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Original Research Article

Environmental occurrence of Immune-afflicting pathogens in Tertiary care Hospitals in Chennai, India and screening of their Drug resistance patterns

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Abstract: ***Background***: Occurrence of microorganism in the hospital environment indicates the compromise in the infection prevention and control procedures. Higher prevalence and emergence of multidrug resisting bacteria pose the threat of nosocomial infection outbreaks. ***Materials and Methods***: Sampling of airborne bacteria using open plate method was carried out in the intensive care units of two each of the Government and private hospitals for a period of five months. Isolation and identification of bacteria were done following standard bacteriological procedures. Isolates of gram-positive and gram-negative bacteria were tested for drug sensitivity against eight select antibiotics by Kirby-Bauer disc diffusion method. Drug resistance of the bacteria was enumerated and evaluated by statistical methods. ***Results***: a total of 120 isolates with the preponderance of gram-positive bacteria (51.7%) over their counterparts (48.3%) were obtained. S. epidermidis was the predominant gram-positive bacteria, followed by S. aureus, E. faecalis, Micrococcus sp. and E. cloacae. Among the gram-negative bacteria, A. baumannii occurred with high frequency followed by K. pnuemoniae, E. coli and P. aeruginosa. Highest multidrug resistance (87.5%) was observed with S. epidermidis and S. aureus and A. baumannii isolates. Moderate resistances were associated with P. aeruginosa (75%) and E. faecalis (62.5%). The bacteria Micrococcus sp., E. cloacae, K. pneumoniae and E. coli demonstrated moderate to low (50-37.5%) drug resistances. Conclusion: Association of multidrug resistance characteristics and the reports implicating these nosocomial bacteria with the immune suppression in patients with critical illness could be highly challenging and needs priority attention for their surveillance.

Keywords: Nosocomial, Intensive care units, airborne, bacterial pathogens, drug resistance

INTRODUCTION

The hospital acquired or nosocomial infection is the cause of priority concern in health care industries throughout the world. The nosocomial pathogens may arise either from endogenous (patient's own microbial flora) or exogenous (hospital environment) sources. Animate sources include hospital staff, other patients, and visitors, while inanimate sources constitute food, water, fomites, urinary catheters, intravenous devices, respiratory equipment and other prostheses [1]. Common agents implicated with nosocomial infections are bacteria (e.g., Enterobacteria, Staphylococcus, Pseudomonas, Legionella, Clostridium difficile, Burkholderia), viruses (e.g., VRS, Rotavirus, Hepatitis B and C Viruses, HIV, Influenza Virus), fungi (Aspergillus, Candida), parasites such as Plasmodium and some non-conventional agents (e.g., prions). Common complications caused by nosocomial infections are Urinary tract infections (UTI), Surgical wound infections (SWI), Lower respiratory infections (LRI), Blood stream infections (BSI), Ventilator-associated pneumonia (VAP), Hospital-acquired pneumonia (HAP), Tuberculosis, Legionnaires disease, and so on [2].

The modes of transmission of nosocomial pathogens are contact, droplet, airborne and common vehicles. Contact transmission is the most common which involves direct (body surface to body surface) and indirect (cross-contamination) modes of transmission. Indirect contact involves body surface contact with a contaminated intermediate object. Airborne transmission occurs when a droplet containing microorganisms evaporates and suspends in the air freely or with dust particles [3]. Airborne diseases are caused by pathogens transmitted through the air. An airborne disease can be caused by exposure of susceptible individuals to the contaminated air and transmission of the pathogen to the portal of entry such as nose, mouth, open wound or cut. Some of the airborne diseases which cause outbreaks in hospitals include bacteremia (Staphylococcus aureus), tuberculosis (Mycobacterium tuberculosis) and colitis (Clostridium difficile). Other common diseases of public health importance are Chickenpox, Anthrax (inhalational), Measles Influenza and Smallpox [4].

