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THE BANE OF ENTEROBACTERALES IN HOSPITAL INFECTION CONTROL; A TERTIARY CARE BASED STUDY

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ABSTRACT

Aim: To assess the prevalence of enterobacterales in hospital acquired infections and hospital environment. **Material and Methods:** Enterobacteriaceae from patient isolates and high touch surfaces in the hospital environment were identified using conventional and automated methods in the bacteriology laboratory. The antibiogram of both patient and hospital isolates was compared for possible correlation. **Result:** 147 patients were diagnosed with nosocomial infections according to the CDC-NHSN criteria. The prevalence of enterobacteriaceae as nosocomial pathogens was found to be 45.57%. The most common hospital acquired infection was revealed to be urinary tract infection(61%), followed by ventilator associated pneumonia(19%). As far as the patient isolates are concerned, the most predominant bacteria was *Klebsiella pneumoniae*(61%) followed by *Escherichia coli*(34%).In the hospital environment, the predominant organism was *Klebsiella pneumoniae*(58%), followed by *Enterobacter cloacae*(25%) and *Escherichia coli*(17%). The tap was found to be a source of multidrug resistant *Klebsiella pneumoniae.* **Conclusion:** The hospital environment is a major source of multidrug resistant enterobacteriaceae.

KEYWORDS: nosocomial infections, enterobacterales, high touch surfaces, hospital acquired, antibiogram, multidrug resistant organism.

INTRODUCTION

The most common cause of nosocomial infections are aerobic gram negative bacilli. They account for urinary tract infections, hospital acquired pneumonia and 25%-30% of bloodstream and surgical site infections.[1] Among the plethora of gram negative bacilli existing in the hospital environment, enterobacteriaceae form an important subset.

In 2020, a taxonomic change was made, where "enterobacterales" was used as the name of a new scientific order. Enterobacteriaceae is now a family within the "Enterobacterales" order.[2]
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Ironically, enterobacterales are a part of normal human commensal flora, colonizing the aerodigestive tract. They are microaspirated and introduced into the sterile sites causing endogenous infections.[3] Hence this study was undertaken to assess the prevalence of enterobacterales as nosocomial pathogens.

OBJECTIVES

1. Identification of enterobacteriaceae responsible for hospital acquired infections.
2. Isolation and identification of enterobacteriaceae from the hospital environment.
3. To perform and compare the antibiogram of both type of isolates.

MATERIALS AND METHODS

The study was performed in the Bacteriology Unit of the Calcutta School Of Tropical Medicine from January 2019-January 2020.Only patients who were admitted for more than 48 hours were included in the study. Samples were collected by using sterile, aseptic measures from patients who met the CDC-NHSN criteria for various nosocomial infections. Swab samples of high touch surfaces in the hospital environment was collected by using sterile, Himedia swabs were moistened in normal saline. Both types of samples were transported to the bacteriology laboratory where they were inoculated in appropriate media. Only bacteria from the family

enterobacteriaceae were processed using conventional laboratory guidelines and VITEK 2D.Antibiotic susceptibility testing was performed using Kirby Bauer disc diffusion method and VITEK 2D AST cards.

Data Analysis

The data was entered into MS Excel. A patient demographic detail was subsequently analyzed. Antibiogram of both patient and hospital bacterial isolates was compared.

RESULTS

A total of 147 patients were diagnosed with nosocomial infections according to the CDC-NHSN criteria.67 bacterial isolates belonging to the family enterobacteriaceae were identified from various samples collected. Hence the total prevalence of enterobacterales as nosocomial pathogens was 45.57%.

The sex predilection was more in males (63%) than females (37%).

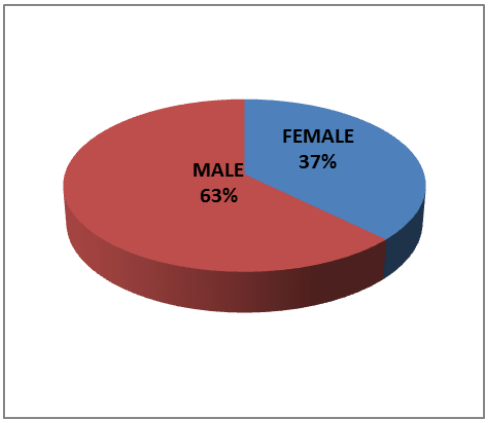

Figure 1: Pie chart showing sex predilection.

It was observed, that nosocomial infections due to enterobacterales were more prevalent in the IPD (60%) than the CCU (40%).

