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Original Research Paper

Studies on Environmental Monitoring of Pathogenic Bacterial Flora of Hospital Air and Threat of Antibiotic Resistance

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ABSTRACT

Hospital air quality is important determinant of health of patients. Pathogenic bacteria if present in hospital may lead to various infections. Severity of infections is increased many-fold if those bacteria acquire antibiotic resistance. Most populated 10 hospitals of Akola city were analysed for presence of bacterial pathogens in indoor and outdoor hospital air. Resistance pattern of isolated bacteria was checked against most commonly used 10 higher generation antibiotics. The most predominant bacteria isolated were *Klebsiella pnenumonie* (25.76 %), *Staphylococcus aureus* (21.74%), *Pseudomonas aeruginosa* (23.23 %), *E. coli* (10.77 %), *E. faecalis* (9.08 %), *Proteus mirabilis* (2.87 %) and *Proteus vulgaris* (6.5 %). Out of the different wards examined more number of pathogenic bacteria were found in general ward and Maternity ward. All isolates showed varied degree of antibiotic resistance. Out of the total 2014 isolates, 38 isolates have shown resistance against all the 10 used antibiotics.

INTRODUCTION

Atmospheric pollution is one of the most pressing problem of this age that has now reached to an advanced level, which possesses a potential threat to health and well being of population. The atmosphere consists of different components which enhance or promote the survival of microorganisms in air. The health and well being of public is affected by physical, chemical and biological properties of indoor environment. The quality of indoor environment is not easily defined or controlled and can potentially place human occupants at risk (Ekhaise et al. 2008).

There are large evidences of hazardous nature of indoor air pollutants, on their source or condition leading to human exposure. The indoor air quality of hospital has become important issue these days. This is because density of pathogens is greater in hospital environment than any other place (Tambekar et al. 2007). The biological quality of air in hospital environment is of particular concern as patients may serve as source of pathogenic bacteria to staff and hospital visitors, in addition to fallow patients. Survey of bacterial level in hospitals has raised worldwide concern as approximately 10 % of all patient infections are suspected to hospital acquired (Meers et al. 1990, Haley et al. 1985, Mayon-White et al. 1988). Common sources of aerial transmission in the hospital environment include respiratory ejection from mouth and nose, skin exudates, infected lesions as well as respiratory apparatus and air conditioning plants. Studies detailing the ambient concentrations of airborne bacteria in hospital environment are sparse in literature, although concentration of over 7000 colony forming unit per cubic meter of air have been reported in some hospitals (Obbard & Lim 2003).

Increasing antibiotic resistance also increases severity of nosocomial infections. The emergence and spread of resistance are also threatening to create species resistant to all currently available agents. Approximately 20 % of *Klebsiella pnenumonie* infections and 31% of *Enterobacter* species infection in intensive care unit in United States now involve strains not susceptible to higher generation antibiotics (Paterson 2006).

The purpose of the study was to isolate and identify bacterial pathogens from hospital outdoor and indoor environment and to check antibiotic resistance of all isolated pathogens against widely used 10 higher generation antibiotics. This study helps to assess the new potent antibiotics and current resistance pattern against commonly used antibiotics.

MATERIALS AND METHODS

The study was carried out over a period from June 2009 to August 2010. Ten most populated hospitals of the city were selected for the study. All the hospitals were given a code in order to hide their identity. Air samples from different wards like General ward, waiting room, Maternity ward, intensive care units (ICU) and Operation theatre were taken along with the outdoor environment.

Isolation and identification: Specific Hicrome agar (M 1353) for isolation of pathogenic bacteria was filled in media strips and loaded in Himedia air sampler. Air sampler was operated for fixed period of time i.e., for 5 minutes at each sampling site. All media strips were incubated at 37°C

for 24 hours and isolates were identified by following standard procedures (Bergey's Manual of Determinative Bacteriology 1974).

Antibiotic sensitivity test: All isolates were forwarded for antibiotic resistance against 10 selected antibiotics. Muller-Hinton agar was used to study antibiotic resistance pattern. On the basis of zone of inhibition each isolate was categorized into three classes as sensitive, intermediate and resistant for particular antibiotic.

RESULTS AND DISCUSSION

Total 60 air samples from 10 hospitals were analysed, in which 2014 pathogenic bacterial isolates were obtained from various wards. The most prominent bacterial isolates were *Klebsiella pnenumonie*, *Staphylococcus aureus*, *Pseudomonas aeruginosa*, *Escherichia coli*, *E. faecalis*, *Proteus mirabilis* and *Proteus vulgaris*.

Number of bacterial isolates from different wards and outdoor environment is given in Table 1. Highest pathogenic bacterial isolates were obtained from hospital given code PH 5, and lowest pathogenic bacterial isolates from hospital given code PH 4. In all the ten hospitals, highest numbers of bacterial pathogens were present in General ward and Maternity ward and least in Operation theatre. Outdoor environment has shown notable number of bacterial pathogens. In some hospitals indoor environments are predominated by bacterial pathogens while in others, outdoor environment carry more number of pathogens. Bacterial pathogens isolated from ICUs and Operation theatre increases severity of issue.

