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Microbial Contamination of Currency Notes and Coins in Circulation: A Potential Public Health Hazard

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Abstract **Background:** A Paper currency note is widely exchanged for goods and services in countries worldwide and it was first developed in China. An individual living in unhygienic conditions having unhygienic habits will contaminate the notes with bacteria and these notes will act as a vehicle delivering bacteria to contaminate the hands of the next user. 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 leads to the contamination and these notes will act as a vehicle delivering bacteria to contaminate the hands of the next user. The money makes for easy transfer of microorganisms and thus cross contamination. Paper notes of currency which is handled by a large number of people, under a variety of personal and environmental conditions thus increase the possibility of acting as environmental vehicle for the transmission of potential pathogenic microorganisms. Accumulated data obtained over the last 20 years on the microbial status and survival of pathogen on currency notes indicate that this could represent a potential cause of sporadic cases of food borne illness. The lower the index values of the money, the higher the microbial contamination of the currency. They further showed that the age of the notes and the material that was used to produce the notes influence the number of microbial contamination. Lower denomination notes harbor the greatest bulk of infectious agents since they are exchanged more than higher denomination notes. Several studies have reported bacterial contamination from 60% to as much as 100% on tested paper currencies. Study conducted on India rupee, Bangladesh Teka, Iraqi and Ghanaian Currency Notes were contaminated with 100% by pathogenic or potentially pathogenic bacteria. Eighty-eight percent of the Saudi one Riyal paper note, 96.25% of Palestine banknote, 69% of Mexico, 91.1% Colombian bills, 90% of South African banknotes were contaminated with pathogenic or potentially pathogenic bacteria with mixed bacterial growth. Currency notes in circulation are contaminated with various microbial agents of which most are resistant to commonly used antibiotics and therefore represents risks and public health hazards to the community and individuals handling currency notes.

Keywords: *contamination, ethiopian currency (birr), antibiotics, resistant, sensitivity, bacterial species*

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1. Background

In ancient times, people didn't need money. They got everything they needed through bartering. In bartering, you trade something you don't need for something you do need. Thousands of years ago, the first money was commodity money. Commodities are things that everyone values enough to trade for and accept as payment. Commodity money varied from place to place, depending on what the local people valued. E.g. Shells, salt and iron nail. But many forms of commodity money were difficult to carry and could lose their value. In due course, these were replaced by coins (pieces of metal) made of gold, silver, bronze and copper and much later paper money was developed the first time in China [1,2].

Money is the most widely used and sought after service on the planet. The transfer of paper currency has been the model of economic exchange since its introduction in China circa 1000 AD [3]. In the late 1800s and early 1900s, scientists began to theorize that the transmission of money was associated with the transmission of disease [4]. Modern scientific techniques have confirmed these theories and have shown that viable pathogenic organisms (viruses, bacteria, and fungi) can be isolated on the surfaces of both paper and coin currency [5,6].

Modern banknotes are made from a special blend of cotton, linen, other textile fiber and animal gelatin for the surface coating of banknotes with small segments of fiber. The cotton/ linen/fiber combination of banknotes produce a strong bond and do not pull apart, unlike the fibers of ordinary paper. Recently many countries have been replaced banknotes from paper to plastic polymers

substrate [7]. Although the primary purpose for the development of this plastic polymers substrate was to enhance security, it has been proven that this material provides other advantages i.e. it has a higher tear resistance than paper, more resistant to folding and soiling, it is nonporous, and it does not absorb water or sweat. Given these characteristics, polymer banknotes may be cleaner than paper currency [7,8]. Studies have shown that polymer-based banknotes often have a relatively low bacterial count compared with the cotton-based 'paper' banknotes. This may be due to various physicochemical parameters of polymers [9,10].

Inanimate surfaces have often been described as the source for outbreaks of nosocomial infections. The most common nosocomial pathogens may well survive or persist on surfaces for months and can thereby be a continuous source of transmission if no regular preventive surface disinfection is performed[11]. The possibility that currency notes might act as environmental vehicles for the transmission of potential disease-carrying microorganisms was suggested in the 1970s [12]. Paper notes of currency which is handled by a large number of people increase the possibility of acting as environmental vehicle for the transmission of potential pathogenic microorganisms [13,14,15].

