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Bacteriological Profile of New and Old Currency Notes in Circulation in Northern Indian Hospital

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ABSTRACT

Background: Currency notes are handled by everyone and are exchanged among for trade. While transaction of money, different kinds of pathogenic and non-pathogenic microorganisms contaminate the notes. Money makes easy transferof microorganisms as they act as environmental vehicle and thus cross contamination occurs.

Objective: To study and compare the bacteriological profile of new currency and old currency notes and to study antimicrobial susceptibility pattern of the isolates to know the circulation of resistant strains in hospital.

Material and method: Different pathogenic and non-pathogenic isolates were isolated from the currency notes circulating in different departments like Medicine, Surgery or Intensive care unit of a tertiary care hospital and medical college at Jalandhar. The antimicrobial susceptibility tests were performed to check the resistant strains circulating here.

Results: A total of 200 currency notes (all from hospital premises) were collected. Out of 200, we isolated total of 232 isolates like *Staphylococcus aureus, Staphylococcus citreus, Bacillus subtilis, Klebsiella sp. etc.* The comparative study of the isolates collected from older currency generated before demonetization (127 out of 232 i.e. 54.75%)and newer currency generated after demonetization (105 out of 232 i.e. 45.25%) shows the newer currency gets contaminated in very less time span. The antimicrobial susceptibility tests showed 122 strains that were resistant to different antibiotics. These strains are in circulation in hospital and may become the cause of various infections.

Conclusion: The higher number of pathogenic microorganisms isolated from currency notes from hospital may contribute to nosocomial infections or hospital acquired infections as well as community acquired infections. The currency notes must be handled with care and proper hygiene of hands must be maintained after dealing with money.

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INTRODUCTION

The currency notes are one of the sources of infection. From doing the bacteriological profile of notes, we get to know about the types of bacteria that are present on the notes and whether these bacteria are pathogenic or non-pathogenic.[1-3]The way of the survival of bacteria on notes can also be judged by their growth habits and survival requirements. After examining the notes for bacteria we can come to know how fast these notes get infected. In the hospital community, notes are highly exchanged in between patients and hospital workers. These notes are also the source of nosocomial infections.

Various studies have shown that the currency notes are mostly contaminated with Gram positive and Gram-negative bacteria. [4, 5]When notes are transferred from one hand to another hand, the notes get contaminated with potentially pathogenic bacteria from an individual to another especially in hospitals. Even the hospitalized patients can get infections from these notes. [6]

Contamination of paper currency results from contaminated hands (after using toilets), counting notes using saliva, placement of notes on dirty surfaces.[7-9]These contaminating microorganisms can be pathogenic and non pathogenic as well. Important factors for the survival of pathogenic agents on surfaces are presence of organic matter, solar irradiation, temperature and humidity. Many Gram-positive bacteria, such as *Enterococcus spp*., *S. aureus*and *Streptococcus pyogenes,* and Gram-negative bacteria, such as *Acinetobacter spp., Escherichia coli, Klebsiella spp., Pseudomonas aeruginosa, Serratiamarcescens*and *Shigella spp*., can survive for months on surfaces. [10][11]Most of the nosocomial pathogens are present on the notes and prove to be continuous source of transmission if regular preventive surface disinfection is not performed.

Notes have rough surfaces that allow the pathogenic and non-pathogenic microorganisms to settle and survive for longer times. The level of contamination of notes depends on the time and duration of the circulation of that note and also on the capacity of it to absorb moisture. The mostly exchanged object is money so it is highly subjected to harbor disease-causing microorganisms. The phrase “dirty money, a potential health twist” was proved when the scientists found the antibiotic resistant genes along with bacteria, viruses, fomites, parasites etc. [7]

The study on the microbial status and survival of pathogens on currency notes was started many years ago. The studies from last 20 years have shown that notes are becoming the potential cause of sporadic cases of food borne illness. “The lower the index value of the money, the higher the

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microbial contamination of the currency." Lower denomination notes are exchanged more and stay more time in circulation than the higher index value notes. So these harbor the greatest risk of contamination with infectious agents. [12]

Post demonetization new currency notes of Rupees 500 and 2000 denominations came into circulation and thereafter-newer currency in the denominations of 10, 50 and 200 came into existence. Theoretically chances of their bacterial contamination are much less as compared to the old currency notes. No study on the microbial load of new currency notes is available in the literature, to the best of our knowledge.

Therefore present study was undertaken to know the bacterial contamination of new currency notes, which are in circulation for past two years only versus old currency notes. It will depict how quickly microbial flora can invade the currency notes, a highly potent source of infection transmission.

