International Journal of Research in Medical Sciences
Shanmugam S et al. Int J Res Med Sci. 2015 Sep;3(9):2366-2375
www.msjonline.org
pISSN 2320-6071 | eISSN 2320-6012

DOI: http://dx.doi.org/10.18203/2320-6012.ijrms20150633

Research Article

Surveillance data on micro-organisms in respiratory tract infections at a tertiary care teaching hospital in South India

Sriram Shanmugam[1]*, Mohankumar Thekkinkattil[2], Manish Kanayalal[1], Minu Mohan C[1], Charmie Mohnot[1], Monisha K[1]

[1]Department of Pharmacy Practice, College of Pharmacy-Sri Ramakrishna Institute of Paramedical Sciences, Sri Ramakrishna Hospital Campus, Coimbatore -641044, Tamil Nadu, India
[2]Consultant Pulmonologist, Sri Ramakrishna Hospital, Coimbatore-641044, Tamil Nadu, India

Received: 25 July 2015
Revised: 27 July 2015
Accepted: 10 August 2015

***Correspondence:**
Dr. Sriram Shanmugam,
E-mail: visitram@yahoo.com

ABSTRACT

Background: Respiratory tract infections are the leading cause of infections and associated hospitalizations in India. Generally, there is little control on the use of antibiotics. Community awareness of the issues involved in antibiotic therapy is poor and this is compounded by over-the-counter availability. The main aim was to compare the resistance developed by respiratory microbes.
Methods: A retrospective and prospective study was designed and conducted to compare the pattern of resistance developed by microorganisms affecting the respiratory tract.
Results: The sensitivity of *K. pneumoniae* to cefepime/tazobactum has decreased from 91.9% to 47.6% and S. aureus to Linezolid has decreased from 93.4% to 80% and *S. pyogenes* to azithromycin from 51.4% to 24.8%. Whereas sensitivity pattern of *S. pneumoniae* to amoxicillin/clavulanate is increased from 65.6% to 82.3%. The prevalence of *Klebsiella pneumoniae* was increased 19% to 25.2% whereas the prevalence of *S. pneumoniae* was decreased from 66.8% to 65.2%. Our study suggests that all microorganisms isolated are susceptible to carbapenems and cefepime/tazobactum in the cephalosporin class.
Conclusions: There is major shift in the sensitivity pattern of microorganisms towards antibiotics. Therefore, these results must be kept in mind by the practitioners in the study site, prior to making decisions over a medication regimen empirically for patients and also to maximize the output of medications by rational prescribing and dosing.

Keywords: Antibiotics, Sensitivity pattern, Respiratory tract infection

INTRODUCTION

Several reports from different parts of the world revealed that antibiotics are used both widely and indiscriminately. RTIs comprise the most common indication for consulting a general practitioner, and obtaining an antibiotic prescription.

Respiratory tract infections (RTI) are the most frequently reported of all human infections. Some of these infections are mostly mild, transient lasting, sometimes self-limiting and some are serious infections that compel an individual to seek medical attention and prescription of antibiotics. LRTI's have been attributed to account for almost 20% mortality among the infectious disease deaths in India as reported by World Health Organization (WHO).[1]

The choice for antimicrobial therapy is usually straight forward when the etiologic agents and their susceptibility patterns are known.[2] It has been reported that diagnostic

laboratories and clinical pharmacist have a critical role to play in the diagnosis and management of LRTI's. Most RTIs are treated empirically, possibly because of higher cost of laboratory services wherever available. The emergence of antibiotic resistance in the management of RTIs is a serious public health issue, particularly in the developing world apart from high level of poverty, many factors are taken into account ranging from poor utilization of antimicrobial agents, to the transmission of resistant bacteria from patient to patient and from healthcare workers to patients and vice versa, also a lack of guidelines for an appropriate and judicious use of antimicrobial agents, to lack of easy-to-use auditing tools for restriction, ignorance and poor hygienic practices are also a major issue; there is also high prevalence of fake and spurious drugs of questionable quality in which are in circulation.[3]

Antibiotic resistance often leads to therapeutic failures of empirical therapy, which is why the knowledge of etiological agents of RTIs and their sensitivities to available drugs is of immense importance to the selection and use of antimicrobial agents and to the development of appropriate prescribing policies.[4] In the era of emerging antimicrobial resistance, regular monitoring of antimicrobial susceptibility patterns, changing prescription patterns, cautious and judicious use of antibiotics will be of extreme importance in improvised patient care. This study was hence conducted to determine the prevalence of microbial agents of human respiratory tract infections and the susceptibility patterns of bacterial isolates.

In a north Indian study of 2400 prescriptions, antibiotics were found to be widely and inappropriately used by practitioners.[5] In Andhra Pradesh, 60% of drugs particularly antibiotics and vitamins prescribed in rural areas and 47% of them in urban areas, were non-essential, compared to 47% in urban areas.[6]

Studies also revealed that in majority of the cases, antibiotic prescribing was empirically directed at the putative site of infection. Since culture and sensitivity facilities are available in a very small number of hospitals in India, empirical antibiotic use is rampant.[2] The distressing fact is that wherever these are available, they are infrequently requested and when advised, often the results are not considered for actual decision making.