Research has shown that paper currency serves as an ideal breeding ground for microorganisms for several reasons. First, the paper bills offer a large surface area for organisms and organic debris to collect [16]. Secondly, folds and/or deliberate depressions or projections specifically engineered into the bills' design as anti-counterfeiting methods serve as settling sites for both organisms and debris, which allow the microorganisms to live longer [6]. Lastly, banknotes weave their way through the population for many years before they come to rest. Studies indicate that the age and denomination of a bill have a direct correlation with the contamination observed (e.g., older bills had the most contamination while newer bills had the least) [17].

An individual living in unhygienic conditions having unhygienic habits will contaminate the notes with bacteria e.g. 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 leads to the contamination and these notes will act as a vehicle delivering bacteria to contaminate the hands of the next user. The money makes for easy transfer of bacterial and thus cross contamination [6,18,19]. Physical transfer of material from hands, surfaces, and the environment can contaminate currency [6,20]. Individuals from almost every socio-economic background routinely hold and transfer paper currency. Any object that can spread communicable diseases throughout a diverse population should be considered a risk to public health. Therefore, currency has an important role in the transmission of pathogenic microorganisms and presents a moderate risk to public health.

Contamination of different objects by potential pathogenic microorganisms is of public health importance as contaminated materials can be possible sources of transmission of such pathogens. Bacteria have been shown to be spread from person to person via contact with fomites. Currency is commonly and routinely passed among individuals. Thus, bacteria could be spread on the surface of paper currency [21]. Investigator suggest that dirty currency could host harmful micro-organisms which are also deposited on currency counting machines and the counting rooms' environment thereby posing risk to customers and bankers alike [22]. Money, therefore presents a particular risk to public health, since communicable diseases can spread through contact with fomites [5,23,24,25].

Several authors have raised the concern that banknotes and coins could serve as vectors for the transmission of disease-causing microorganisms [12,26].) Microbial contaminants may be transmitted directly, through hand-to-hand contact, or indirectly, via food or other inanimate objects. As a result, hand hygiene is considered critical for preventing food outbreaks and healthcare-associated infections [27]. However, only few data are available about the types of patient care activities that are able to transmit the patient flora to healthcare workers' hands. In addition, it remains unclear how long bacteria can survive on paper or how many organisms may be transferred in a full hand-to-paper-to-hand transmission cycle [27]. Although little has been written concerning the potential of banknotes, coins and fomites to become reservoirs and vehicles for the transmission of pathogens, the data have been quietly accumulating. Here, we review the infectious potential of coins, currency notes and fomites.

1.1. Search Strategy

We searched PubMed, Web of Science, Google and Google Scholar databases for peer-reviewed, English-language articles with no date restrictions. The search terms were combinations of 'bacteria, virus, yeast, fungi, infection, transmission' and 'coins', 'currency notes', 'banknotes', 'fomites', 'dirty money', 'hands' and 'surfaces'. The literature was also searched for every pathogen identified by the previous search; for example, '*S. aureus*, hepatitis A virus (HAV) and so on'.

1.2. Persistence of Pathogens on Surfaces

Money on which pathogenic microorganisms might survive represents an often overlooked reservoir for enteric disease [28]. Quite a number of organisms bear the potentials for survival on dry fomites like currency notes. They have evolved complicated separate physiologic resting stages that give them the advantage for surviving or hibernating due to low water activity. Studies conducted in ordinary paper showed differences in length of survival depending on environmental room conditions, but were stable on paper for up to 72 hours and still cultivable after seven days [29]. Some gram-negative bacteria can remain as long as eleven days on coins and it was demonstrated that influenza virus can survive on currency notes about 3 to 17 days [30].

