

ORIGINAL ARTICLE

Evaluation of Bacterial Contamination of Old and New Indian Paper Currency Notes

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Abstract

Background: Currency is widely exchanged for goods and services. It gets contaminated during handling. Contaminated currencies might act as fomites, playing an important role in the transmission of microorganisms. Since no level of contamination can be regarded as safe, this study was focused on bacterial contaminants of paper currency of India. **Objectives:** The present study was conducted to isolate and identify microorganisms contaminating old and new currency notes. **Methods:** This study was conducted in Department of Microbiology, GMC Akola from 10th November 2016 to 25th December 2016. A total of 400 Indian currency notes were screened for bacteriological contamination. Dividing the notes into two groups new and old, contamination was noted accordingly. **Results:** Of total 400 screened currency notes, 200 were new and 200 were old. 91.5% of old notes whereas 28% of new notes were found to be contaminated. A total 448 isolates were identified. Of the all isolates of old notes, majority (22.95%) were Coagulase negative Staphylococcus spp (CONS). While in new currency Micrococcus (64.29%) was found predominant. **Conclusion:** Money which is responsible for solving health problems can turn out to be as a cause of creating health problem. Therefore, public education on proper handling also cashless or electronic money transaction should be initiated to avoid such public hazards.

Keywords: Old currency, New currency, Bacterial contamination

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Introduction

Microorganisms are found in almost everywhere in our environment. Most of the things we use in our everyday life work as a potential carrier of pathogenic microorganisms. One such media is our paper currencies. Currency is widely exchanged for goods and services and is commonly handled by various categories of people during transaction. Although paper currency is disinfected before sent into circulation to inhibit microorganisms, pathogens are still isolated from paper currency notes because of their changing trends against disinfection.⁽¹⁾ Currency contaminated by microbes might also act as fomites, playing an important role in the transmission of microorganisms.

The contamination of the notes could also be from several sources; it could be from the atmosphere, during storage, usage, handling or production. Paper currency can be contaminated by droplets during coughing, sneezing, touching with previously contaminated hands or other materials and placement on dirty surface and clothes.⁽²⁾ An individual living in unhygienic conditions and having unhygienic habits will contaminate the notes e.g., keeping currency notes in socks, shoes and pockets, under the carpet or rugs and squeezing them in the hand frequently introduces an array of microbes to the notes. In addition, contamination of currency notes can also be traced to dust, soil, water, microflora of the body of handlers.

Various microorganisms have been isolated from money worldwide including developed countries.⁽³⁾ Accumulated data over the past two decades indicates that simultaneous handling of

paper currency and food is related to the sporadic food-borne illness cases. *Bacillus* species and *Staphylococcus aureus* have been identified as common contaminants isolated from paper currency. Antimicrobial resistance is a global phenomenon. Studies reveal many multidrug resistant bacteria to be prevalent in the currency which include methicillin resistant *Staphylococcus aureus*, methicillin resistant coagulase negative staphylococci, multi drug resistant *Escherichia coli* and *Klebsiella* species. The fact that no level of contamination can be regarded as safe, keeping this in mind this study was focused on bacterial contaminants of paper currency.

Aim

To isolate and identify microorganisms contaminating old and new currency notes.

Materials and Methods

The study was conducted in department of Microbiology over a period of one and half months from 10th November 2016 to 25th December 2016 in the demonetization phase. A total of 400 Indian currency notes were screened for bacteriological contamination. These currency notes were divided into two groups. First group included 100 of each, newly arrival, uncirculated paper currency of denomination of Rs.500 and Rs.2000 collected from banks and ATMs. While second group included 50 of each old paper currencies of denomination of Rs.10, Rs.20, Rs.500 and RS.1000 collected from hospital billing counter of Government Medical College Akola.

Bacterial isolation and identification

The two samples from each currency note were taken with sterile cotton swabs. Swabbing was done from each corner and central parts from both sides of currency. On same day first swab was directly inoculated on solid media like Blood agar and Mac-Conkey agar. Simultaneously other swab was inoculated in 1% peptone water broth and incubated at 37°C for overnight. Next morning 50µl of incubated peptone water is inoculated on solid media. The inoculated media were incubated aerobically at 35- 37°C for 24 hours and then examined for bacterial growth. The colonies were identified phenotypically by colony characteristics, Gram

staining, motility, biochemical tests as per standard microbiological techniques.