The limited use of antibiotics in the future does not appear to be sufficient enough to change the behaviour in antibiotic prescribing and self-initiated antibiotic use. GRIP members were selected; in particular, all members are focused on implementing change in antibiotic use and the treatment of non-serious infections, such as Respiratory Tract Infections (RTIs), in primary care. GRIP is committed to address antibiotic overuse-related problems using evidence-based studies to support suitable rationale for antibiotic use and promote antibiotic stewardship among healthcare professionals. A framework is being developed for non-antibiotic treatment options for symptoms of acute RTIs.

Inappropriate antibiotic use in normally self-limiting RTIs is common in many countries and is contributing to the increase in antibiotic resistance. To reverse this tendency, a multi-faceted international, collaborative framework needs to be developed that facilitates behavioural change towards a non-antibiotic, patient-centered symptomatic management strategy in primary care. This framework should not only set the rationale for why appropriate antibiotic use in RTIs is essential, but it also should particularly outline how to enforce its implementation to change practice through improved dialogue between the healthcare provider and patient, as articulated in the framework outline. The framework should be adaptable at country level to reflect cultural sensitivities, differing healthcare provision systems and national guidelines, and could serve as a model for change in other therapeutic sectors where overuse of antibiotics in the primary care is of concern. This framework will be supplemented with practical materials that facilitate conversations between healthcare professionals and patients to promote appropriate antibiotic use.

The aim of our study was to compare the retrospective and prospective antibiotic sensitivity pattern of micro-organisms and to know the resistance pattern of the organisms causing RTI, based on which, guidelines were framed for the study hospital.[7-9]

METHODS

Study design**:** Retrospective-prospective study

Patient selection

Inclusion criteria: All the inpatients with RTI for whom at least one antibiotic was prescribed.

Exclusion criteria: Outpatients and those unwilling to participate in the study.

The study was carried out in three phases:

Phase I: (Retrospective study)

During the first phase of the study, a retrospective analysis was conducted to check the sensitivity pattern of microorganisms to various antibiotics for a two year period. The documented data were reviewed and necessary information like specimen collected, organism isolated and their sensitivity pattern were noted down.

Phase II: (Prospective study)

To perform a prospective study on the common organisms isolated during culture and sensitivity testing

and their antibiotic sensitivity patterns for a period of six months.

Phase III

In this final phase, a comparative study on the data collected from the retrospective as well as prospective sensitivity pattern study was carried out to look for any changes in the antibiotic sensitivity and emergence of resistance.

The antibiotic usage pattern for RTI was analyzed in detail. The details regarding the results obtained from the study, which were evaluated, were made as a report and were submitted to the concerned department, for their perusal.

RESULTS

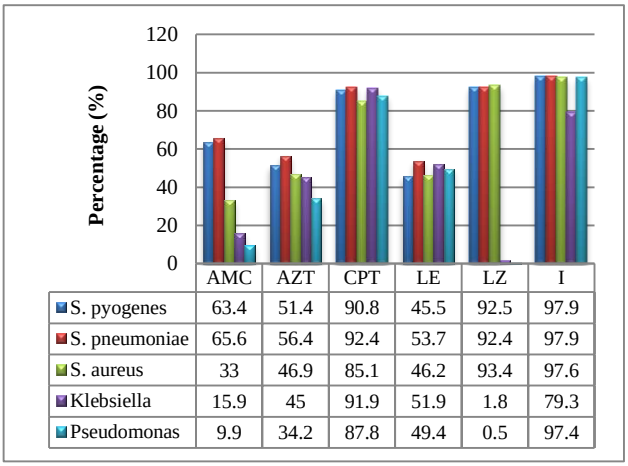
The results from the retrospective data was analyzed with 24 antibiotics and summarized in the Table 1 and it was found that *S. pneumoniae* was highly prevalent followed by *K. pneumoniae*. Susceptibility of highly prevalent organisms isolated towards different classes of antibiotics was analyzed. From the prospective data we observed that *S. pneumoniae* was the most prevalent microorganism in Table 2. The microbial susceptibility towards most effective antibiotics (Figure 1), towards cephalosporins (Figure 2) and towards other antibiotics (Figure 3). Antibiotic Susceptibility of organism obtained from prospective data was given in the Figure 4. Results obtained from the comparison of prevalence of microorganisms between retrospective and prospective data given in Table 3. Emerging resistance of microorganisms towards antibioticsare provided in Table 4. The retrospective data on micro-organisms V/s specimen is shown in Figure 5 and that of prospective in Figure 6.

During the retrospective study a total of 6591 records were analyzed which revealed that the microorganisms isolated were *S. pneumoniae* (27%), *Klebsiella* (21.8%), *E. coli* (15.3%) and *S. aureus* (10.6%). Most of the organisms were sensitive to imipenem. It was found that imipenem showed the best results in *Streptococcus pneumoniae* (97.9%), Staphylococcus aureus (97.6%), and Pseudomonas (97.4%). *S. pyogenes* also showed better sensitivity to linezolid (92.5%); Proteus towards cefepime/tazobactum. Most of the organisms showed good sensitivity to imipenem.