Multiple drug resistance (MDR) is a condition enabling pathogens to resist wide variety of antimicrobial agents including the antibiotics, antifungal, antiviral and antiparasitic drugs and chemicals targeted at eradicating the pathogens. The main consequences of MDR are compromised and increased length of therapy of human infections, complications for immunocompromised elderly and children, prolonged hospital stay and increased burden of treatment cost [5]. The occurrence of MDR in hospital associated pathogens eventually results in the recurrent and difficult-to-treat nosocomial infections in patients.

Among the various pathogens, bacterial resistance poses a major threat to health care. The examples of bacteria possessing such drug resistance are, methicillin-resistant Staphylococcus aureus (MRSA), vancomycin-resistant staphylococcus aureus (VRSA), vancomycin-resistant Enterococcus (VRE), penicillin resistant Pneumococci, multidrug-resistant pseudomonas aeruginosa (MDRPA), carbapenem-resistant *Klebsiella spp.*, carbapenem-resistant *E. coli*, Acinetobacter and so on. The emergence and reemergence of bacterial pathogens such as Shigella, non-typhoidal Salmonella, Campylobacter and *Neisseria gonorrhoeae* in hospital environments is due to the development of resistance to common antibiotics. In recent years, occurrences of fluconazole-resistant Candida species and multidrug-resistant mycobacterium tuberculosis (MDR-TB) cause significant public health problems [6].

The intensive care units (ICU) are reportedly the hot zones of emergence of multidrug resistant organisms in hospital environment. Previous studies have indicated that about 60% of transmission of nosocomial infections takes place in ICU [7]. Proper follow of sanitation and stringent observation of infection control constitute the important strategy for the control and prevention of emerging and reemerging nosocomial infections. The airborne transmission of drug-resistant pathogenic microorganism could be life threatening for patients under ICU care especially those with compromised or suppressed immune status. Therefore, the present study was undertaken to estimate the prevalence of airborne bacterial pathogens in ICU wards of health care setups and to assess their drug-resistant patterns. Such data obtained from the study could help in planning effective infection control strategies for assuring sustainable health care.

MATERIALS AND METHODS

Study area and period

This study was conducted in four different hospitals comprising of two each of government (GH) and private hospitals (PH) located in Chennai city (Tamil Nadu state, India). Air samples were collected from the ICUs of these hospitals for a period of five months from April 2010 to August 2010.

Sample collection and processing

The sample was collected by settle-plate method using three different sterile solid media viz., Nutrient agar (NA), MacConkey agar (MCA) and Blood agar. These media plates were kept on areas such as floor and shelf in ICU wards and exposed to the air by keeping the lid open for 30 min. Then the plates were brought to the Microbiology laboratory and placed in bacteriological incubator set at 37°C over a period of 24 hours. Further to the incubation, the plates were observed for the growth of the bacteria on the media. Sampling was done once in 15 days and each time five samples were collected from each ICU.

Isolation of bacteria

The isolation and identification of bacteria grown on the exposed media plates were carried out by following the standard procedures described in the manual of Mackie & McCartney (Collee et al., 1996). Macroscopic identification of bacteria was done based on the colony morphology on NA, lactose fermentation on MCA and the hemolytic activity on BA. Microscopic identification of bacteria was performed using Gram staining and hanging drop motility testing. Further identification was achieved by biochemical tests such as catalase, oxidase, Coagulase, urease, IMViC and other specific tests. Isolates of identified bacteria were sub-cultured and preserved in agar slopes until further use.

Antibiotic susceptibility testing

For the purpose of recording the sensitivity / resistance pattern of the bacterial isolates, antimicrobial susceptibility testing was done by Kirby-Bauer disc diffusion method as per the guidelines of Clinical and Laboratory Standards Institute (CLSI). Overnight cultures of bacterial isolates (turbidity equivalent to 0.5 McFarland standard) were swab inoculated on sterile Mueller Hinton agar (Hi-media, India) plates and antibiotic discs were placed over it. The plates were incubated 24 h at 37°C and observed for the zones of growth inhibition around the antibiotic discs. Based on the zone size, the responses of the isolates to the antibiotics were determined as sensitive (>15 mm), resistant (<7 mm) and intermediate (size falling between the mentioned limits).

