	1%
Enterobacter cloaca complex	1	1%
Morganella morganaii	1	1%
Total	**207**	**100%**

Table.4 Antibiotic sensitivity pattern shown by Gram positive isolates

Antibiotic / Organism	Staphylococcus aureus (n=24)	CONS (n=5)	Enterococcus faecium (n=3)	Enterococcus faecalis (n=3)
Amoxicillin	9 %	20%	-	-
Amoxicillin/ Clavulanic acid	17%	20%	-	-
Benzylpenicillin	9%	20%	0%	33%
Cefepime	22%	20%	-	-
Cefotaxime	22%	20%	-	-
Cefoxitin	26%	20%	-	-
Ceftriaxone	22%	20%	-	-
Cefuroxime	22%	20%	-	-
Ciprofloxacin	39%	40%	0%	0%
Clindamycin	26%	60%	0%	0%
Deptomycin	78%	80%	-	-
Doxycycline	78%	80%	33%	0%
Erythromycin	17%	60%	0	0%
Gentamicin	83%	80%	-	-
Imipenem	22%	60%	-	-
Levofloxacin	39%	60%	0%	0%
Linezolid	91%	80%	33%	33%
Meropenem	22%	60%	-	-
Oxacillin	22%	60%	-	-
Pipercillin/ Tazobactam	17%	20%	-	-
Teicoplanin	91%	80%	33%	100%
Trimethoprim/ Sulfamethoxazole	65%	60%	-	-
Vancomycin	100%	100%	100%	100%

(Percentages are reflected as sensitive rates)

Table.5 Antibiotic sensitivity pattern shown by Gram negative lactose fermenter isolates

Antibiotic / Organism	*Klebsiella* sp. (n=51)	E. coli (n=26)	Enterobacter cloacae complex (n=1)
Amikacin	53%	58%	0%
Amoxicillin	2%	4%	0%
Amoxicillin/Clavulanic acid	18%	15%	0%
Ampicillin	2%	4%	0%
Cefepime	24%	23%	0%
Cefoperazone/Salbactam	27%	31%	0%
Cefotaxime	18%	12%	0%
Ceftriaxone	18%	12%	0%
Cefuroxime	12%	12%	0%
Cefuroxime Axetil	12%	12%	0%
Ciprofoxacin	39%	15%	0%
Colistin	94%	100%	100%
Ertapenem	49%	65%	0%
Gentamicin	49%	42%	0%
Imipenem	57%	69%	0%
Meropenem	53%	69%	0%
Nalidixic Acid	29%	15%	0%
Piperacillin/Tazobactam	35%	35%	0%
Tigecycline	69%	73%	0%
Trimethoprim/Sulfamethoxazole	35%	31%	0%

(Percentages are reflected as sensitive rates)

Table.6 Antibiotic sensitivity pattern shown by Gram negative lactose non fermenter isolates

Antibiotic / Organism	*Acinetobacter baumannii (n=40)*	*Pseudomonas sp. (n=33)*	*Pseudomonas aeruginosa (n=9)*	*Acinetobacter lwoffii (n=5)*	*Pseudomonas putida (n=2)*	*Acinetobacter junii (n=2)*	*Proteus vulgaris (n=2)*	*Morganellamorganii (n=1)*
Amikacin	-	48%	56%	20%	100%	50%	0%	100%
Cefepime	18%	39%	56%	20%	100%	100%	0%	100%
Cefoparazone/ Salbactam	18%	36%	44%	60%	50%	100%	0%	100%
Ceftazidime	18%	33%	56%	0%	100%	50%	0%	100%
Ciprofloxacin	18%	45%	56%	40%	0%	100%	0%	0%
Colistin	95%	-	100%	100%	-	100%	50%	0%
Doripenem	18%	52%	56%	40%	-	50%	0%	0%
Gentamicin	21%	42%	56%	40%	100%	100%	0%	100%
Imipenem	18%	55%	56%	40%	100%	100%	0%	0%
Levofloxacin	18%	39%	67%	60%	0	100%	0%	0%
Meropenem	24%	55%	56%	40%	100%	100%	0%	100%
Minocycline	36%	45%	-	60%	100%	100%	0%	0%
Pipercillin/ Tazobactam	18%	48%	44%	100%	0%	100%	0%	0%
Ticarcillin/ Clavulanic Acid	18%	36%	33%	60%	0%	100%	0%	0%
Tigecycline	68%	45%	-	100%	50%	100%	0%	0%
Trimethoprim/ Sulfamethoxazole	24%	21%	-	40%	0%	100%	0%	0%

(Percentages are reflected as sensitive rates)

Incidence of Nosocomial Infections is increasing day by day. The factors that can account for the higher infection rate may be the availability of high number of visitors, lack of knowledge and proper monitoring and setup of the hospital.

This frightening incidence of Nosocomial Infections can be reduced by decontamination and cleaning of soiled instruments and other items. Sterilization and high-level disinfection processes and improving safety in operating rooms and other high-risk areas can also decrease the incidence of Hospital acquired infections. (Ginawi *et al.,* 2014).

The present study on the microbiological profile and antimicrobial susceptibility shows 187 isolates with HAI. The most frequent site of HAI was surgical site followed by respiratory tract. *Klebsiella* sp., *Acinetobacter baumannii* and *Pseudomonas* sp. were common organisms followed by E. coli and Staphylococcus aureus. Maximum isolates were isolated from surgery ward followed by medicine ward.

Gram positive isolates shown most sensitivity towards vancomycin and gram negative isolates towards colistin. The high frequency of HAI and poor sensitivity of common antibiotics suggests the implementation of strict measures regarding infection control. These measures include hand washing practices, operational theater surveillances and periodic training of health care workers.

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How to cite this article:

Dipak M. Panjwani, Sucheta J. Lakhani, Sanjay J. Mehta, Kunjan M. Kikani and Khushboo Madaan. 2020. A Study of Hospital Acquired Bacterial Infections and its Antimicrobial Susceptibility Pattern in a Teaching Hospital of Gujarat, India. *Int.J.Curr.Microbiol.App.Sci.* 9(02): 1399-1408. doi: https://doi.org/10.20546/ijcmas.2020.902.162