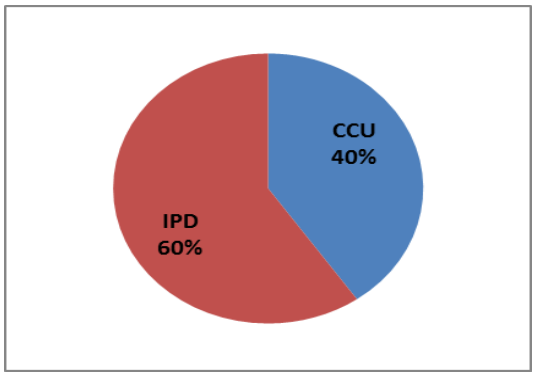

Figure 2: Prevalence of enterobacteriaceae in CCU and IPD.

It was also noted that such infections were most prevalent in the age group 51-60 years (27%).

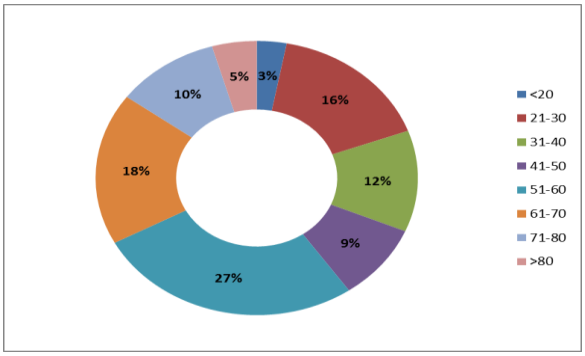

Figure 3: Pie diagram depicting distribution of infections across various age groups.

23% of the patients had chronic kidney disease as the underlying illness, followed by HIV infection (20%) and chronic liver disease (18%).

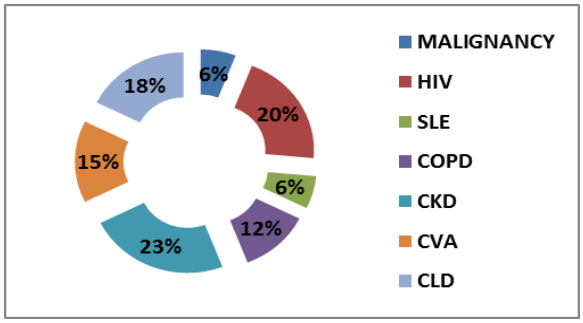

Figure 4: Pie diagram depicting underlying infections.

The most common hospital acquired infection due to enterobacteriaceae was urinary tract infection (61%, n=41) followed by ventilator associated pneumonia (19%, n=13).

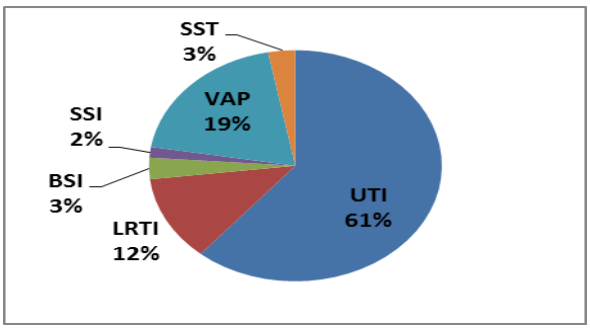

Figure 5: Pie diagram showing various hospital acquired infections.

Nosocomial Infection Diagnosed(According To Cdc-Nhsn) Criteria	Number(N)
Urinary Tract Infection	41
Lower Respiratory Tract Infection	8
Bloodstream Infection	2
Surgical Site Infection	1
Ventilator Associated Pneumonia	13
Skin And Soft Tissue Infection	2

The most predominant bacteria was *Klebsiella pneumoniae* (61%, n=41) followed by *Escherichia coli* (n=23, 34%).

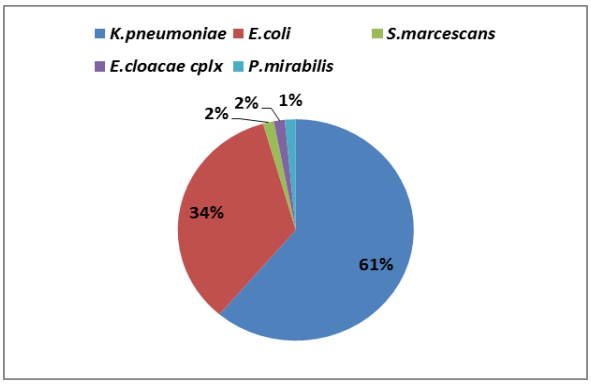

Figure 6: Pie diagram showing predominant organisms in patient isolates.