The comparative study was done between retrospective data (2011-2013) and prospective data (6 months) obtained from the study hospital. Sensitivity of *E. coli* was found to be decreased towards piperacillin/tazobactum from 97.4% to 81.9% and showed increased sensitivity towards meropenem from 46% to 72%. *Klebsiella* sp. was observed to have a decline in sensitivity to Ceftriaxone from 45.5% to 30.2% and its sensitivity elevated towards Meropenem and cefaperazone/sulbactum from 49.7% to 83.8% and 51.9% to 86.5% respectively. *S. pneumoniae* has found to have reduced sensitivity towards amikacin from 69.6% to 60.2% and showed increased sensitivity towards vancomycin and linezolid. Antimicrobial activity of piperacillin/tazobactum against *S. aureus* was reduced from 96.5% to 80.7% and sensitivity of vancomycin was increased from 50.9% to 91.7% and ceftriaxone from 27.5% to 57.9%. Antibiotic susceptibility of ceftriaxone and pipercillin/tazobactum were decreased against Pseudomonas from 26.4% to 23.6% and 76.9% to 72.2% respectively. Whereas activities of levofloxacin and meropenem were increased from 36.8% to 47.5% and 36.5% to 77.7% respectively.

It was found that S. pneumonia was the major organism identified in 45.4%. In the prospective study a total of 361 documented records were analysed and of the isolated specimens, followed by *S. pyogenes* (27.9%), *Klebsiella* (17.45%). The sensitivity pattern data of the prospective study revealed that *S. pneumoniae* was highly sensitive to imipenem (97%) and also to piperacillin/tazobactum (95.7%), Actinobacter to levofloxacin (100%), and piperacillin/tazobactum (93.1%) showed good sensitivity against *S. pyogenes*.

The comparative phase showed that *K. pneumoniae* developed 44.3% resistance to cefepime/tazobactum, *S. aureus* to linezolid (13.4% resistance) and *S. pyogenes* to azithromycin (26.3% resistance). In general the three antibiotics which were sensitive to almost all the organisms were imipenem, piperacillin/ tazobactam and cefaperazone/ sulbactum.



	AMC	AZT	CPT	LE	LZ	I
S. pyogenes	63.4	51.4	90.8	45.5	92.5	97.9
S. pneumoniae	65.6	56.4	92.4	53.7	92.4	97.9
S. aureus	33	46.9	85.1	46.2	93.4	97.6
Klebsiella	15.9	45	91.9	51.9	1.8	79.3
Pseudomonas	9.9	34.2	87.8	49.4	0.5	97.4

Figure 1: Microbial susceptibility towards most effective antibiotics-retrospective (n=6591).

AMC - Amoxicillin/clavulanic acid; AZT - Azithromycin; CPT - Cefepime/tazobactum; LE- Levofloxacin; LZ - Linezolid; I - Imepenam; *K. pneumonia – Klebsiella pneumoniae*; *S. aureus - Staphylococcus aureus; S. pneumonia - Staphylococcus pneumonia; S. pyogenes - Staphylococcus pyogenes; P. aeruginosa - Pseudomonas aeruginosa*

Table 1: Sensitivity pattern - retrospective study (January 2012 to February 2014) (n= 6591).

Organism	No. of patients infected	Amikacin	Amoxicillin/ Clavulanic acid	Cotrimoxazole	Ceftriaxone	Ciprofloxacin	Ofloxacin	Netillin	Sparfloxacin	Cloxacillin	Piperacillin /Tazobactam	Cefepime / tazobactum	Cefoperazone/ Sulbactam	Meropenem	Imipenem	Vancomycin	Teiclpolanin	Levofloxacin	Polymixin B	Nalidixic acid	Azithromycin	Linezolid	cefuroxime	Nitrofurantoin	Norfloxacin
E. coli	1011	810	166	226	320	204	454	708	252	0	829	926	708	728	818	4	4	346	405	23	336	9	34	481	90
K. pneumoniae	1439	1151	229	319	435	364	717	880	455	3	1050	1323	1246	1206	1141	26	13	747	745	52	647	26	39	418	96
S. pneumoniae	1783	1074	1170	210	1241	390	908	1195	554	63	1593	1648	1583	1616	1746	1606	636	957	16	2	1005	1647	211	15	11
P. aerogenosa	547	431	54	50	129	260	260	297	190	5	395	480	441	425	533	3	1	270	304	2	187	3	4	73	29
S. aureus	699	540	231	128	405	162	345	482	226	33	564	595	591	612	682	641	209	323	3	9	328	653	69	111	12
S. pyogenes	481	281	305	64	357	136	246	307	179	11	434	437	392	423	471	425	138	219	3	3	247	445	74	9	3
S. epidermidis	86	68	42	12	39	17	45	62	25	1	68	74	86	70	36	78	34	62	3	0	55	80	7	1	0
S. saprophyticus	179	146	81	31	67	25	94	184	57	5	138	141	157	159	177	160	81	108	7	1	97	157	7	101	7
Proteus vulgaris	23	20	11	5	13	10	15	11	7	0	17	23	15	20	22	0	0	6	3	1	1	0	0	8	2
Proteus mirabilis	28	21	11	6	19	11	16	11	9	0	22	23	25	28	28	0	0	19	8	1	6	0	1	5	5
Enterobacter	25	23	12	23	10	9	12	15	10	0	22	22	13	19	21	0	0	5	8	2	3	0	1	16	4
Actinobacter	148	74	29	12	14	15	49	15	76	0	67	122	121	71	143	0	0	50	79	0	31	0	2	4	2
Staphylococcus	34	28	13	5	15	11	11	21	15	4	23	33	22	24	34	33	7	12	0	0	4	32	0	4	0
Streptococci	66	31	46	10	38	16	32	37	18	0	58	49	57	59	65	51	20	32	0	0	42	61	13	1	0
Salmonella	21	17	5	5	11	8	13	14	7	0	14	19	18	19	21	0	0	14	5	0	9	0	0	11	3
Pneumococci	13	5	8	0	7	3	4	6	4	0	12	12	10	10	10	12	4	8	0	0	7	12	4	0	0
Gram negative bacilli	6	2	0	1	2	3	3	4	4	0	5	5	6	5	6	0	0	4	2	0	3	0	1	3	1
Nesseria	2	1	2	0	0	0	1	1	0	0	1	2	2	2	2	0	0	1	1	0	2	0	1	0	0
Non lactose fermentors	1	1	0	0	0	0	0	1	0	0	1	1	1	1	1	0	0	1	0	0	0	0	0	1	0

Table 2: Sensitivity pattern - prospective study (March 2014 to August 2014) (n=361).