The objective of this study is to get the knowledge of microbial diversity of currency notes in circulation to raise the health awareness and consciousness in people during handling currency and control of infection transmission.

MATERIALS AND METHODS

The present study was undertaken in the Department of Microbiology at Punjab Institute of Medical Sciences, Jalandhar. It was a prospective study carried over a period of four months from 1st January 2018 to 30th April 2018. All the glassware used in this project was purchased from Thermo Fisher Scientific India Pvt. Ltd., Mumbai, India. The media, antimicrobial agents, chemicals used were obtained from HiMediaTM Laboratories Pvt. Ltd., Mumbai, India.

Test swabs: A total of 200 swabs were taken from the currency notes collected from various departments in the hospital premises. 8 swabs were collected every time from which the 7 swabs were the test swabs.

Controlswabs: In the group of 8 swabs, 1 swab was always the control. It was not swabbed on the currency note. The swab was taken out from the packet in sterile conditions and just inoculated in TS broth and rest procedure was same as the test swabs.

Methods for isolation and identification of microbes

Specimencollection: Notes sample were collected from the patients visiting the hospital. The swabbing of the notes was done in sterile conditions. All the measures were taken care of to avoid the contamination of the swab. The swabbing was done on both sides of the notes. These swabs were

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then inoculated in the TS broth test tubes for 4 hours incubation. After the incubation, the swabs were streaked on TS agar and incubated for 24 hours.

Isolation andidentification: The microbes were isolated by culture and identification of the microbes was done based on colony morphology, staining characteristics, catalase, coagulase and other relevant biochemical tests and antibiotic sensitivity test.

RESULTS

The present study was conducted at the Department of Microbiology on a total of 200 currency notes, which were collected from various wards in Punjab Institute of Medical Sciences, Jalandhar for bacteriological processing.

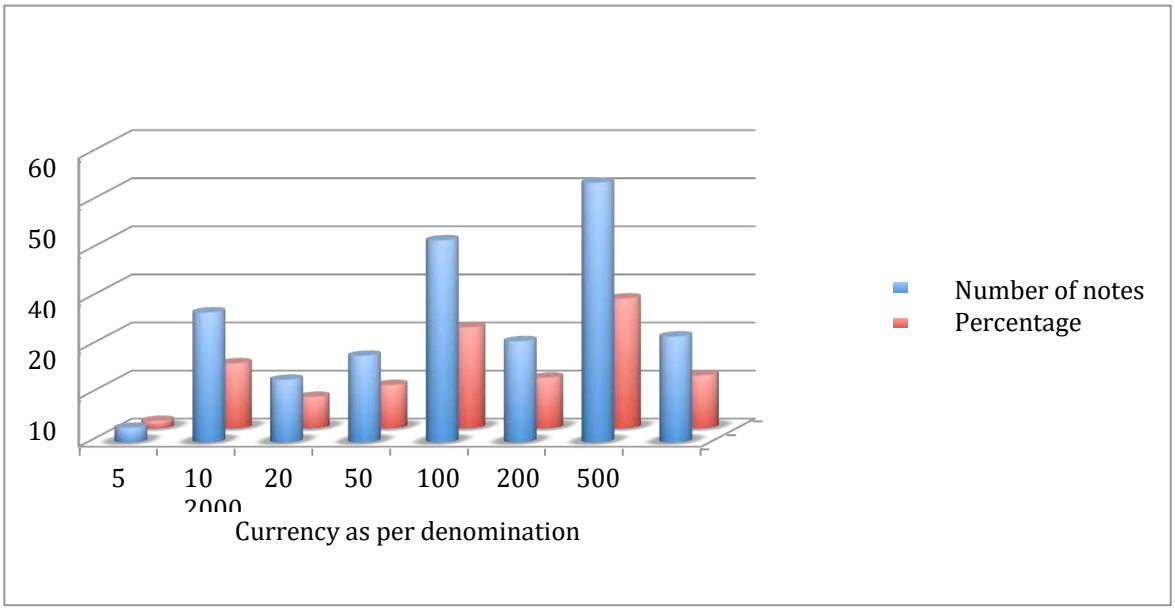

Fig. 1: Distribution of currency notes asper denomination: This graph represents the denomination of the currency notes in an increasing order on X-axis and number of notes collected of each denomination with percentage on Y-axis.