The panel of antibiotics used for testing the susceptibility of gram-positive and gram-negative bacteria isolated in the study are presented in table 1. Each group of bacteria were tested against eight commonly used antibiotics. Bacterial isolates showing intermediate susceptibility to an antimicrobial agent were also categorized as resistant isolate for data analysis and presentation. In order to estimate the multidrug resistance characteristics, the bacterial species which resist more than 50% of the antibiotics were designated as multidrug resistant.

Statistical analysis

The data of antibiotic susceptibility of bacteria were analyzed using Mann–Whitney *U*-test. The variable categorization and the multi-drug resistance pattern were determined using Chi-square tests. Overall univariate and multivariate analyses of antibiogram were performed in SPSS 23.0 (USA). The significance of data was set at $p < 0.05$ and all the results were obtained based on two- tailed tests.

Table 1. Panel of antibiotics used for testing drug susceptibility of bacteria

Gram positive bacteria			Gram negative bacteria		
Antibiotic	**Symbol**	**Concentration**	**Antibiotic**	**Symbol**	**Concentration**
Ampicillin	AM	10 µg	Ampicillin	AM	10 µg
Ciprofloxacin	CIP	10 µg	Ciprofloxacin	CIP	10 µg
Gentamicin	GM	10 µg	Gentamicin	GM	10 µg
Vancomycin	VA	30 µg	Amikacin	AK	10 µg
Trimethoprim	TS	10 µg	Cefoxitin	FOX	10 µg
Bacitracin	B	10 µg	Meropenem	MEM	10 µg
Tetracycline	TE	30 µg	Nitrofurantoin	NI	300 units
Clindamycin	DA	10 µg	Cotrimoxazole	CO	25 µg

RESULTS

Prevalence of bacteria in hospital environment

Further to the isolation and identification studies, a total of sixty-two and fifty-eight isolates, respectively of gram-positive and gram-negative bacteria, were obtained (fig. 1; tables 2 and 3). The bacterial species that were rare and negligible in occurrence were voided as the study focused mainly on the most common and prevalent bacteria. In general, the gram-positive bacteria were more dominant (5 species) than their gram-negative counterparts (4 species). Among the gram-positive bacteria, the most prevalent was *S. epidermidis* (25.8%) and the bacteria of least occurrence was *E. cloacae* (12.9%). While the most common among the gram-negative bacteria was *A. baumannii* (31%), the bacteria *P. aeruginosa* occurred at a low frequency (12.1%).

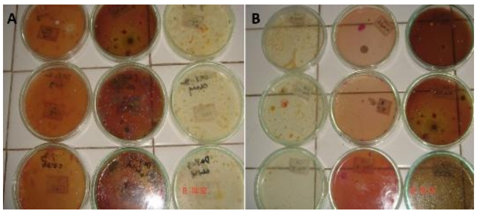

Figure 1. Isolation of bacteria from hospital environment
A, Gram positive bacteria; B, Gram negative bacteria

Table 2. Prevalence of Gram-positive bacteria among the ICU wards

Bacterial species	No. of isolates obtained from each ICU ward				Total no. of isolates	%
	GH-1	GH-2	PH-1	PH-2		
Staphylococcus aureus	5	3	2	1	11	17.7
Staphylococcus epidermidis	6	3	4	3	16	25.8

Micrococcus sp.	4	6	2	2	14	22.6
Enterococcus faecalis	4	5	1	3	13	21.0
Enterobacter cloacae	4	2	2	0	8	12.9

GH, Government hospital; PH, Private hospital

Table 3. Prevalence of Gram-negative bacteria among the ICU wards

Bacterial species	**No. of isolates obtained from each ICU ward**				**Total no. of isolates**	**%**
	GH-1	**GH-2**	**PH-1**	**PH-2**		
Escherichia coli	5	3	2	2	12	20.7
Klebsiella pneumoniae	7	6	2	3	18	31.0
Pseudomonas aeruginosa	2	3	0	1	7	12.1
Acinetobacter baumannii	5	7	5	4	21	36.2