Antibiotic Susceptibility Testing

Antibiotic sensitivity testing of the bacterial isolates was performed by Kirby-Bauer method of disc diffusion susceptibility testing, modified by CLSI (Clinical Laboratory Standard Institute 2016).⁽⁴⁾

Results

Out of the 400 currency notes, 200 notes were new and 200 were old. 91.5 % of old notes were found to be contaminated; whereas 28% of new notes obtained from the bank were found to be contaminated. Growth of 212 isolates was obtained by direct swab method while growth of 236 isolates was obtained by inoculating swab in peptone water broth. A total 448 isolates were identified. Same organism from same note obtained by two inoculating methods was considered as a one organism. Thus 254 isolates were followed for antibiotic susceptibility testing. A total of 8 different species of bacteria were found. Of the all isolates of old notes, majority (22.95%) were Coagulase negative *Staphylococcus* spp (CONS) followed by *Micrococcus* (19.67%), *Klebsiella* spp (14.76%), *Bacillus* (13.11%) *E.coli* (10.38%), *Staphylococcus aureus*(8.7%), *Pseudomonas* spp (13.04%) and *Acinetobacter* spp (2.17%). While in new currency *Micrococcus* (64.29%) was the most frequently isolated bacterial species followed by CONS (21.43%) *Staphylococcus aureus* (7.14%) and *Klebsiella* spp (7.14%) given in Table 2. Of the all 21 *Staphylococcus aureus*, 7 were MRSA and of the 55 CONS, 16 were resistant to cefoxitin though none of the *Staphylococcus* isolates were resistant to vancomycin, teicoplanin and linezolid. Resistant pattern of gram positive and gram negative isolates are given in table 3 and 4.

Table 1: Isolation of bacteria in relation to physical condition of currency

Type of currency	No. of currency	Culture positives
Old	200	183
New	200	56

Table 2: Isolation of bacterial species on old currency notes of different denominations

Currency denominations	Old currency				Total
	Rs.10	Rs.20	Rs.500	Rs.1000	
No of isolates(N)	N=81	N=49	N=31	N=22	N=183(%)
CONS	22	9	6	5	42(22.95)
<i>Micrococcus</i>	16	10	6	4	36(19.67)
<i>Klebsiella</i> spp	11	8	5	3	27(14.76)
<i>Bacillus</i>	9	6	4	5	24(13.11)
<i>E.coli</i>	8	5	4	2	19(10.38)
<i>S.aureus</i>	8	5	2	2	17(9.29)
<i>Pseudomonas</i> spp	3	4	2	1	10(5.47)
<i>Acinetobacter</i> spp	4	2	2	0	8(4.37)

Table 3: Isolation of bacterial species on new currency notes

Currency denominations	New currency		
	Rs.500	Rs.2000	Total
No of isolates(N)	N=30	N=26	N= 56(%)
<i>Micrococcus</i>	21	15	36 (64.29)
CONS	6	7	13(23.21)
<i>S.aureus</i>	2	2	4(7.14)
<i>Klebsiella</i> spp	1	2	3 (5.36)

Table 4: Isolation of growth by direct swab and by swab inoculated in peptone water

Organism	Growth by direct swab	Growth by inoculated peptone water	Total number of isolates
CONS	47	54	101
<i>Micrococcus</i>	68	72	140
<i>Klebsiella</i> spp	26	30	56
<i>Bacillus</i>	24	24	48
<i>E.coli</i>	13	17	30
<i>S.aureus</i>	18	21	39
<i>Pseudomonas</i> spp	10	10	20
<i>Acinetobacter</i> spp	6	8	14
Total	212	236	448

Table 5: Resistance pattern of Gram positive bacteria

Antibiotic	<i>S.aureus</i> (21) n(%)	CONS(55)n(%)
Penicillin	4(19.05)	12(21.81)
Ampicillin	5(23.81)	14(25.45)
Cefoxitin	7(33.33)	16(29.09)
Amikacin	4(19.04)	10(18.18)
Erythromycin	3(14.28)	12(21.81)
Clindamycin	5(23.81)	11(20)
Azithromycin	3(14.28)	6(10.90)
Ciprofloxacin	3(14.28)	5(9.09)
Linezolid	0	0
Vancomycin	0	0
Teicoplanin	0	0

Table 6: Resistance pattern of Gram negative bacteria

Antibiotic	<i>E.coli</i> N=19 (%)	<i>Klebsiella</i> spp N =30(%)	<i>Pseudomonas</i> spp N=10 (%)	<i>Acinetobacter</i> spy N=8 (%)
Ampicillin	7(36.84)	15(50)	3(30)	8(100)
Amikacin	2(10.52)	4(13.33)	2(20)	3(37.5)
Piperacillin	4(21.05)	7(23.33)	2(20)	2(25)
Ceftazidime	5(26.31)	8(26.67)	3(30)	3(37.5)
Cefotaxime	3(15.78)	7(23.33)	3(30)	3(37.5)
Ciprofloxacin	6(31.57)	4(13.33)	3(30)	2(25)
Cefepime	3(15.78)	3(10)	2(20)	4(50)
Amoxyclav	10(52.63)	12(40)	4(40)	2(25)
Imipenem	1(5.26)	2(6.66)	1(10)	2(25)

Discussion

In day to day paper currency notes are poorly handled and transferred from one individual to another which transmits the microorganisms present on it. The currency notes are frequently circulated for daily activities where notes get tattered and dirty, therefore become more contaminated. Folding or crumpling of currency notes creates pouches or crevices which could harbor dust particles and microorganisms. Several studies from United States reported contamination of paper and the identification revealed the presence of pathogenic microbes. It may cause a wide variety of diseases from food poisoning, wound and skin infections, respiratory and gastrointestinal problems to life threatening diseases such as meningitis and septicemia.¹ An evidence of microbial contamination of currency notes has been reported by various researchers from Myanmar, Turkey, Australia, India and China.