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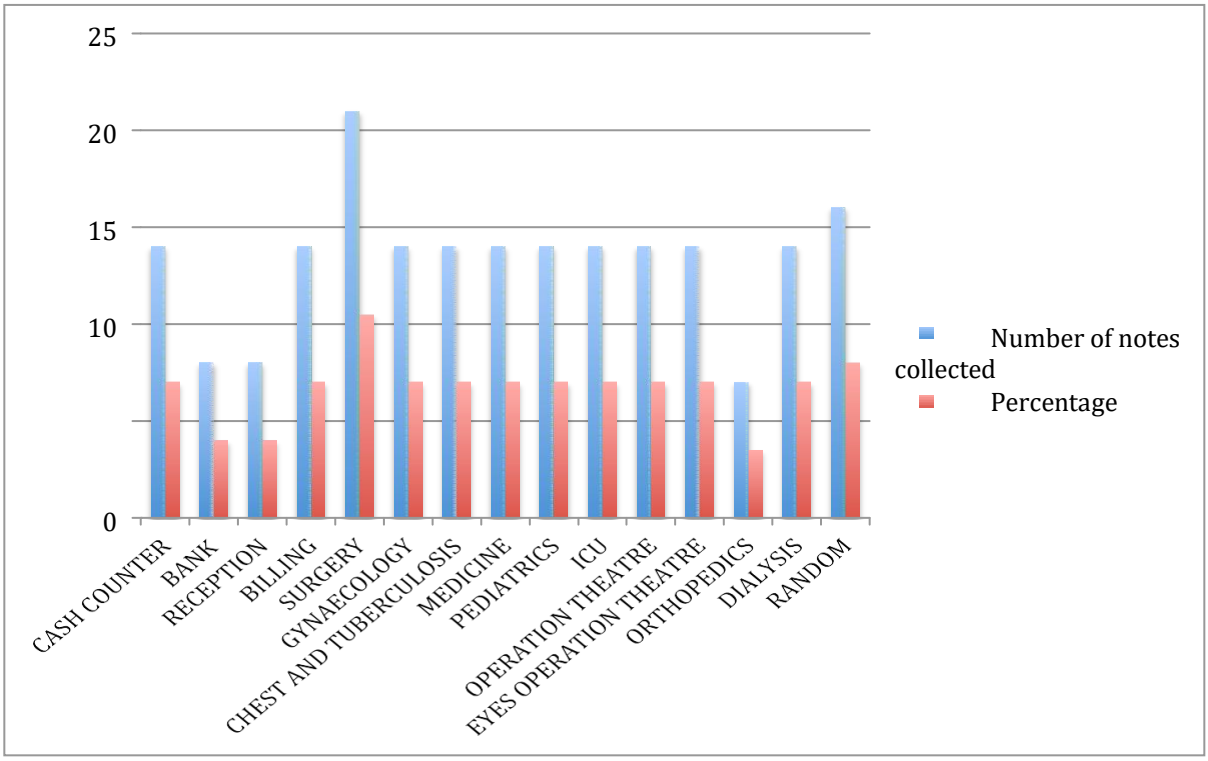

Fig. 2: Distribution of currency notes as per area of collection: This graph shows all the areas or departments in hospital premises from where the currency notes were collected with number and percentage of notes collected. On X-axis, department names are given and on Y-axis, number and percentage of notes.