Organism	No. of patients infected	Amikacin	Amoxicillin/ Clavulanic acid	Cotrimoxazole	Ceftriaxone	Ciprofloxacin	Ofloxacin	Netillin	Sparfloxacin	Cloxacillin	Piperacillin /Tazobactam	Cefepime / tazobactum	Cefoperazone/ Sulbactam	Meropenem	Imipenem	Vancomycin	Teicoplanin	Levofloxacin	Polymixin B	Nalidixic acid	Azithromycin	Linezolid	Cefuroxime	Nitrofurantoin	Norfloxacin
E. coli	2	1	0	0	1	0	1	0	0	0	1	0	0	1	1	0	0	1	1	0	0	0	0	0	0
K. pneumoniae	63	45	7	18	15	14	24	9	0	0	45	30	37	42	49	2	2	33	31	0	11	2	17	0	0
S. pneumoniae	164	55	135	12	121	17	37	42	0	0	157	145	147	150	159	158	20	84	0	0	52	152	76	0	0
P. aerogenosa	16	12	0	2	1	5	8	5	0	0	11	7	7	10	12	0	0	7	9	0	3	0	1	0	0
S. aureus	5	1	2	0	2	0	0	1	0	0	3	2	3	2	3	4	0	2	0	0	0	4	1	0	0
S. pyogenes	101	37	79	7	74	9	13	14	0	0	94	83	87	81	92	92	12	43	1	0	25	94	57	0	0
Proteus	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Acinetobacter	9	0	0	0	0	0	2	0	0	0	3	2	4	2	7	0	0	5	9	0	0	0	0	0	0

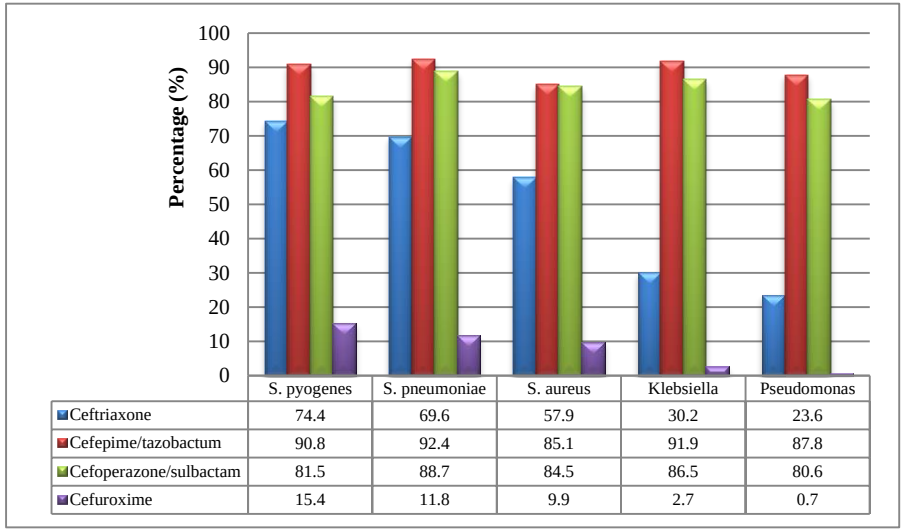


Figure 2: Microbial sensitivity towards cephalosporins-retrospective (n=6591).

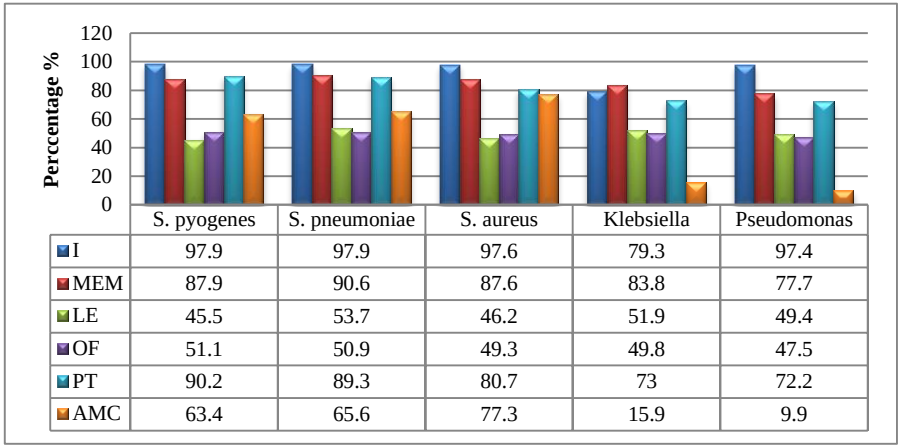
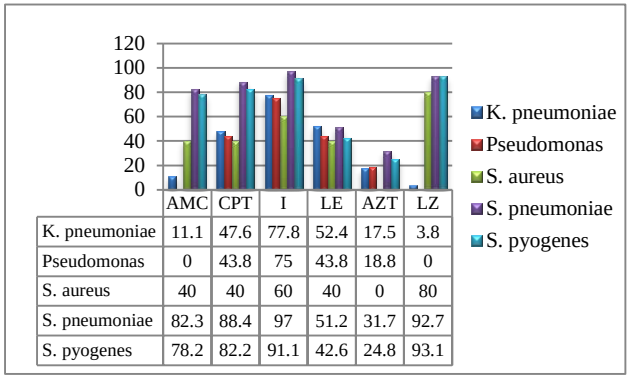


Figure 3: Microbial sensitivity towards other antibiotics-retrospective (n=6591).