Important factors for the survival of pathogenic agents on surfaces are the presence of organic matter, solar irradiation, temperature and humidity [31]. A recent review reported that 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*, *Serratia marcescens* and *Shigella* spp., can survive for months on surfaces [11]. In addition, mycobacteria and *Clostridium difficile*can survive for

months, while other pathogens, such as *Bordetella pertussis*, *Haemophilus influenzae*, *Proteus vulgaris*or, *Vibrio cholera*, persist only for days [11]. *Candida albicans* can survive for up to 4 months on surfaces, whereas respiratory tract viruses, such as Coronavirus, Coxsackievirus, Influenza virus, severe acute respiratory syndrome-associated virus or Rhinovirus, can persist on surfaces for a few days [11]. Noroviruses are environmentally stable, able to survive both freezing and heating (although not thorough cooking), and resistant to many common chemical disinfectants, and can persist on surfaces for up to 2 weeks [32]. Herpes viruses persist for only a few hours to 7 days, and viruses of the GI tract, such as Astrovirus, HAV, Poliovirus and Rotavirus, persist for approximately 2 months [11].

1.3. Prevalence of Microorganisms

Two constant aspects of the studies researched show that denomination and age of a bill directly correlate with contamination. Currency notes of lower denominations were the most contaminated, presumably because lower denomination notes pass through more hands in their lifetime than the higher denomination notes [6,16]. Other studies demonstrated that the age of the currency note had a positive correlation with microbial contamination. Increased contact time is presumed to escalate contamination [33].

2. Bacteria

Studies from around the world have reported high rates of microbial contamination of currency notes in circulation [16,17,33]. Although every location contained endemic bacterium, the microorganisms most commonly isolated on money included members of the family *Enterobacteriacea*, *Mycobacterium tuberculosis*, *Vibrio cholerae*, *Bacillus* sp., *Staphylococcus* sp., *Micrococcus* sp., and *Corynebacterium* sp. [20]. Common background contaminants of paper money were environmental organisms such as gram-positive flora (especially *Bacillus* sp.) and those arising from human normal skin flora such as *Staphylococcus aureus [20]*. Developing nations have the highest rates of currency contamination. One particular study conducted in the Venda region of South Africa showed that bacteria and fungi were isolated from 96% of the used banknotes collected in the study [33], but no microorganisms were isolated from new banknotes received directly from the bank.

Several studies from the United States reported contamination of coins and paper bills and revealed the presence of pathogenic microbes like *Staphylococcus aureus*, *Escherichia coli*, and *Klebsiella enterobacter [9]*. One such study of US currency isolated 93 types of bacteria (belonging to the species *Staphylococcus*, *Streptococcus*, *Enterobacter*, *Acinetobacter*, *Pseudomonas*, *Bacillus*, Diptheroids, *Klebsiella pneumoniae*, and *Escherichia vulneris) [20]*. Thus, Microbial contamination of paper money is not only confined to developing nations.

The degree to which paper notes are contaminated is incredible. Studies in different parts of the world have reported high rates of microbial contamination of currency notes in circulation. Previous Studies conducted on India rupee [17,25], Bangladesh Teka [20], Iraqi [34] and Ghanaian [18] Currency Notes were contaminated with 100% by pathogenic or potentially pathogenic bacteria. Eighty-eight to 100% of the Saudi one Riyal paper note [35], 96.25% of Palestine banknote [36], 69% of Mexico polymer notes, [37], 91.1% Colombian bills [38], 96% of South African banknotes [33], 98% of coins and 100% of Indian currency notes [38], 75% of Nepal banknotes [19], 96.25% of Palestine [36], 95% of Nigerian currency counting machines [23] and some of the Nigerian Automated Teller Machines [39] were positive for the presence of pathogenic or potentially pathogenic bacteria with mixed bacterial growth.

The isolation of bacterial agents from currency notes in various study confirmed that currency might be a vector playing an important role in the transmission of pathogenic microorganisms in the community. Different Studies around the world shows that currency notes and coins studied were contaminated with Gram positive as well as Gram negative bacteria. The culture from the collected currency and coins yielded different types of bacterial species. For example, E. *coli*, *Proteus sp.*, *S. aureus*, *Pseuodomonas* sp., *Bacillus* sp., and *Klebsiella* sp., *were isolated from* currency notes and coins of India [17,24,40,41], Bangladesh [21], Nepal [6], Iraqi [34,42], Palestine [36], Colombia [38], Saudi Arabia [35], Ghana [13,18], Nigeria [21,34,43,44,45] and Tanzania (9). In addition, *Vibrio* sp., *Salmonella* sp., *and shigella sp., were also isolated from coins and currency notes [6,18,21,24,34,36,42,44,46]*. The source of contamination on the used notes must be from handling and use. Of particular concern was the isolation of Shigella and Salmonella from the currency, which indicated fecal contamination. This finding supports the theory that individuals who prepare food after handling contaminated currency notes have a higher risk of infecting themselves and others with food borne pathogens. *Moreover*, lower denomination currency notes showed presence for Acid fast bacilli (3.70%) [46] which is responsible for the cause for tuberculosis.

