Changing trends in aetiology and antibiotic resistance of symptomatic community acquired bacterial pneumonia in hospitalised adult patients -A South Indian study

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Abstract

Background: Community Acquired Pneumonia (CAP) of bacterial origin in adults is a leading cause of mortality and morbidity in developing countries. Etiological diagnosis plays a significant role in hospitalised patients for better treatment strategies. The present study analyses the trends in bacterial pathogens causing adult CAP in hospitalised patients along with comparison of their annual drug resistant profiles between years 2016 and 2017.

Methodology: A total of 113 suspected cases of CAP in hospitalised patients from 2016 and 135 cases from year 2017 were included in the study. Respiratory specimens like sputum, broncho alveolar lavage and tracheal aspirates were collected aseptically in sterile containers and inoculated on appropriate culture media. Bacterial pathogens were identified by conventional methods and antimicrobial sensitivity testing was performed by Kirby-Bauer's disc diffusion method.

Results: Incidence of bacterial pathogens in hospitalised patients with CAP had increased from 60% in 2016 to 68% in 2017. *Staphylococcus aureus* (35%) and *Klebsiella pneumoniae* (27%) were common causative agents in 2016 while *Klebsiella pneumoniae* (36%) followed by *Staphylococcus aureus* (27%) were major pathogens in 2017. An upsurge in resistance pattern among Gram positive and Gram negative pathogens from 2016 to 2017 was observed. A rise in Methicillin Resistant *Staphylococcus aureus* and Extended Spectrum beta lactamase producing *Escherichia coli* and *Klebsiella pneumoniae* is of major concern.

Conclusions: Periodical monitoring of local Etiological agents together with a study on resistant patterns would help in better management protocols in CAP.

Keywords: Community Acquired Pneumonia; *Klebsiella pneumonia; Staphylococcus aureus.*

Introduction:

Community acquired pneumonia (CAP) is a common clinical entity encountered in daily practice. Though community acquired pneumonia can affect people of any age it is more common in adults especially in the elderly and those with chronic diseases [1]. Patients commonly present with symptoms like fever and chills, cough with or without expectoration, chest pain and altered sensorium.

Diagnosis is made clinically by lung examination findings and confirmed with chest radiography. Etiological diagnosis is important in hospitalised patients to guide treatment and to predict clinical outcome. CAP is one among leading causes of death in developing countries. In adults aged over 59 years, 1.6 million deaths annually are attributed to community acquired pneumonia [1].

Several studies have reported the common bacterial pathogens causing community-acquired pneumonia [2,3]. The local pattern of the bacterial pathogens and their susceptibility patterns greatly influence the empirical treatment options suggested in framing hospital antibiotic policy. In this background the present study was undertaken to observe the trends in bacterial aetiologies of community acquired pneumonia in adult hospitalised patients along with their antibiotic susceptibility profile over a period of 2 years (2016 and 2017).

Materials and Methods:

The present study was conducted between January 2016 to December 2017 (2 yrs. period) at the GSL Medical College and General Hospital, Rajahmundry, India. A total of 248 adult inpatients (113 in year 2016 and 135 in the year 2017) with typical symptoms like fever, chest pain, cough with expectoration for less than 15 days and radiological evidence of consolidation were included in this study. An ethical committee approval and the consent of subjects was obtained.

All relevant socio–demographic data of inpatients was documented along with clinical and laboratory investigation details. Appropriate samples like sputum, broncho-alveolar lavage, tracheo–bronchial aspirates were collected from several inpatients (both in wards and ICU's) aseptically in sterile containers prior to initiation of therapy and immediately delivered to microbiology laboratory for Gram staining and culture. Gram staining was done for all sputum samples and only those with at least 25 polymorphonuclear leukocytes per low power field were accepted for culture [4]. All these samples were inoculated on to MacConkey, blood and chocolate agar plates (Hi Media) and incubated for 24– 48hrs [5].

All the isolates obtained were identified by Gram staining and biochemical tests by conventional methods. *Staphylococcus aureus* was identified by positive catalase, coagulase tests, haemolysis on blood agar and growth on mannitol salt Agar [6].

Streptococcus pneumoniae were identified by their sensitivity to 14mm optochin disc placed on blood agar. Several Gram negative bacteria were identified based on their colonial morphology on MacConkey Agar and biochemical tests like oxidase, urease, citrate utilisation test, sugar fermentation, indole production tests [7].