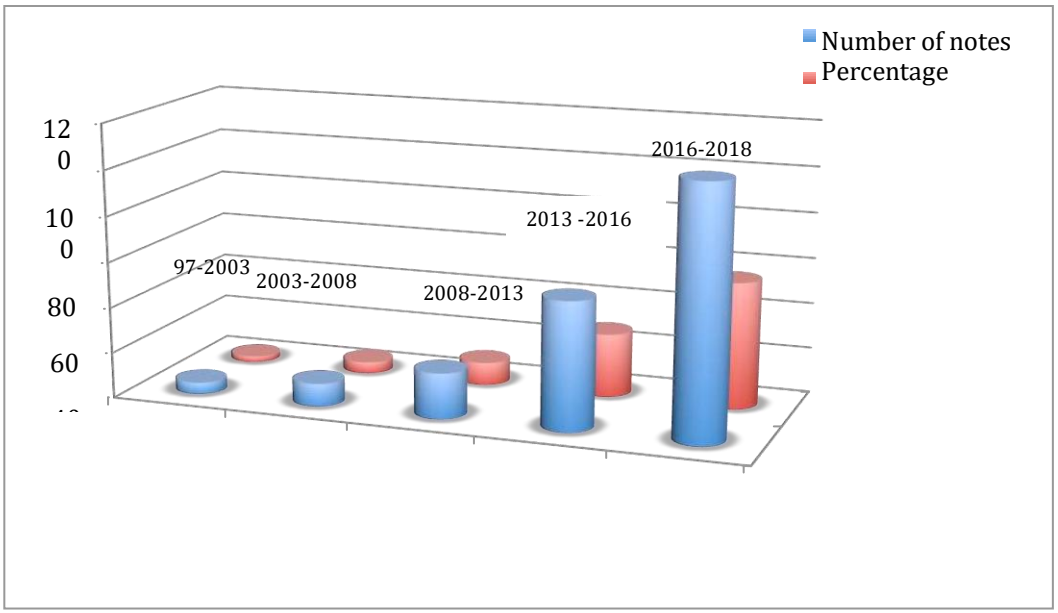

Fig. 3: Distribution of currency notes as per year of generation: This graph indicates the year of generation of notes on X-axis. The Governor's sign on note tells about the year of generation of note. On Y-axis, we have number and percentage of notes collected of eachyear.

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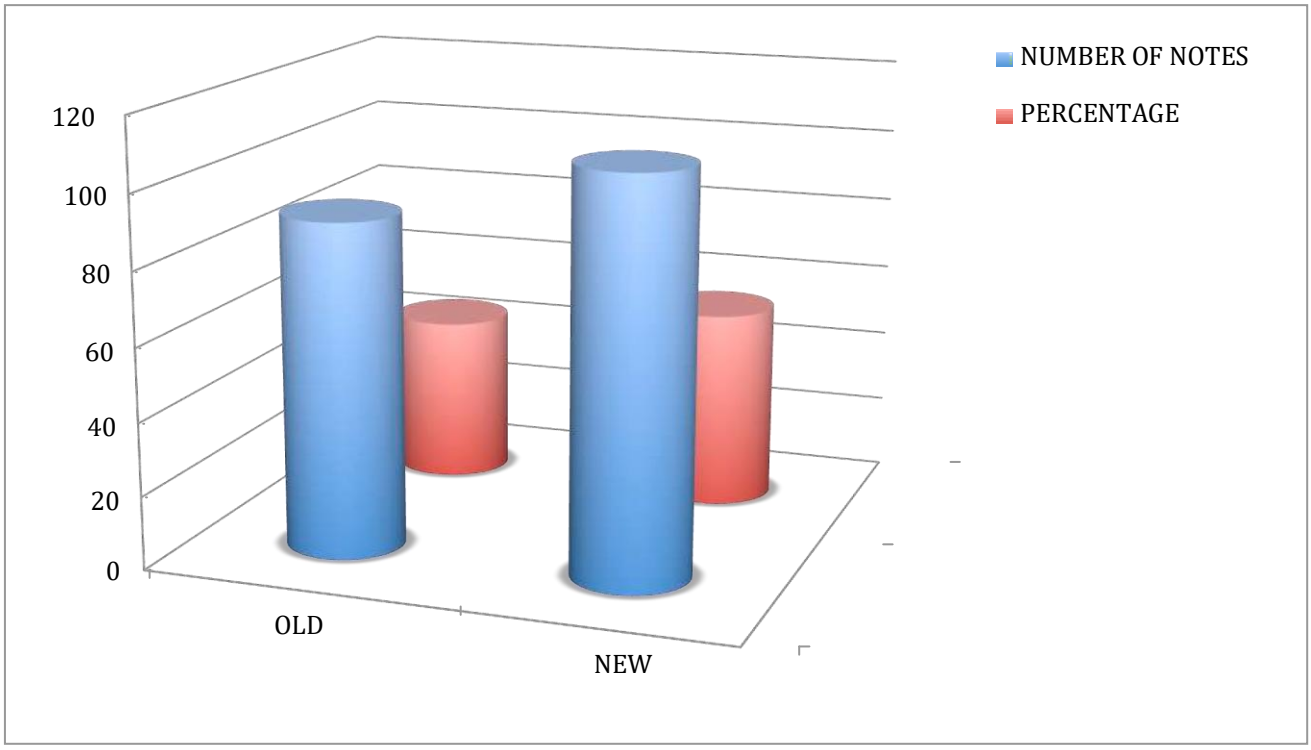

Fig. 4: Distribution of currency notes sample into old (1997-2016) and new (2016-2018): Older notes of year span 1997 to 2016 and newer notes of year span 2016 to 2018 are shown on X-axis. Number and percentage of notes are shown on Y-axis. Older notes indicate the notes generated before demonetization and newer notes indicate the notes generated after demonetization.