Enterobacteriaceae in the hospital environment

A total of 200 samples were collected from various high touch surfaces in the hospital environment of which 134 sites showed growth in routine culture media. Gram negative bacilli belonging to family enterobacteriaceae was isolated from 12 sites. Thus the prevalence of enterobacteriaceae in the hospital environment was 8.95%. The most predominant organism among them was *Klebsiella pneumoniae*(n=7, 58%), followed by *Enterobacter cloacae* cplx(n=3,25%) and *Escherichia coli* (n=2,17%).

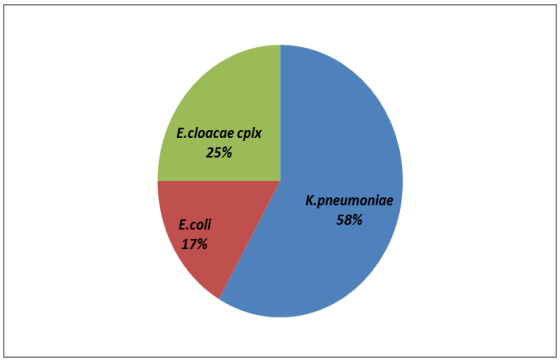

Figure 7: Pie diagram showing predominant organisms in hospital environment.

Maximum organisms were isolated from the tap (n=6).

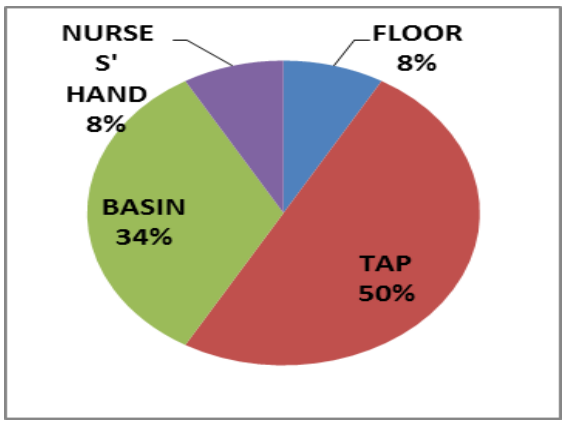

Figure 8: Diagram depicting percentage of organisms isolated from various hospital sites.

Analysis of Antibiogram

74%(n=50) of the bacteria isolated from patient samples were carbapenem resistant enterobacteriaceae(CPE).Of the 12 isolates of enterobacteriaceae from the hospital environment, only 3(25%)isolates of *Klebsiella pneumoniae* were found to be carbapenem resistant.

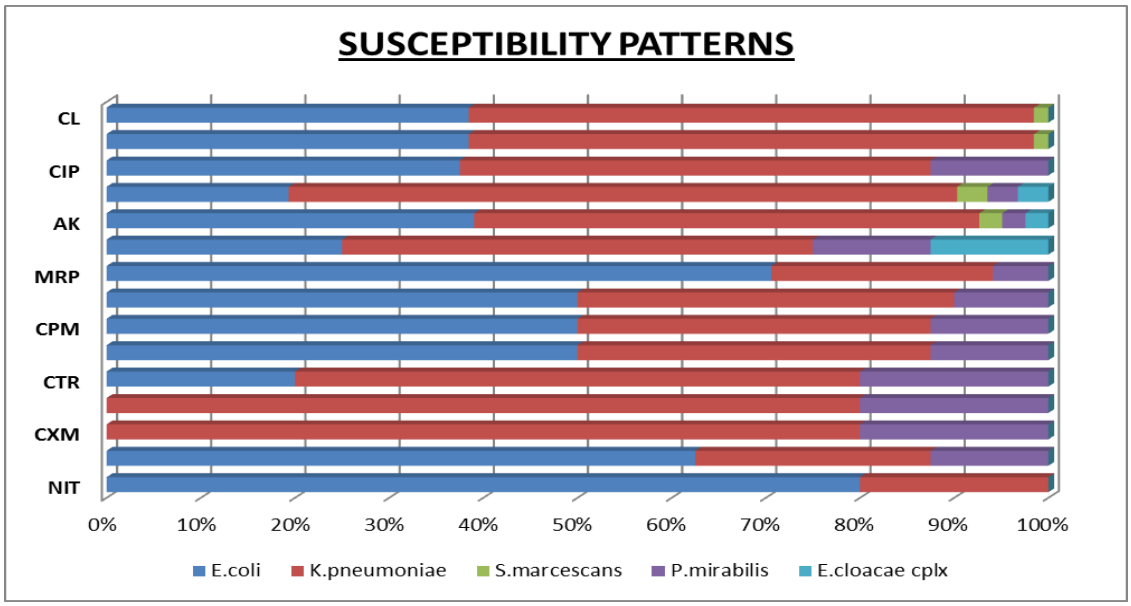

Figure 9: Antibiogram of patient and environmental isolates.

