

RESEARCH NOTE

BACTERIAL CONTAMINATION OF SAUDI "ONE" RIYAL PAPER NOTES

AK Al-Ghamdi^{1,2}, SMA Abdelmalek², MS Bamaga³, EI Azhar¹, MH Wakid¹
and Z Alsaied¹

¹Faculty of Applied Medical Sciences, King Abdulaziz University, Jeddah, Saudi Arabia; ²Department of Pharmacology and Biomedical Sciences, Faculty of Pharmacy, University of Petra, Amman, Jordan; ³Alhada Armed Forces Hospital, Taif, Saudi Arabia

Abstract. Fomites are inanimate objects that are capable of absorbing, harboring and transmitting infectious microorganisms. Paper currency, an exchangeable fomite, is constantly subjected to contamination. This study investigated bacterial contamination on the Saudi one Riyal paper note. Two hundred one Riyal bills (100 4th version and 100 5th version) were collected in the city of Jeddah for examination. The notes were examined for bacterial contamination using blood agar and MacConkey agar. Eighty-eight percent of the notes were contaminated with mixed (≥ 2 types) bacterial growth. All 4th version notes had mixed bacterial growth: gram-positive bacilli (79%), coagulase-negative staphylococci (75%), *Staphylococcus aureus* (38%), *Klebsiella* spp (21%), *Pseudomonas* spp (19%), *Escherichia coli* (9%), viridans group streptococci (VGS) (8%), and non-hemolytic streptococci (4%). Seventy-six percent of the newer 5th version notes had mixed bacterial growth: gram-positive bacilli (68%), coagulase-negative staphylococci (64%), *S. aureus* (13%), *Klebsiella* spp (9%), *Pseudomonas* spp (5%), *E. coli* (2%) and VGS (2%). These results indicate the Saudi one Riyal paper note is commonly contaminated with bacteria, and may act as a vehicle for the transmission of potentially pathogenic bacteria. The more the bill had been handled the greater the contamination was.

Keywords: Saudi Riyal, paper currency, bacterial contamination

INTRODUCTION

Money is handled by persons of varying health and hygienic standards and is stored under varying environmental and personal hygienic conditions. Paper

Correspondence: AK Al-Ghamdi, Faculty of Applied Medical Sciences, King Abdulaziz University, PO Box 80324, Jeddah 21589, Saudi Arabia.

E-mail: aalghamdi@kau.edu.sa

currency is widely exchanged for goods and services. Some gram-negative bacteria can remain as long as eleven days on coins (El-Dars and Hassan, 2005). Many coins contain copper which can hinder growth of microbes. Paper currency offers a larger surface area as a breeding ground for pathogens. Microbes may persist on it for longer periods. The older the paper note the more accumulation of microbes occurs (El-Dars and Hassan,

2005). Lower-denomination notes receive the most handling because they are exchanged more often. Money may serve as an unrecognized reservoir for pathogenic and non-pathogenic bacteria. One type of pathogenic bacteria that represents a threat is enteric bacteria (Oo *et al*, 1989). Accumulated data over the past two decades indicates simultaneous handling of paper currency and food is related to sporadic food borne illness cases (Brady and Kelly, 2000; Michaels, 2002).

Studies of the contamination of money with microbial agents is lacking in most developing countries. Shortage of information may contribute to the absence of public health policies regarding currency usage, handling, and circulation.

In Jeddah, Saudi Arabia, the minimal change handled for services, such as public transportation, buying a newspaper or daily groceries, is a one Riyal bill. Two versions of the one Riyal note are being exchanged: the 4th version issued in 1984 and the newer 5th version issued in 2007.

The current study was designed to add to the limited body of literature on bacterial contamination of currency notes and to emphasize the risks associated with microbial contamination from handling money. This study aims at investigating the status of bacterial contamination of the 4th and 5th versions of the Saudi one Riyal note.

MATERIALS AND METHODS

A total of 200 (100 4th version and 100 of 5th version) one riyal notes were collected in Jeddah city. The notes were collected from various sources, including supermarkets, minimarkets, gas stations, cafeterias and schools. Samples were obtained randomly and aseptically. These paper notes were collected with sterile

gloves and placed in sterile containers. Specimens were transported to the laboratory and each note was immediately placed in 5 ml of brain heart infusion broth.