I-Imepenem; MEM-Meropenem; LE-Levofloxacin; OF-Ofloxacin; PT-Piperacillin/Tazobactum; AMC-Amoxcillin/Clavulanate



	AMC	CPT	I	LE	AZT	LZ
K. pneumoniae	11.1	47.6	77.8	52.4	17.5	3.8
Pseudomonas	0	43.8	75	43.8	18.8	0
S. aureus	40	40	60	40	0	80
S. pneumoniae	82.3	88.4	97	51.2	31.7	92.7
S. pyogenes	78.2	82.2	91.1	42.6	24.8	93.1

Figure 4: Prospective analysis-sensitivity pattern of micro-organisms (n=361).

AMC-Amoxcillin/clavilanate; CPT-Cefepime/tazobactum; I-Imepenem; LE-levofloxacin; AZT-Azithromycin; LZ-Linezolid

Results obtained from the comparison of prevalence of microorganisms between retrospective and prospective data given in Table 3.

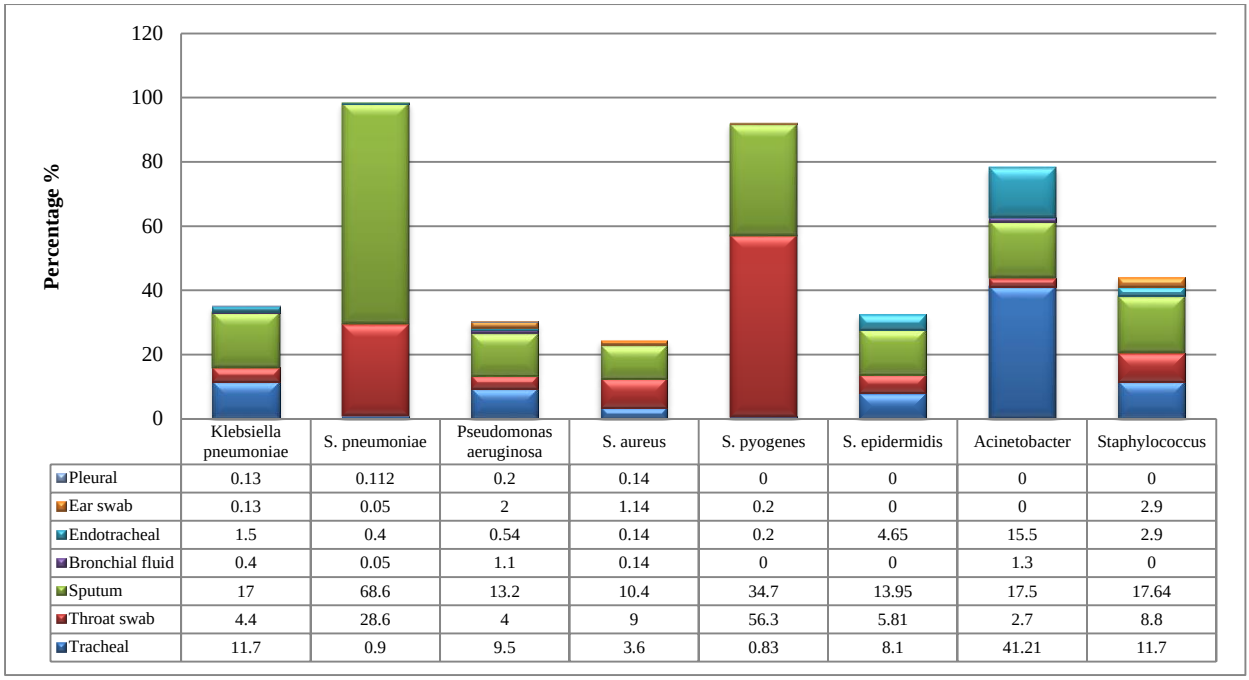
Table 3: Percentage prevalence of microorganisms - comparison.

Organism	% Prevalence	
	Retrospective (n=2631)	Prospective (n=250)
E. coli	1.8	0.8
Klebsiella	19	25.2
S. pneumoniae	66.8	65.2
S. aureus	6.3	2
Pseudomonas	6.1	6.4
Proteus	0.04	0.4

Table 4: Emergence of resistance.