Percentage distribution of various bacterial pathogens is as shown in Fig. 1. Most predominant bacterial pathogens were *Klebsiella pnenumonie* (25.76 %), *Staphylococcus aureus* (21.74%), *Pseudomonas aeruginosa* (23.23 %), *E. coli* (10.77 %), E. *faecalis* (9.08 %), *Proteus mirabilis* (2.87 %) and *Proteus vulgaris* (6.5 %). It clearly indicates that in hospital environment *Klebsiella pnenumonie*, *Staphylococcus aureus* and *Pseudomonas aeruginosa* are present in highest number while *Proteus mirabilis* is present in least number.

Initially, a survey was made in all hospitals of Akola city and name of most commonly used antibiotics were collected. Ten higher generation antibiotics selected for the study are: Ceftriaxone, Imipenem, Ciprofloxacin, Clindamycin, Ampicillin, Meropenem, Azithromycin, Amoxicillin, Clarithromycin and Ofloxacin. When all 2014 isolates were assayed for antibiotic resistance against these most commonly used higher generation antibiotics, most of the isolates have shown different resistance. There were 103 isolates, which are sensitive to all 10 antibiotics, while remaining 1911 isolates have shown resistance to one or more antibiotics (Table 2). Out of that 1911 isolates 38 have shown resistance to all ten commonly used higher generation antibiotics.

Among the 38 isolates, which are resistant to all ten antibiotics, 16 were identified as *Klebsiella pnenumonie*, 9 as *Pseudomonas aeruginosa*, 8 as *Staphylococcus aureus* and

Table 2: Number of isolates, which have shown resistance to one or more antibiotics.

Sr. No.	Category	Number
1	Number of isolates resistant to only 1 antibiotic	548
2	Number of isolates resistant to 2 antibiotics	324
3	Number of isolates resistant to 3 antibiotics	149
4	Number of isolates resistant to 4 antibiotics	216
5	Number of isolates resistant to 5 antibiotics	344
6	Number of isolates resistant to 6 antibiotics	114
7	Number of isolates resistant to 7 antibiotics	078
8	Number of isolates resistant to 8 antibiotics	059
9	Number of isolates resistant to 9 antibiotics	041
10	Number of isolates resistant to all 10 antibiotics	038
	Total	1911

Table 1:- Number of pathogenic bacterial isolates from different wards.

Sr. No.	Hospital Code	GW	MW	ICU	OT	WR	OD	Total
1	PH 1	45	64	11	04	34	38	196
2	PH 2	30	31	08	00	18	22	109
3	PH 3	64	49	14	03	47	28	205
4	PH 4	18	16	02	00	12	54	102
5	PH 5	106	109	22	14	68	71	390
6	PH 6	69	83	17	09	41	60	279
7	PH 7	24	34	07	02	28	34	129
8	PH 8	58	45	08	00	39	34	184
9	PH 9	47	51	16	05	37	48	204
10	PH 10	59	58	15	01	44	39	216
Total								2014

PH-Private hospital, GW-General Ward, MW-Maternity Ward, ICU-Intensive Care Unit, OT-Operation Theatre, WR-Waiting Room, OD-Outdoor

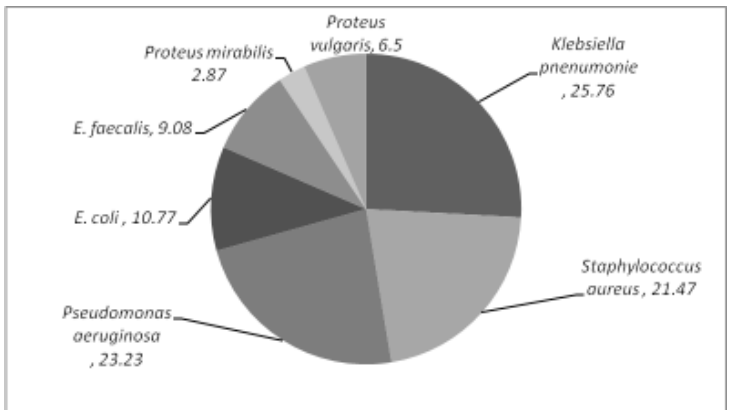

Fig. 1: Percentage distribution of bacterial pathogens in hospital environment.

remaining 5 as *E. coli.* All these observations clearly indicate severity of pollution in hospital environment with bacterial pathogens and risks of antibiotic resistance. It is very necessary to take preventive measures like maintenance of proper aseptic conditions in hospital environment, timely cleaning of hospital floors, safe disposal of hospital waste and use of only appropriate antibiotics to make hospitals safer place for patients, hospital staff and visitors as well.

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