Fifty control samples were also included. Those were new one-Riyal paper notes of 5th version obtained from different banks and never used.

Isolation of bacteria from the notes was performed using standard techniques described previously (Singh and Thakur, 2002). Briefly, each sample was placed in 5 ml of brain heart infusion broth in a sterile container, and vortexed for one minute. The total suspension of 200 µl was plated out on blood agar and MacConkey agar. The media was incubated aerobically at 35-37°C for 24 hours. Pure colonies of isolates were identified and characterized using standard microbiological techniques (Cheesbrough, 2006).

RESULTS

A total of 176 samples (88%) of the examined 200 one Riyal notes (100 of the 4th version and 100 of the 5th version) had mixed (≥ 2 types) bacterial growth. One hundred percent of the 4th version notes had bacterial contamination, of which 60% were potentially pathogenic bacteria: *Staphylococcus aureus* (38%), *Klebsiella* spp (21%), *Pseudomonas* spp (19%) and *Escherichia coli* (9%) (Table 1). The bacteria isolated from the 4th version notes were: gram-positive bacilli (79%), coagulase-negative staphylococci (75%), viridans group streptococci (VGS) (8%), and non-hemolytic streptococci (4%) (Table 2).

Seventy-six percent of the 5th version notes harbored mixed bacteria, of which 25% were potentially pathogenic bacteria (Fig 1): *S. aureus* (13%), *Klebsiella* spp (9%), *Pseudomonas* spp (5%) and *E. coli* (2%)

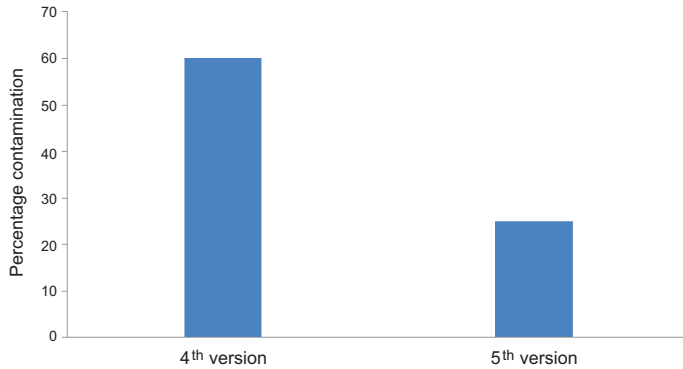


Fig 1–Percentage of bills contaminated with potentially pathogenic bacteria comparing the 4th and 5th versions of the Saudi one Riyal note.

Table 1
Comparison of potentially pathogenic bacteria on the 4th and 5th versions of the Saudi one Riyal note.

Potential pathogens	Percentage occurrence of organisms	
	4 th version	5 th version
<i>Staphylococcus aureus</i>	38%	13%
<i>Klebsiella spp</i>	21%	9%
<i>Pseudomonas spp</i>	19%	5%
<i>Escherichia coli</i>	9%	2%

Table 2
Comparison of normal bacterial flora on the 4th and 5th versions of the Saudi one Riyal note.

Bacterial flora	Percentage occurrence of organisms	
	4 th version	5 th version
Gram-positive bacilli	79%	68%
Coagulase-negative staphylococci	75%	64%
Viridans group streptococci (VGS)	8%	2%
Non-hemolytic streptococci	4%	-

(Table 1). The bacteria isolated were: gram-positive bacilli (68%), coagulase-negative staphylococci (64%) and VGS (2%). The 50 control samples had no bacterial growth.

DISCUSSION

The bacteria isolated from Saudi one Riyal notes are similar to other studies (Gökta and Oktay, 1992; Pope *et al*, 2002; Basavarajappa *et al*, 2005; El-Dars and Hassan, 2005; Rashed *et al*, 2006;

Oyero and Emikpe, 2007; Umeh *et al*, 2007; Uneke and Ogbu, 2007), suggesting contamination is a common phenomenon.

Several mechanisms have been suggested to explain the contamination: improper hand washing after using the toilet, counting paper notes using saliva, coughing and sneezing on hands then exchanging money, and placement or storage of paper notes on dirty surfaces. Microbes are then transferred from one contaminated note to other notes. Most people are not used to washing their hands after handling money. The majority of people are not aware they may be infected by pathogenic bacteria transmitted to them by handling paper currency.