A recent study in Cameroon reported that there was a significant difference in contamination with respect to currency denomination, physical state and source. All samples from butchers and patients/personnel in hospitals were contaminated. Lower denominations showed significantly higher levels of contamination than higher denominations. Dirty currency was more contaminated than clean currency [48].

Studies in Nigeria have shown that, the Nigerian currency counting machines yielded six different bacterial species such as *Salmonella typhi*, *Staphylococcus* sp., *Escherichia coli*, *Streptococcus* sp., *Streptococcus pyogenes*, *Enterococcus* sp., *Proteus* sp. and four genera of fungi were isolated: *Aspergillus* sp., *Mucor* sp., *Rhizopus* sp. and *Penicillium* sp [23]. In addition, similar study reported that the Automated Teller Machines (ATM) is likely to be contaminated with various microorganisms due to their vast contact by multiple users. The results of the study indicated that some of the Automated Teller Machines were positive for the presence of microorganisms as indicated: *Staphylococcus auerus* 4 (28.57%), Coagulase-negative staphylococcus 3 (21.43%), *Streptococcus* species 2 (14.29%), *Pseudomonas* species 1 (7.14%), *Enterobacter* species 1 (7.14%) and *Escherichia coli* 3 (21.43%) [39].

Currencies with different denominations collected from people of various categories i.e., butchers, fish mongers, sweepers, roadside vendors, carpenters has shown the presence of various pathogenic microorganisms [41]. Most of the dirty paper currencies which were collected mainly from the butchers, sweepers & fish mongers were found to be carrying most the pathogenic microorganisms [41]. In contrast, Indian currency collected from bank, Municipal Corporation, food sellers, butchers, hospital showed that currencies used by public (bank, hospital, Municipal Corporation) were found to be extremely contaminated with various pathogenic bacteria followed by the currency used by butchers and food sellers [17].

Another study conducted in Australia showed that the lower the index values of the money, the higher the typical bacterial content of the currency. They further showed that the age of the notes and the material that was used to produce the notes influence the number of bacterial contamination [9]. Lower denomination notes harbor the greatest bulk of infectious agents since they are exchanged more than higher denomination notes [49]. In addition, a Study from Nigeria, reported that Contamination was significantly correlated with the denomination of the notes. Lower denomination notes were more contaminated than higher denomination notes [45]. This finding is supported by other studies which shows Higher denomination currency showed lower contamination [45,46].

2.1. Bacterial Pathogens of Concern

Potentially dangerous bacterial agents that have been isolated on paper currency include the following: 1. *Streptococcus* and *Staphylococcus* that have developed resistance to conventional antibiotics [6]. 2. *E. coli* is usually nonpathogenic, but some strains can cause serious (potentially fatal) food-poisoning infections [6]. 3. *Enterobacter cloacae* is associated with urinary tract and respiratory tract diseases [6]. 4. *Staphylococcus epidermidis* is usually nonpathogenic but can cause infection in patients whose immune system is compromised [6]. 5. *K. pneumoniae* is a virulent organism that can cause pneumonia, typically along with urinary tract and wound infections, particularly in immunocompromised individuals [6]. 6. *Enterobacter aerogenes* is a nosocomial and pathogenic bacterium that causes opportunistic infections in skin and other tissues [6]. 7. *Salmonella choleraesuis* can cause salmonellosis, an acute gastroenteritis with sudden onset of headache, abdominal pain, diarrhea, nausea, and sometimes vomiting [6]. 8. *S. aureus* can cause a range of illnesses, from minor skin infections such as pimples, impetigo boils, and abscesses, to life-threatening diseases such as pneumonia, meningitis, osteomyelitis, endocarditis, toxic shock syndrome (TSS), and septicemia [6]. However, other organisms like, *Micrococcus* sp., *Corynebacterium* sp., *Vibrio cholerae*, *Mycobacterium tuberculosis* and, *Shigella dysentriae* have been isolated from currency notes too [13,46]. This 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 [47] including acid fast bacilli which can cause either tuberculosis, leprosy or buruli ulcer, depending on the *Mycobacterium* species [13,46,50]. The matter of great importance (*Vulnerable Populations)* is that not only children and immunocompromised (including those with HIV, undergoing chemotherapy, or taking other medications that suppress the immune system) but also healthy people are prone to serious dangers, due to presence of different and abundant pathogens on paper notes[42].