GH, Government hospital; PH, Private hospital

Susceptibility testing of bacterial isolates

The results of antibiotic susceptibility testing of bacteria are present in tables 4 and 5. The test results indicated that among the gram-positive bacteria, *E. cloacae* isolates were highly susceptible to the tested antibiotics as they were inhibited by five out of the eight antibiotics. Relatively higher susceptibility was seen with the bacteria *Micrococcus sp.* and *E. faecalis*, which were respectively inhibited by four and three antibiotics. Least susceptibility to the antibiotics was associated with the bacteria *S. aureus* and *S. epidermidis* as both were inhibited by one antibiotic each. While all the isolates of the bacteria *S. aureus* were susceptible to the antibiotic tetracycline, *S. epidermidis* isolates were susceptible to vancomycin (fig. 2).

Among the gram-negative bacteria, higher susceptibility to the antibiotics was recorded with *E. coli* as the isolates have been inhibited by five antibiotics out of the eight tested. This was followed by the bacterial *K. pneumoniae* and *P. aeruginosa* which were susceptible to four and two antibiotics respectively. Least susceptibility was noted with the isolates of the bacteria *A. baumannii*, which were inhibited by only one antibiotic (amikacin).

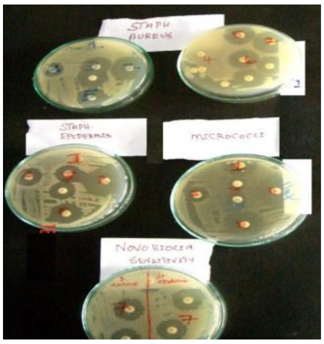

Figure 2. Antibiotic sensitivity testing of bacteria

Table 4. Drug resistance pattern of Gram-positive isolates of ICU wards

Bacteria	**Antibiotic tested and % of resistance**								***P* value**
	AM	**CIP**	**GM**	**VA**	**TS**	**B**	**TE**	**DA**	
S. aureus (n=11)	3 (27.3)	1 (9.0)	1 (9.0)	2 (18.2)	1 (9.0)	1 (9.0)	0	1 (9.0)	0.049
S. epidermidis (n=16)	5 (31.3)	3 (18.8)	2 (12.5)	0	2 (12.5)	2 (12.5)	1 (6.3)	1 (6.3)	0.055
Micrococcus sp. (n=14)	3 (21.4)	0	5 (35.7)	0	0	0	2 (14.3)	4 (28.6)	1.076
E. faecalis (n=13)	2 (15.4)	3 (23.0)	3 (23.0)	2 (15.4)	0	0	0	3 (23.0)	0.085
E. cloacae (n=8)	3 (37.5)	0	0	0	2 (25.0)	0	0	3 (37.5)	1.232

AM, Ampicillin; CIP, Ciprofloxacin; GM, Gentamicin; VA, Vancomycin; TS, Trimethoprim; B, Bacitracin; TE, Tetracycline; DA, Clindamycin

Table 5. Drug resistance pattern of Gram-negative isolates of ICU wards

Bacteria	Antibiotic tested and % of resistance								*P* value
	AM	CIP	GM	AK	FOX	MEM	NI	CO	
E. coli (n=12)	4 (33.3)	0	0	4 (33.3)	4 (33.3)	0	0	0	1.095
K. pneumoniae (n=18)	4 (22.2)	0	0	5 (27.8)	0	0	5 (27.8)	4 (22.2)	0.069
P. aeruginosa (n=7)	1 (14.3)	1 (14.3)	1 (14.3)	2 (28.6)	1 (14.3)	1 (14.3)	0	0	0.047
A. baumannii (n=21)	6 (28.6)	3 (14.3)	4 (19.0)	4 (19.0)	0	2 (9.5)	1 (4.8)	1 (4.8)	0.036

AM, Ampicillin; CIP, Ciprofloxacin; GM, Gentamicin; AK, Amikacin; FOX, Cefoxitin; MEM, Meropenem; NI, Nitrofurantoin; CO, Cotrimoxazole