Eighty-eight percent of the paper notes tested was contaminated with a variety of microorganisms, some of which were potentially pathogenic (Fig 1). These findings are similar to the results of other studies. Ninety-four percent of US one dollar bills had bacterial contamination (Pope *et al*, 2002) and 80 ± 5% of old two-Taka notes in Bangladesh had (coliform) bacteria contamination (Hosen *et al*, 2006).

Eighty-nine percent of Nigerian Naira notes studied were contaminated with

bacteria (Umeh *et al*, 2007). Other studies have shown the more paper currency stays in circulation the higher the risk of becoming contaminated. Egyptian paper notes minted in the year 2000 had more bacterial contamination than those minted in 2003 (El-Dars and Hassan, 2005). A significant direct relationship was found between the physical condition of the paper notes and bacterial contamination: the dirtier and more mutilated the note was, the more contaminated it became (Uneke and Ogbu, 2007). Our study found all (100%) of the paper notes of the old (4th) version had bacterial contamination and 76% of the newer (5th) version notes had bacterial growth.

Quantitative analysis of the microbial content on the Saudi one Riyal note revealed similar patterns of microbial contamination to those obtained during previous studies (Gökta and Oktay, 1992; Pope *et al*, 2002; Basavarajappa *et al*, 2005; El-Dars and Hassan, 2005; Oyero and Emikpe, 2007; Umeh *et al*, 2007; Uneke and Ogbu, 2007). The money collected was commonly contaminated with normal skin flora and potentially pathogenic bacteria; such as *S. aureus*, *Klebsiella* spp, *Pseudomonas* spp and *E. coli* (Tables 1, 2). Sixty percent of older 4th version notes had potentially pathogenic bacteria compared to 25% of newer 5th version notes (Fig 1). Normal skin flora isolated included gram-positive bacteria, coagulase-negative staphylococci, VGS and gram-positive bacilli (Table 2).

The presence of pathogenic staphylococci on money was expected because *S. aureus* carriers and diseased persons are common in the population (Chambers, 2001). Simple nose rubbing, coughing or sneezing could cause contamination of the notes (Oyero and Emikpe, 2007). Infection with *S. aureus* is a major problem in

hospitals, but over the past few decades the incidence of community acquired *S. aureus* infection has also increased (Chambers, 2001). Paper currency has recently been identified as a mode of transmission of community-acquired *S. aureus* in (Bhalakia, 2005). Since staphylococci have developed resistance to many antibiotics, spread of antibiotic resistant strains by paper currency is inevitable. However, in the present study no methicillin resistant *S. aureus* (MRSA) strains were detected among the isolates (results not shown).

Enteric bacteria, *Klebsiella* spp, *E. coli* and *Pseudomonas* spp, have been common isolates on paper currency in several studies (Gökta and Oktay, 1992; Pope *et al*, 2002; Basavarajappa *et al*, 2005; El-Dars and Hassan, 2005; Oyero and Emikpe, 2007; Umeh *et al*, 2007; Uneke and Ogbu, 2007). *Klebsiella* spp and *E. coli* are coliform bacteria, indicating fecal contamination. This reflects poor personal (Oyero and Emikpe, 2007). However, *Klebsiella* spp also causes respiratory infections that contribute to its presence through droplet infection. Other species isolated from the one Riyal notes included: gram-positive bacilli, coagulase-negative staphylococci, non-hemolytic streptococci and VGS. These isolates do not typically cause infections in healthy people, but have been known to cause significant infections in those with suppressed/compromised immune systems, including those infected with HIV, undergoing cancer chemotherapy or those taking other medications that suppress the immune system (Uneke and Ogbu, 2007).

The notes were collected randomly (supermarkets, minimarkets, gas stations, cafeterias and schools). The pervasive presence of these bacterial isolates reveals the majority of people are exposed to contaminated money. No samples were

collected from hospital staff (physicians, nurses) who are in contact with patients. Had such samples been collected, we speculate they would have demonstrated even more pathogenic or antibiotic resistant bacteria.