2.2. Other Agents

In a study performed in the 1970s, various yeast and fungi were isolated from paper currency collected from laboratory personnel [21]. In addition, 118 saprophytic fungal isolates were isolated from currency notes in India [50]. More recently, fungi were isolated from both old and new currency notes in Riyadh, Saudi Arabia [51]. The most commonly isolated fungal species was *Aspergillus niger*, followed by *Aspergillus flavus*, *Candida* spp., *Penicillium* spp. and *Rhizopus* spp. [51]. In another study in India, currency notes from different occupational groups were evaluated for the presence of microbial contaminants, and fungi such as *Aspergillus niger* and *Fusarium* spp. were isolated from these currency notes, in addition to common pathogenic bacteria [51]. A recent study in Cameroon indicated that among the fungi detected, Aspergillus sp (17.3%) and Penicillium sp (15.9%) showed higher frequency of occurrence [48].

Currency notes contaminated with parasites were found in a study performed in Nigeria [53]. Notes were found to be contaminated with *Ascaris lumbricoides* (8%), *Enterobius vermicularis* (7%), *Trichuris trichiura* (3%) and *Taenia* spp. (4%) [52]. Moreover, parasitic contamination was most prevalent on dirty/mutilated notes collected from butchers, farmers and beggars [53].

Transmission of parasites may occur indirectly via inanimate objects in the surrounding environment. One of the objects most handled and exchanged by people are currency coins and banknotes, which could be one of the most potential vehicles to transmit parasites, even between countries. However, study of the potential contamination of currency in circulation with intestinal parasites has not been given the interest it deserves. It was revealed that 60.2% of banknotes and 56.6% of coins obtained from food-related workers had been contaminated with one or more parasitic species. Protozoa were the predominant parasites, with microsporidia and Cryptosporidium spp. being the most prevalent [54]. In this study, there was no statistically significant difference between currency types and the source of the currency regarding parasitological contamination, but there was a significant association between the physical condition of currency and its contamination. Banknotes with the lower denominations were more contaminated [54]. In another study in Nigeria, samples were collected from different denominations of both paper and polymer naira notes from food vendors, churches, students, beggars, and banks. Out of 640 samples examined, 400 were paper notes with 110 (27.5%) parasite contaminated on their surface, 240 were polymer notes with 14 (5.8%) found contaminated with parasites. The isolated parasites were *Entamoeba histolytica* (9%), Flagellates (3.5%) and lice (1.5%). The mutilated and very dirty notes were the most contaminated in both paper and polymer (55.6% and 12.2%) respectively. Hands examination after counting money revealed eggs of mites,

hookworm and *Taenia spp* which were only found in paper notes while in polymer no parasites were found [55]

2.3. Food borne Illness and Currency

Data accumulated during the last 20 years indicate that pathogens on currency notes could represent a potential cause of food borne illness [26]. Many food outlets rely heavily on the exchange of paper currency for their products. If the same person is handling both money and food products (especially ready-to-eat products), the risk of cross-contamination increases [56]. These findings have resulted in several changes regarding how food is prepared and handled in the food service industry. In some instances, the handling of food and money has been physically separated. In other instances, gloves are used to handle food and bare hands are used to handle the money, or vice versa. In both instances, employees of food service establishments are often observed handling money and food improperly [56].Vending operations are of particular concern (food carts, local markets, etc.), as operators often prepare, serve, and collect money from numerous patrons without properly washing their hands [33]. Association has been established between contamination and sources of currency (minibus drivers, butchers, food sellers, and banks were examined in this study), with the highest levels of contamination found among currency notes from minibus drivers (84.8%), followed by butchers (78.0%) and food sellers (62.1%). No bacterial contamination was found on new banknotes obtained from banks [6].