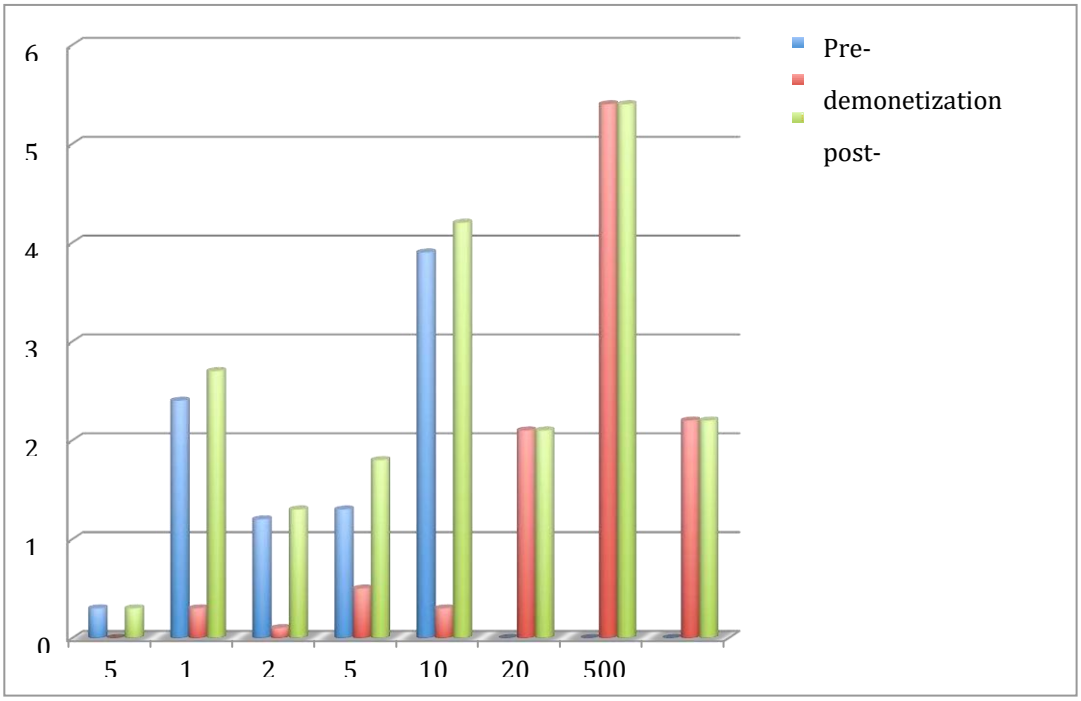

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Fig. 5: Distribution of currency notes with respect to denomination and demonetization status: In this project, 200 notes were collected of different denominations. These notes were generated before and after demonetization. So all the notes with denominations and their demonetization status are distributed in this graph.

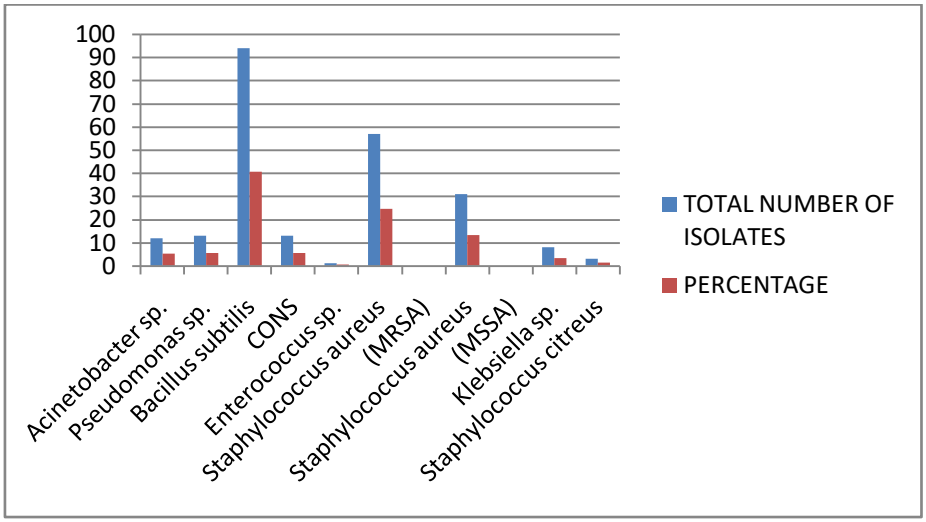

Fig 6: Number and percentage ofisolates obtained from currency notes: While working on the notes collected, we isolated different types of microorganisms. Total numbers of isolates isolated were 232. The isolates are shown on X-axis and number and percentageof isolates collected onY-axis.