Studies indicate that the age of a currency note have a direct correlation with the contamination observed (e.g., older notes had the most contamination while newer notes had the least. This finding is similar with our study. In our study 91.5% of old notes and 28% of new notes were contaminated, which was in accordance with the studies which reported 93.89 % bacterial isolates from old notes.⁽⁵⁻⁸⁾ While study carried out by Pal et al., (2013) showed that 91% of currencies were contaminated with pathogenic organisms.⁽³⁾

It has been observed that contamination rate of old currency notes of lower denominations (Rs.10-44.26%, Rs.20-26.77) were the most than the higher denomination (Rs.500-16.93%, Rs. 1000-12.01%). This finding is consistent

with previous studies.⁽⁹⁻¹²⁾ This is expected, as lower denomination notes pass through more hands than the higher denomination. The denomination notes which receive most handling and exchanged many times are more prone for contamination than other notes.

In this study, along with the non-pathogenic microorganisms, many pathogenic organisms such as *S. aureus*, *E.coli*, *Klebsiella* spp, *Pseudomonas aeruginosa*, *Acinetobacter* spp were also isolated. Non-pathogenic organisms may also cause diseases in immunocompromised people. These findings are in consistent with study carried out by Bohra et al and Sadawarte et al;^(2,10)

In the present study most of the old and new currency notes were contaminated by Gram positive bacteria than gram negative bacteria. A study done by Agarwal et al⁽¹³⁾ and other studies also revealed gram positive organisms as the predominant isolates. Gram positive bacteria can thrive more on inanimate objects like currency. Among pathogenic organism CONS (21.74%) were the most frequent organism isolated in our study, while studies done by Pawani et al; and Agarwal et al;^(3,13) observed 20.68% and 21.2% of CONS respectively. Among gram negative organisms *Klebsiella* spp (15.22%) was found in majority. This finding is similar with study by Sucilathangam⁽¹⁴⁾ where they found 31.7 % of *Klebsiella* isolates. While other studies found lower prevalence of *Klebsiella* spp. The frequency of occurrence of *Escherichia coli* in our study was (10.38%) which may indicates the presence of fecal contamination via cross-contamination with raw products or poor personal hygiene. Similar isolation rate of *E. coli* were seen in the previous studies (12.2% in Sadawarte et al; and

8.2% in Kalskar et al; ^(10, 15) The other isolates found in the present study were *Staphylococcus aureus* (9.29%) *Pseudomonas* spp (5.47%) and *Acinetobacter* spp (4.37%) which is approximately the same as reported in the previous reports.

Majority of the *CONS* strain showed sensitivity or intermediate sensitivity to most of the antibiotics used while highest resistance was seen against Ampicillin (25%). This study revealed that multidrug resistant strains of different isolates were prevalent in the currency which included methicillin resistant *S. aureus* (33.33%), methicillin resistant coagulase negative staphylococci (29.09%). This incidence is similar with other study. ⁽¹⁶⁾ Presence of multidrug resistance strain is always a threat to hospital patients. There also exists a difference of antibiotic resistance pattern between our study and other studies which can be explained by the regional variation of prevalent organisms and different antibiotic regimens used for treating those organisms. ⁽²⁾

Majority the Gram negative bacilli were resistant to Ampicillin, and were sensitive to Imipenem. 36.84 % of *E. coli* and 50% *Klebsiella* spp were resistant to Amoxycylav. These two bacteria were found to be quite sensitive to Imipenem. For other antibiotics resistance of *Klebsiella* spp to varied from 10% to Cefepime to 26% to Ceftazidime. *E.coli* was more resistant to Ampicillin (36.44%) than Amikacin (10.52%). *Pseudomonas* spp were found equally resistant to both cephalosporins and Amikacin (30%) while *Acinetobacter* spp showed 100% resistance to Ampicillin and least resistance to Imipenem.

Conclusion

Money, which is responsible for solving health problems, can turn out to be as a cause of creating health problems. From the present study it was concluded that currency notes are commonly contaminated by pathogenic and non-pathogenic organisms that represents risks and public health hazards. Therefore, public education on proper handling and care of currency should be advocated and public enlightenment campaigns on good money handling practices should be done. As we are living in electronic era cashless or electronic

money transaction should be initiated to avoid such public hazards.

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