The agents most likely to be transmitted by food workers are HAV, Norovirus, Shigella sp., *Salmonella* sp. and *S. aureus* [57]. In a recent study, the number of bacteria on banknotes obtained from food outlets varied widely within a single country and between individual countries [9]. *Salmonella* sp., *E. coli* and *S. aureus* were isolated from the banknotes of most countries [9]. In Bangladesh, banknotes collected from fish sellers, meat sellers, vegetable sellers, food vendors and shopkeepers were contaminated with *E. coli, Klebsiella* sp., *Salmonella* sp., *S. aureus, Bacillus* sp., *Pseudomonas* sp. and *V. cholera*; the highest numbers of isolates were recovered from currencies obtained from the fish and meat sellers [58]. In Nepal, 62% of the currency notes obtained from food sellers were found to be contaminated [16], while in Kenya, banknotes collected from greengrocers, butchers, food kiosk/restaurant attendants and roast maize vendors were also highly contaminated [5]. In addition, yeast fungi, including *A. niger*, *Penicillium* spp., *Candida* spp. and *Cryptococcus* spp., were isolated from coins collected from butchers, maize roasters and food kiosk attendants in Kenya [5]. In summary, money collected from food sellers is highly contaminated, and the presence of infectious agents on banknotes or coins is indicative of poor hygiene in the person who recently handled the banknotes or coins. Moreover, the manner in which the banknotes or coins were kept in food outlets can influence the presence of these infectious agents on the currency.

2.4. Antimicrobial Resistance

Antimicrobial resistance is a global phenomenon that has resulted in high morbidity and mortality as a result of treatment failures and increased health care costs[40]. Research has shown that contaminated fomites or surfaces play a key role in the spread of bacterial infections with antimicrobial resistance. There are several investigation confirms that antibiotic resistant bacterial contaminate currency notes and might play an important role in the transmission of pathogenic microorganisms as well as in the spread of drug-resistant organisms. Currency notes in circulation are contaminated with various microbial agents (bacteria) of which most are resistant to commonly used antibiotics and therefore represents risks and public health hazards to the community and individuals handling currency notes. Study from Ghana showed varied resistance to commonly use antibiotics with *Coagulase negative staphylococci, E. faecalis and Salmonella spp.* having high resistivity of 87.5% whilst *B. cereus and P. aureginosa* showed 50% sensitivity. Isolates were 100% resistant to Ampicillin, Penicillin and Cefuroxime [18]. *Coagulase negative staphylococci (CNS), E. faecalis* and *S. pneumoniae* showed 87.5% resistance. *B. cereus* was 50% resistant, 37.7% susceptible and 12.5% intermediate to the antibiotics whilst *S. aureus* was 75.0% resistant and 25% susceptibility [18] and this investigation was supported by a similar study from Nigeria, about 75% of the isolates were resistant to the broad spectrum antibiotics and the Multi- Antibiotics resistance pattern among the bacterial isolates ranged from 7 to 11% [44]. All the bacteria isolates showed 100% resistant to Augmentin, Nitrofurantoin and amoxicillin, they had 87.5% resistant to tetracycline, chloramphenicol and streptomycin, the isolates showed 50% resistant to Ceftriazone, Cotrimoxazole and Gentamycin, 37.3% and 25.0% resistant to Ofloxacin and Pefloxacin respectively [44]. Another study from Nigeria reveals that *S. aureus and P. mirabilis* showed resistance to all the antibiotics tested. The other six bacteria showed resistance to at least three of the antibiotics [21]. Similar work by Emikpe and Oyero revealed that organisms isolated from Nigerian Naira notes were resistant to first line antibiotics [59].

Investigation in University of Uyo Teaching Hospitals (UUTHC) S. Africa, from 32 paper naira notes thirteen notes (40.6%) gave isolates of S. aureus and subsequent resistant range of between 62.5 and 100% to frequently prescribed antibiotics. The same set of isolates showed three (23.1%) to be susceptible and ten (76.9%) to be resistant to vancomycin [74]. This study was supported by Indian currency, among gram positive spp. *S. aureus* showed 100% ressistance to penicillin. Methecillin-resstant *S. aureus* (MRSA) was found to be 36.4% using cefoxitin disc. Of the gram negative bacteria isolate, *Acinetobacter spp.,citrobacter spp, klebsiella pps, Pseudomonas aeruginosa showed 100%sensitivity to gentamicin. Acinetobacter spp.Showed 100% resistance to piperacillin and 75% of the isolates were resistant to ampicillin and cefoperazon [41]*.