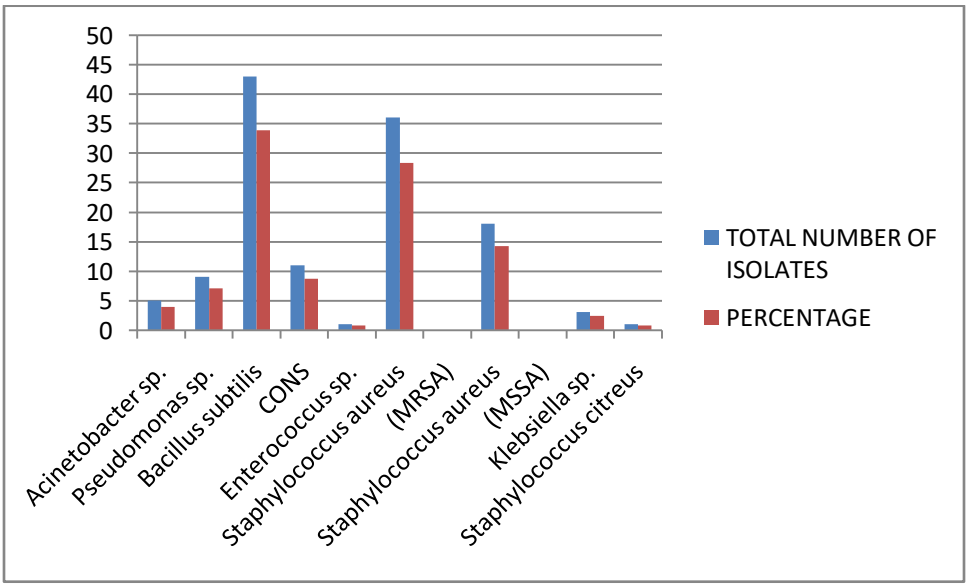

Fig. 7: Distribution of isolates on old currency notes: Out of 232, 127 isolates were isolated from old currency notes. This graph indicates all the isolates and number and percentage of isolates isolated on X-axis and Y- axis respectively.

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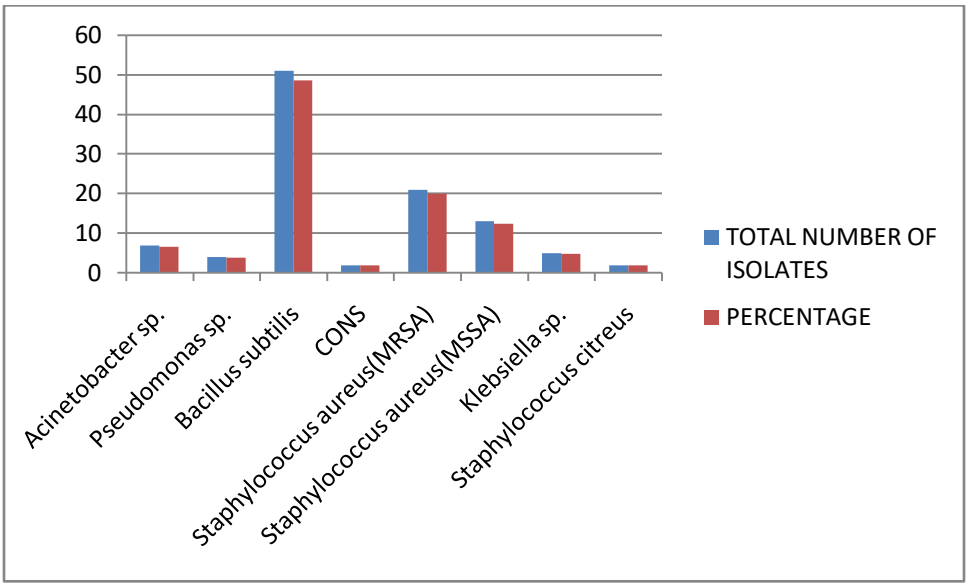

Fig. 8: Distribution of isolates on new currency notes: The remaining 105 isolates were collected from newer notes. This graph shows those isolates on X-axis and number and percentage of isolates on Y-axis.

