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Etiology of Lower Respiratory Tract Infections in Intensive Care Unit of a Tertiary Care Hospital

Dr. Viral Patel	Resident doctor, Dept. of Medicine, SBKS MIRC, Baroda
Dr. Parth Patel	Resident doctor, Dept. of Medicine, SBKS MIRC, Baroda
Dr. Utsav Patel	Resident doctor, Dept. of Medicine, SBKS MIRC, Baroda
Dr. Dattu Vyas	Resident doctor, Dept. of Medicine, SBKS MIRC, Baroda
Dr. Kunjan Shah	Resident doctor, Dept. of Medicine, SBKS MIRC, Baroda

ABSTRACT

Background: Lower respiratory tract infections (LRTI) are the most frequent infections among patients in intensive care units. The consequences of increased drug resistance are far reaching since bacterial infection of the lower respiratory tract is a major cause of death from infectious diseases.

Objective: The study was conducted with the aim of determining the bacterial etiology of LRTI in the intensive care unit (ICU) as well as to update the clinicians with the various antimicrobial alternatives available in the treatment of LRTI.

Methods and Materials: The study was conducted for the period of 1 year from July 2013 to June 2014 in the Medicine Department of a Teaching Tertiary Care Hospital. The LRT specimens from 100 patients admitted in an ICU during the study period were processed. Following culture, the isolated organisms were identified and antimicrobial sensitivity was performed by standard methods.

Results: Out of the 100 LRT specimens evaluated, 88 (88%) were culture positive. A total of 136 pathogens were recovered with a predominance of Gram-negative isolates (n = 129; 94.8%) Pseudomonas aeruginosa was the most dominant pathogen followed by Klebsiella pneumoniae. Markedly high percentage of extended spectrum beta-lactamase and methicillin resistant Staphylococcus aureus isolates were detected. The resistance to cephalosporins, aminoglycosides and carbapenem were noticable.

Conclusions: So that, we can conclude that for effective management of LRTI's, a detailed bacteriological diagnosis and susceptible testing is required to prevent global problem of antibiotic resistance.

KEYWORDS : Extended spectrum beta-lactamase, lower respiratory tract infections, methicillin resistant Staphylococcus aureus

Introduction

Lower respiratory tract infections (LRTI) are the most common bacterial infections among patients in intensive care units (ICUs), occurring in 10-25% of all ICU patients and resulting in high overall mortality, which may range from 22% to 71%. Infection and antibiotic resistance are important public health issues.[1-4] One of the major problems world-wide is the increase in antibiotic resistant strains of bacteria, mainly in hospitals and also in the community, which has proved difficult to control without considerable resources and expenditure.[5] The incidence and associated mortality due to LRTI can be influenced by several factors including characteristics of the population at risk, standard of the health-care facilities available, immunosuppressive drugs, inappropriate antibiotic therapy, distribution of causative agents and prevalence of antimicrobial resistance. Highly resistant strains of Gram-negative bacilli (GNB) continue to spread in hospitals causing therapeutic problems in many parts of the world, particularly in developing countries and where isolation facilities for patients with resistant organisms are often inadequate.

In developing countries, respiratory infections are the leading cause of morbidity and mortality in critically ill patients.[6,7] In almost all cases, eradication of causative agents requires initiation of antimicrobial therapy before obtaining culture report. However, during the last few years, the increase in antibiotic resistance has compromised the selection of empirical treatment.[8] Information on various lower respiratory tract bacterial pathogens and their antibiotic resistance patterns in hospitalized patients is inadequate in our country. Hence, the aim of this study was to determine the antimicrobial resistance profile among microorganisms isolated from patients with ICU-acquired respiratory infections, with a futuristic approach toward antibiotic usage policies.[7]

Methods and Materials

The present study was conducted in the Medicine Department of a Teaching Tertiary Care Hospital during July 2013 to June 2014. The LRT samples like sputum, suction tip, endotracheal and pleural fluid were obtained from the patients having respiratory symptoms, admitted in the ICU of the hospital. The samples were collected aseptically and processed immediately following collection.

Single or mixed growth (two or more than two isolates per specimen) isolated from all the eligible consecutive samples were identified by observing the colony characteristics on the blood agar, MacConkey agar plates and biochemical reactions using standard microbiological methods.[9,10] Isolates from repeat culture of previously recruited patients and isolates identified as commensals or contaminants were excluded.

Results

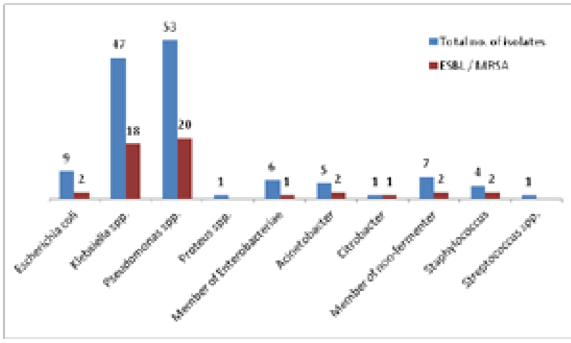
During the study period, LRT specimens of 100 patients who were admitted to ICU were evaluated. Out of 100 LRT specimens (36 sputum, 32 suction tip, 24 tracheal and 08 pleural fluids), 88 (88%) were culture positive, whereas 12 (12%) specimens showed no growth.