Drug resistance pattern of bacteria

Further analysis of results of antibiotic sensitivity testing of bacteria yielded critical information on the drug resistance pattern of the isolates. Among the gram-positive bacteria, significant multidrug resistance was documented with the bacteria *S. aureus* and *S. epidermidis* as both resisted seven out of eight antibiotics tested (table 4). The bacteria *S. aureus* showed the drug resistance in a range of 9-27.3% with a highest resistance towards ampicillin. On the other hand, marginally higher resistance ranging 6.3-31.3% was shown by *S. epidermidis* with a highest resistance towards ampicillin. This was followed by *E. faecalis* with the resistance ranging 14.3% (tetracycline) to 35.7% (Gentamycin). Even though the bacteria *Micrococcus sp.* and *E. cloacae* showed a higher resistance respectively towards gentamycin (35.7%) and ampicillin (37.5%), they were ≥50% susceptible to the total antibiotics tested.

Among the gram-negative bacteria, significant multidrug resistance characteristic was observed with the bacteria *A. baumannii* ranging 4.8-28.6% (table 5). It resisted all the antibiotics except cefoxitin, with a highest resistance against ampicillin. The bacteria *P. aeruginosa*, even though isolated in small numbers, significantly resisted six out of eight antibiotics with a multidrug resistance rate ranging 14.3-28.6%. However, the bacteria *E. coli* and *K. pneumoniae* showed comparatively lesser resistance even though the former resisted three antibiotics at equal rates of 33.3%.

DISCUSSION

The tertiary care hospitals are concerned with the treatment of patients who are critically ill. These patients are most often afflicted with life threatening conditions such as cancer, systemic inflammatory diseases, contagious diseases and post-surgical trauma, multiple injury accidents and so on. Besides, owing to these underlying conditions, these patients may have weakened or suppressed immune system. In particular, the patients under intensive care are at a high risk of acquiring infections if there is a prevalence of nosocomial pathogens in the hospital environment. Once infected, these patients may go through severe complications and act as potential sources of infection if the hygiene and sanitation procedures are breached. By virtue of cross contamination with the equipment in the intensive care units (ICU), the pathogens may be transmitted to the health care workers, who in turn can spread the same to the hospital environment. The cross contamination and environmental occurrence of these nosocomial pathogens can eventually result in outbreak of infectious disease in the hospital [8].

Studies portray that the multidrug resistance (MDR) among the pathogenic bacteria has emerged as major challenge worldwide for offering health care for patients in ICU of the hospitals [9]. A global estimate of 2019 indicates that the MDR infections are incriminated with 4.95 million deaths across the health care setups [10]. In view of growing threats caused by MDR pathogens, the present study was conducted to estimate the prevalence of nosocomial pathogens in ICU wards of selected hospitals in Chennai city and to evaluate the frequency of drug resistance among the isolates of these bacterial pathogens.

The isolation procedures of the present study yielded a total of 120 isolates of bacteria from four different places of sampling. Further analysis of the isolated organisms revealed the dominant occurrence of gram-positive bacteria (51.7%) over the gram-negative bacteria (48.3%) in the ICU wards. In conform to our findings, a recent study by Alkufeid et al. [11] has demonstrated the occurrence of more percentage of nosocomial bacteria of gram-positive category. However, in contrast to the current study, Wu et al. [9] from their studies with the ICU patients have observed higher prevalence of gram-negative bacteria than that of gram-positive bacteria. Another study on the occurrence of nosocomial pathogens in orthopedics has also recorded substantial prevalence of gram-negative bacteria (70.5%) when compared to gram-positive bacteria (28.7%) [12]. Similarly, Ibrahim et al. [13] have reported higher prevalence of gram-negative bacteria (57.4%) than the gram-positive bacteria (42.6%) in the ICU of a hospital in Tripoli. The reason for the preponderance of gram-positive bacteria in our study may be due to the air sampling for the isolation procedure. The widespread environmental occurrence of these bacteria in air, inanimate objects and on human surfaces. The gram-negative bacteria are in most cases pathogenic and occur mainly in clinical specimens.