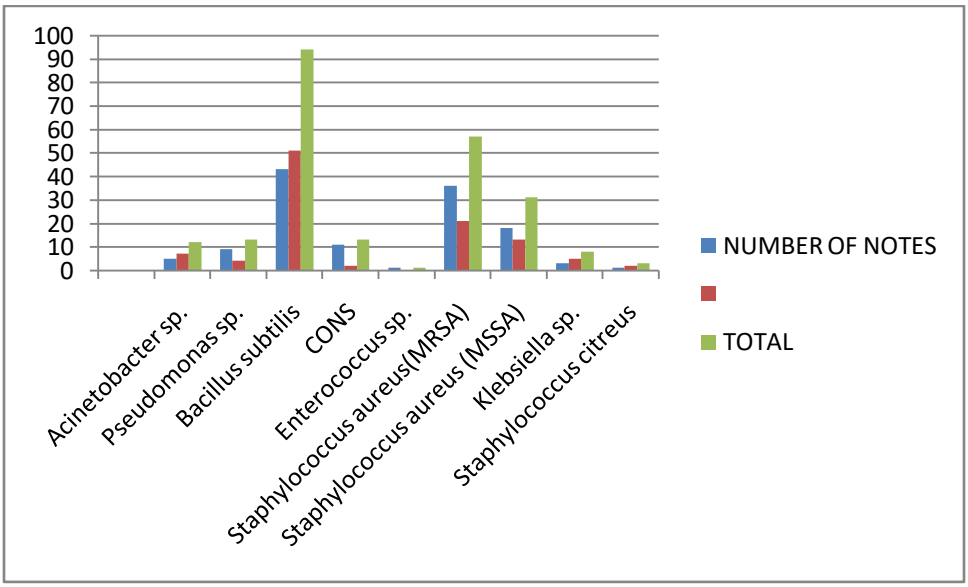

Fig. 9: Comparative study on isolates obtained from old and new currency notes: This graph compares the number and percentage of isolates collected from older and newer currency notes with the type of isolates on Y-axis and X-axis respectively.

DISCUSSION

Money or currency notes serves as a potential source for transmission of microbes from person to person. It is the most commonly handled and exchanged material making it prone to get

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contaminated. Numerous studies showing isolation of both Gram-positive and Gram-negative bacteria from currency notes are available. In the present study, contamination of newer currency notes, that is, notes in circulation after the demonetization was additionally studied to see how fast these could get infected with the microbes. Hospital being sensitive area for acquisition and spread of pathogens makes it imperative to study the potent source of infection in the hospitalenvironment.

In the present study, contamination of 200 Indian currency notes in hospital circulation, both pre and post demonetization was studied using culture method. Study included notes of various denominations and maximum number of notes 54(27%) were of the denomination '500' followed by that of '100' notes 42(21%). The notes to be included in the study were collected from different zones of hospital which included different wards, reception, billing counters, various OPDs, high risk areas like ICUs, operation theatres, dialysis unit and low risk area like bank in the hospital. Out of 200 currency notes tested, 109(54.5%) were new currency notes, which were generated after the demonetization, and these notes bore the name of present governor of RBI, Dr. Urjit Patel. Ninety-one notes (45.50%) were old notes and their year of origin varied from 1997 to 2016. All the currency notes of denominations 200, 500 and 2000 were newer notes while denominations of 100, 50, 20, 10 and 5 were mainly old currency notes, only fewer were of post demonetizationorigin.

In the current study it was observed that out of 200 currency notes 232 microbes were isolated i.e. these notes were contaminated with either single or multiple bacterial strains. In case of old currency notes all were found to be contaminated with pathogens while in case of new currency notes 101 notes out of 109 (92.66%) were contaminated with the microbes. It was found that all the currency notes obtained from the hospital bank whichwere new and yet not entered into the hospital circulation were negative for any growth. The reason for the same could be that these notes have hardly come into contact with the human hands thus preventing the contamination, again reinforcing the fact that due to handling currency notes with dirty or unclean hands microbes are transferred to the notes and provide appropriate conditions for the survival and multiplication of bacteria on the notes.

It was observed that out of 232 isolates, 127(54.75%) were obtained from 91 old currency notes while 105 (45.25%) of the contaminates were grown from new currency notes which came into general circulation following demonetization. The difference in the contamination rate of the two was found to be statistically significant. This indicated that older the currency more likely chances of it to be contaminated with one or more bacteria. The reason for higher contamination of older currency being

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that it has faced more transactions and was being handled by relatively more hands. At the same time high rate of contamination of new currency notes depicts the high pace of getting contaminated with themicrobes.

The majority of isolates were Gram-positive in nature in contrast to Gram-negative bacteria. In the present study 199 isolates of 232 were gram positive in nature. There are other studies with the similar finding of high contamination rate of currency with Gram- positive bacteria. [13, 14] The probable reason for this could be that most of the normal commensal bacteria of skin and hand are Gram-positive in nature. While transient flora can be taken care of by thorough washing but resident flora still survives on the hands. Secondly unhygienic conditions and unclean hands favor the transmission of these Gram- positive bacteria to the notes and thus acting as potential vehicle for the transfer of microbes from one individual toother.