Out of the culture positives, all 88 (100%) specimens showed bacterial isolates while 2 (2.27%) specimens showed growth of *Candida* species also. A single pathogen was demonstrated in 66 (75%) patients and 22 (25%) had mixed bacterial etiology. A total of 136 isolates (including 2 *Candida* spp.) were recovered from 88 patients.

Out of 134 bacterial pathogens recovered, 129 (96.27%) were Gram-negative and 05 (3.73%) were Gram-positive bacteria. The most prevalent Gram-negative pathogen isolated was *Pseudomonas aeruginosa,* which was isolated from 53 (39.55%) patients followed by *Klebsiella pneumoniae* (*n* = 47) (35.07%) while the most prevalent Gram-positive pathogen was *Staphylococcus aureus* (*n* = 4) (2.98%) followed by *Streptococcus* spp. (*n* = 1) (0.74%).

Among 129 Gram-negative bacteria 46 (35.65%) extended spectrum beta-lactamase (ESBL) isolates were recovered while out of 4 *S. aureus* 2 (50%) methicillin resistant *S. aureus* (MRSA) isolates were recovered.

High rates of resistance to cephalosporins (75.38%) were demonstrated by all the Gram-negative bacteria. The susceptibility rates for carbapenem were 75.13% followed by amikacin (71.05%) and Gentamicin (60.45%). The percentage susceptibility of *S. aureus* and *Streptococcus* spp. towards vancomycin was 100% and 76%, while that for linezolid was 100% and 72.6% respectively. [See table below]



Discussion

The main objective of this study was to investigate various isolates from LRTI patients in ICU and to determine the antimicrobial resistance pattern of bacteria against some commonly used antibiotics.

Ventilator associated respiratory infections continue to be a frequent and fatal complication in critically ill patients with mortality ranging from 40% to 80%.[11]

The National Nosocomial Infections Surveillance (NNIS) of the center for disease control of USA reports 60% of nosocomial pneumonias to be caused by aerobic GNB. We found GNB to be the predominant organism (96.27%) with low isolation of *S. aureus* (2.98%). These results were similar to those obtained by Veena Kumari *et al*., Okesola and Ige and Goel *et al*. who found that GNB isolated was 92.2%, 93% and 97.4% respectively.[1,2,12]

Among GNB, *P. aeruginosa* (39.55%) was the most common isolate identical to the study made by Goel *et al*., the results being 35%. Similar results were also quoted by Jarvis and Martone, Gilligan, Jarlier *et al*.[1,13-16]

It was found that 12% of the specimens remained sterile on culture probably due to previous antibiotic therapy or being non-representative specimens. Advances in the medical and surgical manipulations and increase in their applications provide a suitable environment for nosocomial fungal infections. Though in the present study, *Candida* species was isolated in 2 (2.27%) patients, the cases should not be overlooked in future. There was an overall preponderance of GNB among the LRT infection isolates with *P. aeruginosa*, *K. pneumoniae* and non-fermenting GNB as the common isolates as also confirmed from the studies made by Veena Kumari *et al*. (2007).[2] Incidence of mixed bacterial infection in this study was 25% and this is consistent with the fact that the incidence of mixed infections does not usually exceed 30% as has observed in other series (de Roux *et al*. 2006).[17] However, the identification of polymicrobial infections is very important for treatment strategies and to avoid a false impression of critically resistant strains.

Antibiotic resistance is a major problem in ICU admitted patients. We noticed a high rate of resistance to cephalosporins among the various Gram-negative isolates. Similar observations were made by various reporters including Sofianou et al., Veena Kumari et al. and Goel et al.[1,2,18]

High rate of resistance at our hospital might be due to the selective influence of extensive usage of third generation cephalosporins. Carbapenems are frequently used as a last choice in treating serious infections caused by GNB's. Our study showed 24.87% resistance towards carbapenem in accordance to observations made by Akhtar et al[19] that showed 26.1% resistance and Fatima *et al*.[13] that showed 24% resistance. This was in contrast to observations made by Gonlugur *et al*.[20] and Gladstone *et al*.,[21] that comparatively showed lower rates of resistance toward carbapenem, whereas study done by Kucukates and Kocazeybek showed 100% sensitivity to carbapenem.[22] This finding suggests that carbapenem should be judiciously used in ventilated patients to prevent any further increase in resistance.