The city of Jeddah is cosmopolitan with people from various socioeconomic backgrounds interacting, and various hygienic habits being followed, which explains the level of contamination of the paper currency. There is an increasing tendency towards using credit cards which could reduce the transmission of microbes. However, the use of low denomination Riyals will continue in day to day purchasing, hence the problem will continue.

This study clearly shows the Saudi "one" Riyal note, and possibly other denominations, are contaminated with bacteria and it highlights the potential for paper money to spread pathogenic bacteria in the Saudi community. The study confirms how important it is for food handlers to refrain from handling money, since the oral cavity is a major portal for entry of pathogens. It is of paramount importance the general population, and especially food handlers, wash their hands thoroughly after handling currency and before handling food. This study also addresses the threat contaminated money poses to immune compromised individuals in hospitals and in the community. Improvement of personal hygiene standards is strongly recommended to reduce the risk of infection. The authors recommend similar studies of microbial contamination of currency be undertaken on a periodic basis, and include other pathogens, such as fungi and parasites. These studies should include investigation of the presence of antibiotic resistant bacteria and should cover professional

sectors of the community.

ACKNOWLEDGEMENTS

The authors would like to thank the Faculty of Applied Medical Sciences at King Abdulaziz University in Jeddah, Saudi Arabia, for providing the space and facilities for carrying out this study. Thanks also to Mr Fahad Labeeb, Mrs Salma Bakhsh, Mrs Baydaa Jambi and Mrs Roaa Kadam for their assistance during this study.

REFERENCES

- Basavarajappa KG, Rao PN, Suresh K. Study of bacterial, fungal, and parasitic contamination of currency notes in circulation. *Indian J Pathol Microbiol* 2005; 48: 278-9.
- Bhalakia N. Isolation and plasmid analysis of vancomycin-resistant *Staphylococcus aureus*. *J Yong Investig* 2005; 13(4). [Cited 2010 Aug 16]. Available from: URL: <http://www.jyi.org/reseasch/re.php?id=573>
- Brady G, Kelly J. The assessment of the public health risk associated with the simultaneous handling of food and money in the food industry. 2000. [Cited 2010 Apr 10]. Available from: URL: http://www.health.vic.gov.au/foodsafety/downloads/food_money_rpt.pdf
- Chambers HF. The changing epidemiology of *Staphylococcus aureus*? *Emerg Infect Dis* 2001; 7: 178-82.
- Cheesbrough M. District laboratory practice in tropical countries; Cambridge: Cambridge University Press, 2006.
- El-Dars F, Hassan WMH. A preliminary bacterial study of Egyptian paper money. *Int J Environ Health Res* 2005; 15: 235-40.
- Gökta P, Oktay G. Bacteriological examination of paper money. *Mikrobiyol Bült* 1992; 26: 344.
- Hosen MJ, Sarif DI, Rahman MM, MAK Azad. Contamination of coliforms in different paper currency notes of Bangladesh. *Pak J*

- Biol Sci* 2006; 9: 868-70.
- Michaels B. Handling money and serving ready-to-eat food. *Food Serv Tech* 2002; 2: 1-3.
- Oo KN, Win PP, Han AM, Aye T. Contamination of currency notes with enteric bacterial pathogens. *J Diarrhoeal Dis Res* 1989; 7: 92-4.
- Oyero OG, Emikpe BO. Preliminary investigation on the microbial contamination of Nigerian currency. *Int J Trop Med* 2007; 2: 29-32.
- Pope TW, Ender PT, Woelk WK, Koroscil MA, Koroscil TM. Bacterial contamination of paper currency. *South Med J* 2002; 95: 1408-10.
- Rashed T, Ghanaat J, Ghazvini K, Rashed E. Bacterial contamination of current banknotes and coins. *Med J Tabriz Uni Med Sci* 2006;
- Singh DV, Thakur K. Microbiological surveillance of currency. *Indian J Med Microbiol* 2002; 20: 53.
- Umeh EU, Juluku JU, Ichor T. Microbial Contamination of 'Naira' (Nigerian currency) notes in circulation. *Res J Environ Sci* 2007; 1: 336-9.
- Uneke CJ, Ogbu O. Potential for parasite and bacteria transmission by paper currency in Nigeria. *J Environ Health* 2007; 69: 54.