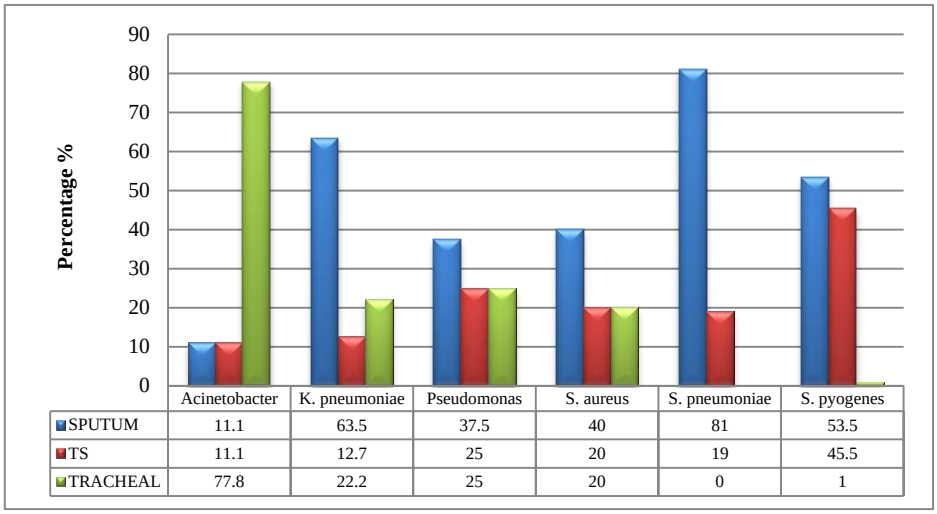
Organism	Antibiotic	% Sensitivity		% Resistance
		Retrospective (n=2631)	Prospective (n=250)	
S. pneumoniae	AMC	65.6	82.3	---
	AZT	56.4	31.7	24.7
	CPT	92.4	88.4	4
	LE	53.7	51.2	2.5
	LZ	92.4	92.7	---
S. pyogenes	AMC	63.4	78.2	---
	AZT	51.4	24.8	26.3
	CPT	90.8	82.2	8.6
	LE	45.5	42.6	2.9
	LZ	92.5	93.1	---
Klebsiella	AMC	15.9	11.1	4.8
	AZT	45	17.5	27.5
	CPT	91.9	47.6	44.3
	LE	51.9	52.4	---
	LZ	1.8	3.8	---
S. aureus	AMC	33	40	---
	AZT	46.9	0	100
	CPT	85.1	40	45.1
	LE	46.2	40	6.2
	LZ	93.4	80	13.4
Pseudomonas	AMC	9.9	0	100
	AZT	34.2	18.8	15.4
	CPT	87.8	43.8	44
	LE	49.4	43.8	5.6
	LZ	0.5	0	100

AMC-Amoxicillin/clavulanate; AZT-Azithromycin; CPT Cefepime/tazobactum; LE-Levofloxacin; LZ-Linezolid



	Klebsiella pneumoniae	S. pneumoniae	Pseudomonas aeruginosa	S. aureus	S. pyogenes	S. epidermidis	Acinetobacter	Staphylococcus
Pleural	0.13	0.112	0.2	0.14	0	0	0	0
Ear swab	0.13	0.05	2	1.14	0.2	0	0	2.9
Endotracheal	1.5	0.4	0.54	0.14	0.2	4.65	15.5	2.9
Bronchial fluid	0.4	0.05	1.1	0.14	0	0	1.3	0
Sputum	17	68.6	13.2	10.4	34.7	13.95	17.5	17.64
Throat swab	4.4	28.6	4	9	56.3	5.81	2.7	8.8
Tracheal	11.7	0.9	9.5	3.6	0.83	8.1	41.21	11.7

Figure 5: Organism vs. specimen-retrospective (n=6591).



	Acinetobacter	K. pneumoniae	Pseudomonas	S. aureus	S. pneumoniae	S. pyogenes
SPUTUM	11.1	63.5	37.5	40	81	53.5
TS	11.1	12.7	25	20	19	45.5
TRACHEAL	77.8	22.2	25	20	0	1

Figure 6: Organism v/s specimen-prospective (March 2014 to Aug 2014) (n= 361).

DISCUSSION

The comparative study was done using the retrospective and prospective data collected from the study hospital, sensitivity of *E. coli* (*Escherichia coli*) was found to be decreased towards piperacillin/tazobactum from 97.4% to 81.9% and showed increased sensitivity towards meropenem from 46% to 72%. *Klebsiella* sp was observed to have a decline in sensitivity towards ceftriaxone from 45.5% to 30.2% and sensitivity elevated towards meropenem and cefaperazone/sulbactum from 49.7% to 83.8% and 51.9% to 86.5% respectively.

Phase I of the study was a retrospective analysis on the prevalence and sensitivity pattern of micro-organisms for a period of two years and two months (Jan 2012 to Feb 2014). During this period all the documented records, regarding the specimens tested, organism isolated, and their sensitivity to various antibiotics were all recorded in a specially designed format and were analyzed.

A total of 6591 cases were analyzed during retrospective study. Nineteen different micro-organisms were isolated of which major organisms identified were *S. pneumoniae* (27%), *Klebsiella* species (21.8%), *E. coli* (15.3%), *S.aureus* (10.6%), *Pseudomonas* (8.3%), *S. pyogenes*

(7.3%). Sriram et al. (2013)[10] conducted similar study which also reported that *E. coli* (38.3%), *Klebsiella* species (19.25%), *S. pneumonia* (16%), *S. aureus* (11.6%), *Pseudomonas* (7.9%) were commonly isolated micro-organisms.

S. pneumoniae was highly prevalent in sputum specimen (68.6%) *S. pyogenes* was found to be more in throat swab specimen (56.3%), *Klebsiella* was more commonly isolated from tracheal sample (11.7%). Khavane K et al. (2010),[11] in a similar study reported that *Klebsiella* species were more common in sputum specimen (n=7).