Paper currency notes collected from meat sellers in market places of Tanga city of Tanzania shows that 28.125% *S.aureus* isolates were multidrug resistant. *S. aureus* isolates resistant to Vancomycin also resistant to Methicillin [60]. This study supported by study conducted in Lusaka, Zambia, A total of 205 Paper currency notes were collected from restaurants and hotels and the prevalence of *S.aureus is* 25.85%. All *Staphylococcus aureus (S.aureus)* isolates showed multidrug resistance and 2.92% of Vancomycin resistance. Isolates resistant to Vancomycin were also resistant to Methicillin [61].

In Cameroon, Bacteria were susceptible (100%) to ceftriaxone, gentamicin, norfloxacin and ofloxacin. Susceptibility to amoxicillin, penicillin, ampicillin, vancomycin and cotrimoxazole was low. Staphylococci were resistant (100%) to vancomycin, penicillin G, and amoxicillin. CoNS in addition showed resistance (100%) to cotrimoxazole. (47).

2.5. Possible Prevention and Control Measures

Money can provide an indirect route for hand-to-hand contamination, and hand washing is critical after handling money if a clinical or food preparation procedure is to be performed. Many pathogenic or antibiotic-resistant bacteria have been isolated from various coins and paper money collected from medical staff and food handlers [62]. Moreover, the possibility that terrorists could contaminate banknotes with pathogens and then put those notes back into circulation has been proposed [63]. As a result, microbial testing of banknotes and replacement of contaminated notes, and the regular withdrawal of damaged notes by federal authorities is recommended. hygienic measures such as thorough hand washing with soap after using currency notes, coins and ATM machine should be observed and the practice of keeping money in shoes and socks and under the carpets should be discouraged. Further, we should avoid the use of saliva during counting of currency notes as well as desist from placing money in the mouth and biting off corners of currency notes. Moreover, ready-to- eat food sellers should be educated to avoid possible cross contamination between currency notes and the food they sell.

3. Conclusion

In this review, we show that contaminated money and coins are a public health risk when associated with the simultaneous handling of food, and currency may spread nosocomial infections. We have highlighted the potential for banknotes and coins to carry bacteria, fungi and *Parasite*, as well as their potential capacity to spread infectious agents. The currency circulating in different parts of the world could serve as a vehicle for transmission of drug resistant pathogenic or potential organisms and contamination could be due to currency usage and handling as mint notes were not contaminated. Cotton-based banknotes provide a fibrous surface, which provides ample opportunity for bacterial attachment, and the longer a paper bill stays in circulation, the more opportunity there is for it to become contaminated. *The isolation of multidrug resistant bacteria from currency notes confirms that currency plays an important role in the transmission of drug-resistant bacteria in the community.* Therefore, hygienic measures such as thorough hand washing with soap after using currency notes and ATM machine should be observed and the practice of keeping money in shoes and socks and under the carpets should be discouraged. Further, we should avoid the use of saliva during counting of currency notes as well as desist from placing money in the mouth and biting off corners of currency notes. Moreover, ready-to- eat food sellers should be educated to avoid possible cross contamination between currency notes and the food they sell.

3.1. Future Directions

The capacity of banknotes, coins and fomites to serve as sources of pathogenic agents represents a major challenge in the 21st century. It is possible that the replacement of cotton-based banknotes by substrate material can play an important role in the reduction of bacterial concentration. Our knowledge of the potential role of currency in virus transmission is limited. In some studies, the enumeration of bacterial agents was difficult because their existence was below that of a typical detection for enumeration. Concerning the presence of virus in currency, classical methods, including isolation and culture of the virus, can improve our knowledge, although frequently, the virus cannot be cultivated under laboratory conditions or the virus does not exhibit its characteristic cytopathic effects in culture.

Competing Interests

The author(s) declared no conflicts of interest with respect to the authorship and/or publication of this review article.

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