Antibiotic susceptibility to various isolates was performed by modified Kirby–Bauer's disc diffusion method using ampicillin (10µg), amoxicillin clavulanic acid (20/10µg), erythromycin (15µg), co-trimoxazole (25µg), gentamicin (10µg), amikacin (30µg), ciprofloxacin (5µg), levofloxacin (5µg), cefotaxime - clavulanic acid 30/10µg), ceftazidime (30µg), ceftazidime-clavulanic acid (30/10µg) piperacillin tazobactum (100/10µg), meropenam (10 µg).

Methicillin resistant *Staphylococcus aureus* (MRSA) among *Staphylococci* were identified by cefoxitin disc diffusion method [8]. Extended Spectrum beta lactamase (ESBL) producing isolates among *Escherichia coli* and *Klebsiella pneumoniae* were identified by combined disc test as per Clinical Laboratory Standards Institute (CLSI) guidelines [9].

Results:

In the year 2016 (January till December), respiratory specimens were received for bacteriological culture from 113 clinically suspected cases of CAP. Out of 113 samples inoculated on culture plates, 68(60%) yielded bacterial pathogens. Similarly in the year 2017 89(68%) samples collected from 135 suspected cases were found to be culture positive (Table 1).

Table 1: **Culture positivity among respiratory samples**

Year	No. of samples processed for culture	No. of culture positive samples
2016	113	68 (60%)
2017	135	89 (68%)

Most of the bacterial pathogens in adults CAP were recovered from patients who fell in the age groups of 36-55 years in both 2016 and 2017 with male preponderance. (Table 2)

Table 2: Age and sex wise distribution of bacterial pathogens recovered from respiratory samples

	Sex	Age group			Total
		15 – 35 yrs.	36 – 55yrs.	>55yrs.	
Year 2016	Male	12	18	15	45
	Female	8	9	6	23
	Total	20 (29%)	27 (40%)	21 (31%)	68
Year 2017	Male	17	25	16	58
	Female	8	13	10	31
	Total	25 (28%)	38 (43%)	26 (29%)	89

Among bacterial pathogens isolated in the year 2016 from hospitalised patients with CAP, 35(51%) out of 68 isolates were Gram positive bacteria while 33(49%) were Gram-negative bacteria. In the year 2017, 60(67%) out of 89 isolates were Gram negative Bacteria and 29(33%) were Gram positive bacteria (Table 3).

Table 3: Distribution of Gram positive and Gram negative bacteria in respiratory samples

Bacterial isolates	Year 2016	Year 2017
Gram positive pathogens	35 (51%)	29 (33%)
Gram negative pathogens	33 (49%)	60 (67%)
Total	68	89

Among the bacterial isolates recovered in 2016 *Staphylococcus aureus* (35%) was the predominant isolate followed by *Klebsiella pneumoniae* (27%), *S.pneumoniae* (16%), *P.aeruginosa* (7%) and *Proteus species* (6%).

In the year 2017, *Klebsiella pneumoniae* was the most frequently isolated pathogen (36%) followed by *S.aureus* (24%), *E.coli* (19%), *P.aeruginosa* (10%), *S.pneumoniae* (9%) and *Proteus species* (2%). (Table 4)

Table 4: Bacterial aetiology of CAP

Bacterial pathogens	Year 2016	Year 2017
S. pneumoniae	11 (16%)	8 (9%)
S.aureus	24 (35%)	21 (24%)
E.coli	6 (9%)	17 (19%)
K.pneumoniae	18 (27%)	32 (36%)
Proteus species	4 (6%)	2 (2%)
P.aeruginosa	5 (7%)	9 (10%)
Total	68	89

Comparison between Antimicrobial Susceptibility rates of Gram positive (Table-5) isolates and Gram negative isolates (Tables 6) between 2016 and 2017 reveals that *S. aureus, K. pneumoniae, E. coli and P. aeruginosa* show increased rates of resistance to several antibiotics tested.

Table 5: Antimicrobial susceptibility profile of Gram positive bacterial pathogens

Antibiotic	No. of susceptible isolates			
	Staphylococcus aureus		*Streptococcus pneumoniae*	
	2016(n=24)	2017(n=21)	2016 (n=11)	2017 (n=18)
Amoxicillin	8 (33%)	9 (43%)	9 (82%)	6 (75%)
Amoxicillin clavulanic acid	12 (50%)	10 (48%)	10(91%)	7 (88%)
Erythromycin	15(63%)	12 (57%)	9 (82%)	6 (75%)
Co-trimoxozole	9 (38%)	8 (38%)	8 (73%)	7 (88%)
Cefotaxime	7(29%)	5 (24%)	7 (64%)	6 (33%)
Pip-taz	22 (92%)	14 (67%)	10 (91%)	7 (88%)
Gentamicin	21 (88%)	15 (71%)	11 (100%)	8 (100%)
Ciprofloxacin	20 (83%)	16 (76%)	9 (82%)	8 (100%)