The retrospective data revealed that almost all organisms were highly sensitive to imipenem. It was found that imipenem showed high sensitivity in Salmonella sps. (100%), *S. pneumoniae* (97.9%), *S. aureus* (97.6%), *Pseudomonas aeruginosa* (97.4%); *S. pyogenes* showed better activity to linezolid (92.5%); *Proteus vulgaris* showed high sensitivity towards cefepime/tazobactum (100%). Similarly cefaperazone/sulbactum is highly efficient against *S. epidermidis* (100%). Similar study was conducted by Shamataj K et al. (2012)[12] which revealed that organisms like *Klebsiella* were highly sensitive to imipenem (38.8%).

Phase II of the study was a prospective analysis of sensitivity pattern of microorganisms isolated from patients admitted to Pulmonology Department and General Medicine Department during the 6 months period. A total of 361 documented records were analysed during phase II study. *S. pnemoniae* (45.4%) was the major organism identified in the isolated specimens followed by *S. pyogenes* (27.9%). *K. pneumonia* (17.45%). Study conducted by Shalini et al. (2011)[13] revealed that *Klebsiella* (20.3%), *Pseudomonas* (9.1%) and *S. aureus* (6.3%) were the most common organisms isolated. Menon RU et al. (2013)[14] conducted a similar study and found that *S. pneumonia* was the most common etiological agent followed by *K. pneumoniae*, *Pseudomonas aeruginosa*.

Sputum (236), Throat swab (91), Tracheal (30) were the major samples collected from patients infected with RTI during the study period. *S. pneumoniae* (81%) was the most frequently isolated microorganism from sputum specimen whereas *S. pyogenes* (45.5%) from Throat swab culture and *Actinobacter* (77.8) from tracheal fluid culture.

The sensitivity pattern of microorganisms during prospective study indicated that *S. pneumoniae* was highly sensitive to imipenem (97%) and *Actinobacter* was sensitive to levofloxacin (100%). Piperacillin-tazobactum showed good sensitivity against *S.pneumoniae* (95.7%) and *S. pyogenes* (93.1%). Ambily Remesh et al. (2013)[15] conducted a study which showed that *E. coli* was sensitive to piperacillin-tazobactam, amikacin; and it was resistant to cefuroxime, ceftriaxone, ceftazidine, ampicillin, ciprofloxacin, and cotrimoxazole. *P. aeroginosa* was sensitive to piperacillin-tazobactam, ceftazidine, and cefoperazone. *K. pneumonia* was sensitive to piperacillin-tazobactam, and imipenam. Resistance was found to be more for ampicillin, cefazolin, and cefuroxime, whereas sensitivity was more for gentamicin, imipenem, piperacillin-tazobactam, and amikacin.

Phase III of the study was to compare the data obtained from the retrospective and prospective study. The comparative phase showed that few organisms have developed resistance to certain antibiotics.

The sensitivity of *K. pneumoniae* to Cefepime/tazobactum has decreased from 91.9% to 47.6%, *S. aureus* to linezolid has decreased from 93.4% to 80% and *S. pyogenes* to azithromycin from 51.4% to 24.8%. Whereas sensitivity pattern of *S. pneumoniae* to amoxicillin/clavulanate has increased from 65.6% to 82.3%. Study conducted by Maksum Radji et al. (2013),[16] revealed that *Klebsiella* is resistant to Ceftriaxone and P. aeroginosa is sensitive to imipenem. Also *S. pneumoniae* has found to have reduced sensitivity towards amikacin from 69.6% to 60.2% and showed increased sensitivity towards vancomycin and linezolid. Antimicrobial activity of piperacillin/tazobactum against *S. aureus* was reduced from 96.5% to 80.7% and sensitivity of vancomycin was increased from 50.9% to 91.7% and ceftriaxone from 27.5% to 57.9%. Antibiotic susceptible of Ceftriaxone and pipercillin/tazobactum were decreased against Pseudomonas from 26.4% to 23.6% and 76.9% to 72.2% respectively.

An antibiogram was prepared which can be used in future by a prescriber or can serve as a guide for empirical therapy.

Study performed had a few limitations. The study was carried out in the 6 months period and seasonal variations in disease pattern and drug utilisations were not considered. The study did not take into account the degree of sensitivity of micro-organism towards antibiotics.

Sensitivity pattern data was collected from the microbiology laboratory of the study hospital for the retrospective study. Prospective study was done during the daily ward rounds, for the all inpatients diagnosed RTI and prescribed with antibiotics. The details were noted down and the data were individually entered in a specially designed data entry form and analyzed.

According to WHO Report on global status of ABR and Surveillance (2014):

- ✓ *E. coli*: resistance to third generation cephalosporins, including resistance conferred by ESBLs and to FQ.

- ✓ *K. pneumonia*: resistance to third generation cephalosporins, including resistance conferred by ESBLs and to carbapenems.
- ✓ *S. aureus*: resistance to beta-lactam antibiotics (Methicillin, MRSA)
- ✓ *S. pneumonia*: resistance or non-susceptibility to penicillin (or both).

The antibiotic susceptibility data generated based on the consistent, reproducible and comparable data among different laboratories will help in producing a better outcome and help in the development of a region-wise antibiogram. The prevention of cross infection is also a very important task as well ensuring the continued antibiotic adherence.