The study of overall occurrence of bacteria in different sampling areas indicated that higher numbers of bacteria were isolated from government hospitals than the private hospitals (tables 2 and 3). The higher occurrence of bacteria in government hospitals may be attributed to the high number of admitted and outpatients and visitors. Due to this overcrowding, frequent sanitation of hospital environment may not be possible. Conversely, due to stringent administration, private hospitals limit the visitors for safety reasons and observe proper hygienic and sanitary procedures to prevent and control the pathogenic microbes in the hospital environment.

Among the gram-positive bacteria isolated in our study, there was a preponderance of the bacteria S. epidermidis (25.8%) followed by Micrococcus sp. (22.6%), E. faecalis (21.0%), S. aureus (17.7%) and E. cloacae (12.9%). Our results agree with the study of Ibrahim et al. [13] which reported S. epidermidis as the commonest strain (50.0%) among the nosocomial bacteria isolated from ICU ward. Similar study conducted by Yang et al. [12] has reported the low frequency occurrence of E. faecalis and E. cloacae in hospital environments. The higher isolation of S. epidermidis in the present study could be due to its nature of being a commonest commensal of the human. Since it dwells mostly on the skin surface of the patients and hospital staff, cross contamination of the equipment and other objects might have facilitated its prevalence.

Analysis of isolation of gram-negative bacteria of the present study inferred that the bacteria A. baumannii occurs at a higher frequency (36.2%) followed by K. pneumoniae (31.0%), E. coli (20.7%) and P. aeruginosa (12.1%). Similar pattern of isolation of gram-negative bacteria from ICU ward has been reported by Ibrahim et al. [13]. These researchers isolated A. baumannii, K. pneumoniae and P. aeruginosa with the isolation rates of 44%, 40% and 5.3% respectively. The emergence of A. baumannii as the leading nosocomial pathogen has been reported by many studies in recent years [14-16]. The study of Wu et al. [9] from China has reported that K. pneumoniae remains the predominant bacteria in ICU wards. Concomitant with their findings, our study identified this bacterial species as the second most prevalent bacteria in ICU environment.

Another essential focus of our study was to screen the drug resistance of the ICU-borne bacterial isolates. Antibiotic sensitivity testing of the isolates demonstrated equally higher multidrug resistance (87.5%) of the bacteria S. aureus and S. epidermidis among the gram-positive bacteria (table 4). While the species E. faecalis showed moderate resistance (62.5%), fewer resistance was associated with Micrococcus sp. (50%) and E. cloacae (37.5%). However, the bacteria E. cloacae exhibited the maximum resistance of 37.5%, compared to other bacteria, towards the antibiotic clindamycin. Similar trends have been recorded in two contemporary studies on the drug resistance of bacteria in surgical wards [17] and ICU wards [13]. Interestingly, all the isolates of S. aureus in our study were susceptible to tetracycline. Comparable study of Yang et al. [12] has portrayed the wider resistance pattern of S. aureus against most of the antibiotics tested including ampicillin (100%) and observed the decreasing trend of resistance towards tetracycline over the years. The reason for the resistance of the antibiotic ampicillin by all the bacterial species may be due to over and excess use of this antibiotic in healthcare setups. However, there was a least resistance of bacterial isolates against vancomycin.

Drug resistance pattern of gram-negative bacteria inferred that the bacteria A. baumannii possesses significant multidrug resistance potential (87.5%) against all the antibiotics tested except cefoxitin (table 5). This was followed by P. aeruginosa, which resisted 75% of the total antibiotics used in the study. However, moderate (50%) and least resistance (37.5%) were exhibited by the isolates of the bacteria K. pneumoniae and E. coli respectively. Overall analysis of results of antibiotic sensitivity test revealed that all the species of gram-negative bacteria of our exhibit considerable range of resistance against the antibiotics ampicillin (14.3-33.3%) and amikacin (19.0-33.3%). In consonance with our data, a five-year prospective study in China has observed a contrasting trend of increasing resistance against ampicillin and decreasing resistance against cotrimoxazole shown by the nosocomial isolates of E. coli [12]. Our study resonates with the recent findings of Wu et al. [9] and Ibrahim et al. [13], who from their independent studies have documented the substantial multidrug resistance rates of 98% and 94% owned by the strains of A. baumannii isolated from ICU wards. These findings vividly illustrate the surging prevalence of A. baumannii as the leading multidrug resistant nosocomial pathogen.