Pip-taz – piperacillin tazobactum

Table 6: Antimicrobial susceptibility profile of Gram negative bacterial pathogens

Antibiotic	No. of susceptible isolates							
	E.coli		*K.pneumoniae*		*Proteus species*		*P.aeruginosa*	
	2016 (n=6)	2017 (n=17)	2016 (n=18)	2017 (n=32)	2016 (n=4)	2017 (n=2)	2016 (n=5)	2017 (n=9)
Amoxicillin	2(33%)	4(24%)	2(11%)	4(13%)	0	0	0	0
Amoxicillin clavulanic acid	3(50%)	5(29%)	4(22%)	3(9%)	0	0	0	0
Cefotaxime	2(33%)	4(24%)	5(28%)	12(38%)	2(50%)	1(50%)	1(20%)	0
Cefotaxime-clavulanic acid	4(67%)	6(35%)	12(67%)	16(50%)	2(50%)	1(50%)	2(40%)	0
Ceftazidime	2(33%)	7(41%)	10(56%)	14(44%)	2(50%)	1(50%)	2(40%)	1(11%)
Pip-taz	5(83%)	13(76%)	16(89%)	18(56%)	4(100%)	2(100%)	3(60%)	4(44%)
Gentamicin	5(83%)	11(65%)	17(94%)	17(53%)	4(100%)	2(100%)	4(80%)	5(56%)
Ciprofloxacin	5(83%)	12(71%)	18(100%)	19(59%)	4(100%)	2(100%)	4(80%)	5(56%)
Levofloxacin	4(67%)	11(65%)	16(89%)	15(47%)	3(75%)	2(100%)	3(60%)	4(44%)

Pip-taz – piperacillin tazobactum

Among *Staphylococcus aureus* isolates (6 out of 24), 25% were found to be Methicillin resistant strains (MRSA) in 2016 and increased to 57% in 2017 (Fig. 1).

Among Gram negative isolates, *E. coli* showed 24% of ESBL production in 2017 while no ESBL producers were detected in 2016. Among *Klebsiella pneumoniae* isolates, 22% were ESBL producers in 2016 while it has risen to 28% n 2017 (Fig. 2).

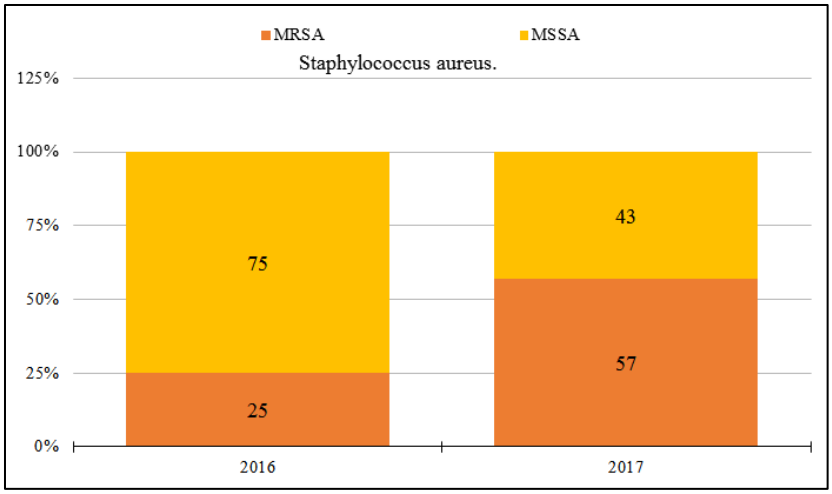

Fig. 1:
MSSA – Methicillin Sensitive *S.aureus*
MRSA – Methicillin Resistant *S.aureus*