Amongst the Gram-positive bacteria maximum number of isolates were of *Bacillus subtilis*with total of 94 out of 232 (40.52%) isolates. Other authors in their studies reported similar findings. [7, 15]*Bacillus* is frequently associated with contamination of currencynotesasitispresentubiquitouslyandbecauseofitscapabilitytoformspores,itsurvives in environment even under hardier conditions like presence of extremes of temperature and in the presence of certain disinfecting agents. Therefore currency notes left on the surfaces or shelves are likely to be infested with Bacillus.

Followed by *Bacillus* species, *Staphylococcus aureus*was the predominant isolate with 88 out of 232 isolates contributing to 37.93% of contamination rate of the currency notes by the pathogen. Out of these 88 isolates of *Staphylococcus aureus,* 57 were found to be Methicillin resistant versus 31 which were found to be sensitive to Methicillin. Categorization of *Staphylococcus aureus*into MRSA and MSSA was done on the basis of sensitivity pattern of isolate against Cefoxitin disc of strength 30 microgram. All sensitive strains were taken as Methicillin sensitive *Staphylococcus aureus*(MSSA) and cefoxitin resistant strains as Methicillin resistant *Staphylococcus aureus*(MRSA). [16]It was observed that number of Coagulase negative *Staphylococci* (CONS) isolated was less as compared to other studies where CONS dominated in the contamination rate of currency notes. [15, 17] This variation in findings could be due to the fact that present study was conducted in a tertiary care hospital that works at nominal charges from patients. Usually indoor patients are critically ill and report to this hospital after taking treatment from other places. Moreover socioeconomic status of majority of patients of the hospital is low and therefore education level is also low. This supports the

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higher rate of contamination with the more resistant strain of *Staphylococcus* rather than its counterpart. However another study conducted in Bhopal showed similar results as in our outcome i.e. more *Staphylococcus aureus*were isolated than CONS from contaminated currencynotes. [18]

In case of Gram-negative isolates, *Pseudomonas* was the predominant species followed by *Acinetobacter*and *Klebsiella*species. Many other studies have reported the similar Gram- negative isolates contaminating the currency notes. [17, 19, 20] There are other reports indicating isolation of species of *Salmonella, Escherichia* and *Proteus* as the predominant isolates. Variation in obtaining different isolates may be related to the variation in local prevalence of the isolates and the study subjects undertaken for the research. In present study *Acinetobacter*was also isolated indicating its presence in the hospital environment.

Overall resistance pattern of Gram-negative bacteria revealed that majority of the isolates were sensitive to most of the antibiotics. This pattern of susceptibility may be suggestive of the fact the isolates were perhaps not of hospital origin and could be the part of normal flora of the individual. But at the same time since these isolates have entered into hospital circulation, these may acquire resistance genes from the hospital environment posing threat to the already immuno-compromised patients of thehospital.

As for the Gram-positive isolates as discussed earlier also that high isolation rate of MRSA from the currency notes is a matter of concern. Antimicrobial susceptibility of Gram-positive isolates indicated that all the strains were sensitive to Vancomycin while majority of strains were found to be susceptible to Clindamycin. Six strains of *Staphylococcus aureus*showed presence of inducible Clindamycin resistance. About forty percent isolates were resistant to the Erythromycin. All strains of Coagulase negative *Staphylococci* were found to be sensitive to Cefoxitin, Vancomycin andClindamycin.[16]

Presence of large number of multidrug resistant Gram-positive bacteria in the hospital circulation demands attention and extensive application of infection control practices. There is need for the education of patients, patient handlers to the practice of clean hands to prevent the spread of infections.

CONCLUSION

In the present study, it is highlighted that currency notes are frequently found to be contaminated with pathogenic and non pathogenic microbes. These contaminated currency notes are major health risk factor, contributing to the nosocomial infections. Isolation of multi drug resistant bacteria from the

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currency notes throws light on the fact that these can pose a threat to already immuno-compromised patients in the hospital.

The study revealed that most Indian currency notes circulating in a teaching hospital were contaminated with *Bacillus subtilis, Staphylococcus aureus, Acinetobacter sp., Klebsiella sp., Staphylococcus citreus,* CONS, *Pseudomonas sp.,etc.* Many of the isolates (122 out of 232) were resistant to different antimicrobial drugs found out in antimicrobial susceptibilitytests.Old currency notes harbor polymicrobial flora and pose greater threat to the health ofindividuals. New currency notes also acquire microbes fast after coming intocirculation.The difference in the number of isolates obtained from new and old currency notes was found not besignificant.

It is concluded from the study that money being frequently exchanged commodity acts as an important source of infection. Whether old or new currency note , threat posed to the health stays same therefore it is recommended that awareness among general public and amongst hospital staff regarding the hand hygiene would go a long way in curtailing the spread of infection from one person to other and in hospital environment.

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