Emergence of MDR pathogens is attributed to many reasons such as indiscriminate and overuse of antibiotics, drug pollution of water bodies, excessive use of antibiotics for food preservation and so on. Another striking cause for the drug resistance is the prescription of empirical antibiotics by the physicians without proper lab reports of sensitivity testing [18, 19]. Fortunately, reports suggest that empirical therapy shall be safe if the antibiotics with the accumulated resistance of less than 15% are used [20].

Isolation of bacteria from the hospital environments in the present study points to the need of critical attention for the prevention and control of these organisms. Some of the pathogens isolated in our study such as A. baumannii, E. coli, S. aureus, P. aeruginosa and E. faecalis have been enlisted in the antibiotic resistant 'priority pathogens' published by the World Health Organization (WHO) as they pose serious threat to the healthcare system [21]. Pathogens, those prevailing especially in ICU wards, can invade the patients under tertiary care and challenge the treatment of life-threatening diseases such as cancer, immune deficiency disorders, systemic inflammatory diseases and so on.

In recent years, there have been increasing reports on the incrimination of pathogens in immunopathological conditions. Pushalkar et al. [22] from their studies have reported the association of microbiome comprising E. faecalis, E. coli, Klebsiella sp., Pseudomonas sp., Bacteroides sp., Helicobacter sp. and Mycoplasma sp. with the pathology of pancreatic cancer. The study demonstrated that the colonization of these bacteria in the cancerous pancreas predispose the development of pancreatic ductile adenocarcinoma (PDA) through induction of innate and adaptive immune suppression. Studies suggest that dysplasia and disruption of epithelial barrier function occurring in precancerous stages pave the way for translocation of commensal microbes which subsequently emerge as opportunistic pathogens and indulge in altering the immune mechanisms of the disease [23]. Morgan et al. [24] from their studies on the immunopathology of lung diseases have reported that the secondary bacterial infections caused by S. aureus, Haemophilus influenzae and Streptococcus pneumoniae dysregulate the innate inflammatory immune responses which eventually leads to complications in patients admitted with viral influenza.

Presence of these nosocomial pathogens with superimposed drug resistance characteristics in ICU wards could endanger the patients with weak immune system due to the underlying critical illness. These reports could be considered as warning signals and eye-opening information necessitating the prevention and control of drug-resistant nosocomial pathogens for assuring proper and sustainable healthcare.

CONCLUSION

In the intensive care unit wards the prevalence of gram-positive bacteria is higher than its counterpart. Among the gram-positive bacteria, S. epidermidis tend to occur with high frequency due to its commensal nature. This is seconded by the bacteria S. aureus, E. faecalis and Micrococcus sp. The bacteria E. cloacae occur at a low rate. The A. baumannii constitute most common gram-negative bacteria in ICU wards followed by the presence of K. pnuemoniae, E. coli and P. aeruginosa. High rate of multidrug resistance (87.5%) is associated with the gram-positive bacteria S. epidermidis and S. aureus. While the bacteria E. faecalis show considerable multidrug resistance (62.5%), the other bacteria Micrococcus sp. and E. cloacae show moderate (50%) and fewer (37.5%) resistances. Ampicillin and vancomycin are the most and least resisted antibiotics by the gram-positive bacteria isolated in the study. The gram-negative bacteria A. baumannii exhibits substantial multidrug resistance characteristics (87.5%) followed by P. aeruginosa (75%). Moderate and least drug resistances are shown by K. pneumoniae (50%) and E. coli (37%) respectively. Contemporary research studies portray the incrimination of some of these pathogens with immune suppression in patients with critical illnesses. Results necessitate the stringent follow of standard procedures to prevent and control these drugs resisting nosocomial pathogens.

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