The continuous surveillance of susceptibility testing is necessary for cost effective customization of empiric therapy. This coupled with the prudent use of antibiotics and infection control, sanitation and hygiene practices will help to limit further increase in resistance.

The pharmacist's role in informing prescribers on antibiotic prescribing is important in order to adhere to rational drug therapy and provide complete patient care. Clinical pharmacists play an important role in promoting optimal antibiotic prescribing practice among physicians, during their routine ward rounds.

ACKNOWLEDGEMENTS

The authors are grateful to all who have contributed to the success of this study. We specially acknowledge the Department of Pulmonology and General Medicine, and the Microbiology laboratory of, Sri Ramakrishna Hospital, Coimbatore, for the provision of the data.

It is our privilege and wonderful experience to be part of this esteemed institution and we owe our sincere thanks to Thiru. R. Vijayakumhar Managing Trustee, SNR Sons Trust, Coimbatore.

We are conceited to express our profound gratitude to Dr. P. Sukumaran, M.S., M.Ch., FIACS, Dean, SRH, Coimbatore who had permitted us and provided with the facilities to execute this work.

We also thank Dr. T. K. Ravi, Principal, College of Pharmacy, SRIPMS, for his constant encouragement throughout the study.

Funding: No funding sources
Conflict of interest: None declared
Ethical approval: The study was approved by the institutional ethics committee

REFERENCES

1. World Health Organization. Disease and injury country estimates, 2013. Available at: http://www.who.int/healthinfo/global_burden_disease/estimates_country/en/index.html. Accessed 12 September 2013.
2. Zafar A, Hussain Z, Lomama E, Sibiie S, Irfan S, Khan E. Antibiotic susceptibility of pathogens isolated from patients with community-acquired respiratory tract infections in Pakistan - the active study. J Ayub Med Coll Abbottabad. 2008;20(1):7-9.
3. Manikandan C, Amsath A. Antibiotic susceptibility of bacterial strains isolated from patients with respiratory tract infections. IJPAZ. 2013;1:61-9.
4. Taura DW, Hassan A, Yayo AM, Takalmawa H. Bacterial isolates of the respiratory tract infection and their current sensitivity pattern among patients attending Aminu Kano Teaching Hospital Kano-Nigeria. Int Res J Microbiol. 2013;4(9):226-31.
5. Aissatou Gueye Ndiaye, Cheikh Saadbou Boye, Edwige Hounkponou, Fatou Bintou, Gueye Aida Badiane. Antimicrobial susceptibility of select respiratory tract pathogens in Dakar, Senegal. J Infect Dev Ctries. 2009;3(9):660-6.
6. M. Shanthi, Uma Sekhar. Antimicrobial susceptibility pattern of methicillin resistant Staphylococcus aureus at Sri Ramachandra Medical Centre. SRJM. 2009;II(2):1-4.
7. India Working Group. Rationalizing antibiotic use to limit antibiotic resistance in India. Indian J Med Res. 2011;134:281-94.
8. GRIP. Global Respiratory Infection Partnership, 2014. Available at: http://www.grip-initiative.org/home.php.
9. Syed Mustaq Ahmed, Ramakrishna Pai Jakribettu, Shaniya Koyakutty Meletath, Arya B, Shakir VPA. Lower respiratory tract infections (LRTIs): an insight into the prevalence and the antibiogram of the Gram negative, respiratory, bacterial agents. J Clin Diagn Res. 2013;7(2):253-6.
10. Sriram S, Vidhya D, Gisha Mary George, Manjula Devi AS, Rajalingam BR, Shivasankhar V. Study on bacterial spectrum and antibiotic resistance of pathogens at a private corporate hospital. Univeral J Pharm. 2013;02(03):63-8.
11. Khavane K, Addepalli V, Bhusar K, Payghan SA, Patweaker S, Kate V. Prescribing pattern of antibiotic and sensitivity patterns of microorganisms towards different antibiotics in multi dispensary health care hospital. IJPBA. 2010;1(2):112-5.
12. Shamataj Kattalagere Rasak, Vishwanath Gurushantappa. Bacteriology of urinary tract infection and antibiotic susceptibility pattern in a tertiary care hospital in South India. Int J Med Sci Public Health. 2012;1(2):109-12.
13. Shalini, Joshi MC, Rashid MK, Joshi HS. Study of antibiotic sensitivity pattern in urinary tract

infection at a tertiary hospital. NJIRM. 2011;2(3):43-6.
14. Menon RU, George AP, Menon UK. Etiology and anti-microbial sensitivity of organisms causing community acquired pneumonia: a single hospital study. J Fam Med Prim Care. 2013;2(3):244-9.
15. Ambili Remesh, Samna Salim, A. M. Gayathri, Uma Nair, K. G. Retnavally. Antibiotics prescribing pattern in the in-patient departments of a tertiary care hospital. Arch Pharm Pract. 2013;4(2)71-6.
16. Maksum Radji, Siti Fauziah, Nurgani Aribinuko. Antibiotic sensitivity pattern of bacterial pathogens in the intensive care unit of Fatmawati Hospital, Indonesia. Asian Pac J Trop Biomed. 2011;1(1):39-42.

Cite this article as: Shanmugam S, Thekkinkattil M, Kanayalal M, Minu Mohan C, Mohnot C, Monisha K. Surveillance data on micro-organisms in respiratory tract infections at a tertiary care teaching hospital in South India. Int J Res Med Sci 2015;3:2366-75.