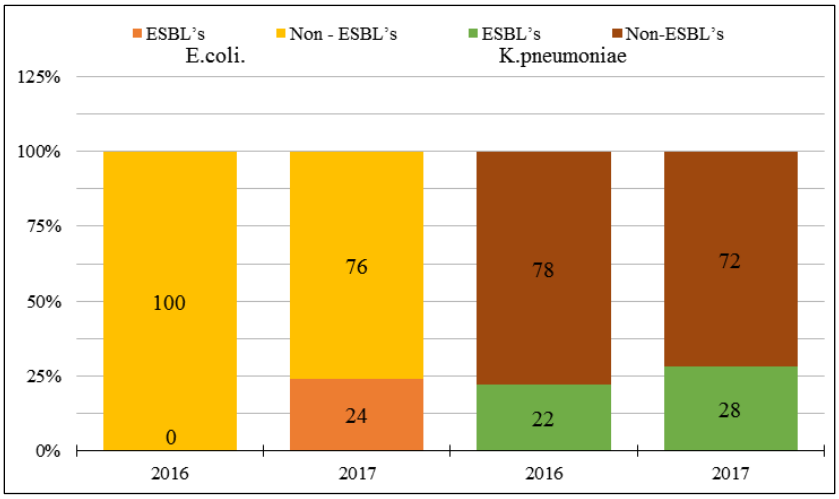

Fig. 2:

Discussion:

Incidence of bacterial pathogens in hospitalised patients with CAP in the present study was found to be 60% while it has increased to 68% in the year 2017 (Table-1). This suggests an increased burden of adult CAP in hospitalised patients and there is a need to conduct studies regarding various risk factors associated with such rise. An Ethiopian study revealed 40% of bacterial pathogens from adult patients with community acquired pneumonia [10]. Other studies revealed bacterial pathogens in the range of 40%-60% [11-14].

Table 2 depicts the increased incidence of bacterial pneumonias in the age group of 36–55 years in both 2016 and 2017. This is consistent with other studies where bacterial CAP was found to be high in elderly age group [2,11]. According to Table 3, Gram positive bacteria (51%) were found to be major etiological agents compared to Gram negative bacteria (49%) in the year 2016. But this scenario was reversed in 2017 where Gram negative bacteria (67%) were found to be predominant causative agents, compared to Gram positive bacteria. Some studies conducted worldwide reported Gram negative bacteria ranging from 3–10% of total isolates. An Ethiopian study revealed higher isolation rate of Gram negative bacteria compared to Gram positive organisms in adult CAP [10].

Table 4 shows various bacterial species implicated as pathogens in CAP. In 2016, *Staphylococcus aureus* (35%) was the major pathogen followed by *Klebsiella pneumoniae* (27%) whereas in 2017 *Klebsiella pneumoniae* (36%) became the leading cause of CAP while *Staphylococcus aureus* (24%) was the second most common agent. Several studies have reported *Streptococcus pneumoniae*, *Staphylococcus aureus*, *Klebsiella pneumoniae*, *Escherichia coli* and *Pseudomonas aeruginosa* as etiological agents in CAP [14-18]. This indicates change in the trends of aetiology of CAP from time to time which calls for periodical surveillance of local patterns of pathogens in CAP to

choose antibiotics for appropriate empirical therapy [12,19].

Antibiogram of different etiological agents between 2016 and 2017 was compared in tables 5 and 6. *Staphylococcus aureus* isolates showed a decrease in susceptibility rates in 2017 compared to 2016 for amoxicillin clavulanic acid, erythromycin, piperacillin tazobactum, gentamicin and ciprofloxacin (Table 5). *Streptococcus pneumoniae* isolates shower good susceptibility to most of the tested antibiotics. Among *Staphylococcus aureus* isolates 25% were found to be MRSA in 2016 which increased to 57% in 2017 (Fig. 1). Among Gram negative bacteria, *Klebsiella pneumoniae, Escherichia coli and Pseudomonas aeruginosa* showed increased resistant rates to cephalosporins, fluoroquinolones and amino-glycosides in the year 2017 than in 2016 (Table 6). Among *E.coli* isolates, no ESBL producers were detected in 2016, but in 2017 24% out of them were ESBL producers. ESBL producing *Klebsiella pneumoniae* increased from 22% in 2016 to 28% in 2017(Fig. 2).

This escalation in antibiotic resistance rates in adult community acquired pneumonia could be attributed to indiscriminate use of antibiotics by the general public via self medication. Unrestricted over the counter sale of antibiotics without prescription from practitioners is also a contributing factor. Previously hospitalised patients may serve as long term asymptomatic carriers disseminating Multi drug resistant (MDR) hospital acquired pathogens into the community.

Educating public regarding the hazards of misuse of antibiotics and restriction of over the counter sale of antibiotics by the government might help to prevent emergence of MDR pathogens in the community setting.

Conclusions:

The present study depicts a shift in the aetiology from Gram positive to Gram negative bacteria in adult CAP among hospitalised patients. Regular monitoring of causative agents and their drug resistant patterns is mandatory for guiding management and treatment protocols of CAP.

Conflicts of Interest: None declared

Acknowledgements: Nil

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