Table 1: The percentage antimicrobial susceptibility of the LRT bacterial isolates towards the various antimicrobial agents

Antibiotic	Gram Negative Bacilli							
	Organism							
	Escherichia coli isolates (09) 02	*Klebsiella spp.* isolates (47) 18	*Pseudomonas spp.* isolates (53) 20	*Proteus spp.* (01)	Member of *Enterobacteriaceae* (06) 01	*Acinetobacter* (05) 02	*Citrobacter* (01) 01	Member of non-fermenter (07) 02
	ESBL	ESBL	ESBL		ESBL	ESBL	ESBL	ESBL
Amikacin	49.2	68.4	69.6	100	69.2	75	75	68
Ampicillin/sulb	47.1	53.4	ND	00	48.1	100	73.2	72.3
Aztreonam	55.5	25.3	60	00	32.2	00	00	50
Cefazolin	15.5	41	83.3	00	00	25.2	50	17.6
Cefepime	12	30	38.3	00	35.9	25.2	50	17.6
Cefotaxime	45.5	50	83.3	00	00	00	00	00
Ceftazidime	26.9	26.5	80	00	33.2	50	50	19
Ceftriaxone	7.6	7.6	83.2	00	38.0	00	00	23.5
Chloramphenicol	58	41.3	83.3	100	47.2	75	75	43.2
Ceftizoxime	00	00	38.3	00	33.2	20	00	5.8
Cefoxitin	38.4	38	83.3	100	23.1	00	00	17.6
Gentamicin	47.7	71.2	57	00	67.7	75	80	89.2
Imipenem	71.1	70	72.6	100	83.2	100	80	83
Meropenem	70	76.8	68	100	86.5	50.5	80	83
Netilmicin	40.6	60	30.8	00	44.4	33.7	00	52.9
Tetracycline	48	67.6	60	00	83.2	75	80.2	78.9
Tobramycin	61	63.8	48.7	00	80	60	75.8	80
Cotrimoxazole	40	50	60	00	00	65	43.3	81.1
Norfloxacin	30.7	37	20.8	100	33.5	50.2	00	41.1
Ampicillin	ND	31	ND	ND	33.6	75	75	47
Piperacillin	ND	ND	60	ND	ND	ND	ND	ND
Piperacillin/Tazobact	ND	ND	72.5	ND	ND	ND	ND	ND
Polymyxin B	ND	ND	91	ND	ND	ND	ND	ND
Ciprofloxacin	55.5	50	20.8	100	55.5	50	60	52.3
Cefmetazole	23	56.8	ND	100	66.6	98.2	85.5	52.6
	Gram-positive cocci							
	Staphylococcus (04) 02 MRSA				*Streptococcus spp.* (01)			
Chloramphenicol	77.7				45.2			
Gentamicin	55.5				48.5			
Tetracycline	33.3				40			
Tobramycin	ND				100			
Clindamycin	33.3				ND			
Levofloxacin	55.5				58.2			
Ampicillin	ND				100			
Erythromycin	33.3				58.5			
Rifampicin	55.5				43.6			
Vancomycin	100				76			
Moxifloxacin	42.8				ND			
Linezolid	100				72.6			

The resistance of some GNB to aminoglycosides to a longer extent to gentamicin than to amikacin has been well-recognized in many hospitals. In this study, the resistance of Gram negative isolates toward amikacin (28.95%) and gentamicin (39.55%), which is again alarming. The causes behind the emergence of such organisms have been a matter of speculation. Due to high rate of progression of resistance to amikacin, a strategy of limited and prudent use of antibiotics is urgently needed.[4] Aminoglycoside resistant strains are more common at sites with poor penetration of drugs.

S. aureus is known to be a common cause of nosocomial lung infection. In our study, MRSA accounted for 50% of nosocomial infections, which was equivalent to NNIS data (52.3%).[23] No ESBL data for comparison was available as most of the authors did not concentrate on studies related to phenotypic ESBL detection. However, the rising percentage of ESBL's (35.66%) and MRSA's (50%) in our study is alarming.

We conclude that multidrug resistant *Pseudomonas* and *Klebsiella* are the most common etiological agents of LRTI in ICU. There is an markedly high rate of resistance to cephalosporins, beta lactam-beta lactamase inhibitors and carbapenem against predominant organism.

The increasing resistance to antibiotics by respiratory pathogens has complicated the use of empirical treatment with traditional agents[24] and a definitive bacteriological diagnosis and susceptibility testing would, therefore, be required for effective management of LRTI.[25]

Now it is well known that critically ill and elderly patients are at greater risk of obtaining GNB-LRT infection. Antimicrobial resistance monitoring helps in optimization of antimicrobial therapy and is more important in the ICUs as infection and antimicrobial consumption are significantly higher.[26]

Conclusion

We can conclude that for effective management of LRTI's, a detailed bacteriological diagnosis and susceptible testing is required to prevent global problem of antibiotic resistance.

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