Maximum susceptibility, both in patient and environmental isolates was seen in case of amikacin, tigecycline and colistin (100%).

DISCUSSION

The antibiotic resistance among enterobacteriaceae has increased dramatically over the past few decades. The clonal spread of multidrug resistant organisms in geographically distant regions has ensured that antimicrobial resistance is presently an undefeatable pandemic. The mounting selection pressures in the intensive care units where antimicrobial stewardship is oft unheard of, especially in low and middle income countries has proved to be a bane.[4] This is especially applicable in case of enterobacterales, commensals and colonizers of the aerodigestive tract that quickly acquire resistance and wreak havoc in the patient's already fragile health.

According to the National Healthcare Safety Network(NHSN), from 2009-2010, E.coli accounts for 12% of hospital acquired infections, *Klebsiella pneumoniae* (8%)and *Enterobacter* species(5%).[5] An ICU based study by Chaudhary et al. found *Klebsiella pneumoniae*(63.11%) as the most common cause of nosocomial infection followed by *Escherichia coli*(36.88%).[6] In our study, we also found *Klebsiella pneumoniae* as the most frequently isolated bacteria(61%), followed by *Escherichia coli*(34%). But in contrast to a study conducted by Khan et al in Pondicherry, where 14 isolates of *Enterobacter* spp was found, we isolated only 1 *Enterobacter cloacae* cplx.[7]

As far as patient demographics is concerned, more males (63%) were affected with enterobacterales than females (37%). This is similar to the findings of a tertiary care hospital based study by Chotiprasitsakul et al. where the sex predilection was more in males (52.5%) than females.[8]

41% of the patients had chronic debilitating diseases (chronic kidney and liver diseases), while 23% of the patients had HIV infection. This is significant, as patients with chronic diseases are more predisposed to requiring frequent admissions than those with acute diseases. This corroborates with the findings of Eilertson et al who found a significant association of carbapenem resistant enterobacteriaceae infections with patients on renal replacement therapy.[9]

74% of the isolates were found to be carbapenem resistant enterobacteriaceae (CPE). A China based study by Wang et.al found 94 isolates of CPE.[10]

In our study, out of the 200 samples collected from hospital environment, 133(67%) showed growth in culture. This is in concurrence with a Morocco based study by Chaoui et al. that found 88% mixed growth in cultures from the hospital environment.[11] A Scotland based study conducted in 2018, found environmental contamination rates as high as 95.7%.[12] Thus we can conclude that hospital environment contamination varies quantitatively and qualitatively over time.

The prevalence of enterobacteriaceae in the hospital environment was found to be 8.95 %(n=12). A study by Ayatolla et al. in Iran found the prevalence of enterobacteriaceae in the hospital environment as high as 30.35%.[13]

The most frequent among our isolates from the hospital environment was *Klebsiella pneumoniae* (n=7), 5 of which were from hospital taps and sinks. A study conducted by Mohapatra et al. found 2 isolates of *Klebsiella pneumoniae* from hospital sinks a well.[14] In our study; *Enterobacter cloacae* complex was isolated from 2 sites, 1 from the hospital sink and 1 from a healthcare worker's hands. A study by Aranega-bou et al. in Manchester revealed isolation of *Enterobacter cloacae* complex from the *Escherichia coli* hospital sink system.[15] We isolated *Escherichia coli* in 2 occasions from the hospital environment. This is in concurrence to the results of the study by Mohapatra et al who also obtained 2 isolates from the hospital environment.[16] From our present study, we can conclude that the hospital sinks and taps are a major reservoir of enterobacteriaceae.

The aqueous environment presents a unique challenge to infection control and prevention. Wet surfaces provide a solid-liquid interface that predisposes to biofilm formation. These biofilms have been proven to harbor multidrug resistant organisms.[15]

Sink traps make ideal environmental reservoirs for complex bacterial biofilms as they are difficult to clean due to the presence of physical barriers.[16] Similar to our findings, a Virginia based study found ongoing transmissions of carbapenem resistant Enterobacteriaceae similar to those found in the hospital sink.[17] Elsewhere, in a study by Rungruanghiranya et al., Thailand, most of the outbreaks found a source in the hospital personnel.[18]

CONCLUSION

Nosocomial infections are an important cause of mortality and morbidity throughout the world. Inspite of the serious consequences of healthcare associated infections and its socio-economic implications, proper diagnosis and surveillance continues to be an underrated topic of interest. Though routine environment surveillance is not recommended, it continues to be a fact that the hospital environment is a rich source of omnipresent multidrug resistant organisms that can be acquired by vulnerable patients. There is a dearth of studies reflecting the association of environmental and hospital acquired enterobacteriaceae in our low and middle income countries. Our study attempted to document the same.

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