Original

Effectiveness of Various Household Methods Used to Disinfect Indian Currency Notes – A Pilot Study

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Abstract

Introduction: Paper currency, like all other materials inevitably becomes contaminated overtime. The possibility that currency notes might act as environmental vehicles for the transmission of potential pathogenic microorganisms was suggested. Disinfection is the process of elimination of most pathogenic micro-organisms (excluding bacterial spores) on inanimate objects.The aim of this study was to evaluate the effectiveness of different household disinfectants on Indian currency notes. Materials and methods: The currency notes were collected randomly from various sources in Chennai city, Tamilnadu and the polythene bags were immediately transported to laboratory of microbiology of Ragas Dental College. The collected currency notes were divided into five groups with three notes in each group. The five various household disinfectant methods like iron box, vinegar, chlorhexidine, sunlight and greenhouse effect were used and the currency notes were examined for bacterial contamination before and after disinfection. Standard loop technique was used to determine the microbial count on Indian currency notes before and after disinfection. Results: Chlorhexidine reduced 70% micro-organisms compared with only 42-45% reduction in micro-organisms present in the currency notes after treatment with sunlight and greenhouse effect. These results will help improve strategies for decontaminating Indian currency notes and thus reduce the incidence of illness caused by these pathogens. Conclusion: Chlorhexidine was the most effective disinfectant producing a greater reduction of micro-organisms than the other method of disinfection. These results will help improve strategies for decontaminating Indian currency notes and thus reduce the incidence of illness caused by these pathogens.

Introduction

Since its origination, currency has become one of the main carriers of our cultural, economic and historical information. Paper currency, like all other materials inevitably becomes contaminated overtime. The possibility that currency notes might act as environmental vehicles for the transmission of potential pathogenic microorganisms was suggested in 1970s.[1] Among the various modes of transmission of infection, fomites are susceptive for the indirect transmission of infection. Multifarious diseases like diphtheria, trachoma, gastroenteritis, whooping cough and pathogenic agents causing diarrhea are known to be transmitted through fomites.[2] Currency might also be a fomite, playing an exceptional role in the transmission of microorganisms and also in the spread of drug resistant strains in the community.

Inanimate surfaces have often been elucidated as the source for outbreaks of nosocomial infections and the most common nosocomial pathogens may well survive or persist on surfaces for months and can thereby be a perpetual source of transmission if no regular preventive surface disinfection is performed.[3] Some simple but prudent practices could save our life like handwashing which is critical after handling money. When planning on saving the paper money or coins as an investment, it is better to clean them.

Disinfection is the process of elimination of most pathogenic micro-organisms (excluding bacterial spores) on inanimate objects. Disinfection of currency is considerably important especially for people who have someone with a compromised immune system in their home, or some other reason to be extra concerned about germs. An ATM was introduced by a company Hitachi in Japan in 1990s that would sterilize bank notes by heating them to 392 degrees.[4,5] But re-contamination of notes occurred as soon as they were touched by human hands. Later few scientists developed a safer money cleaning process which superheats CO2 to 600° at 5,000 PSI[6] wherein it behaves both like a gas and liquid and is able to clean notes without damaging their anti-forgery measures.

Currency paper that is mostly made up of cotton and linen provides a large surface area for organisms and organic debris to collect,[9] playing a vital role in cross-contamination. Hence there should be regular disinfection of currency by using ultraviolet light, fumigation and regular withdrawal of damaged and wornout notes by the concerned authorities. An alternative solution to this issue which can be effective as well as less time-consuming can be use of house-hold products to disinfect currency like use of direct sunlight, greenhouse effect, vinegar, alcohol and iron box.

The purpose of this study was to compare the efficacy of some commonly used household methods for disinfection of contaminated currency notes.

Materials and Methods

A total of 15 samples of Indian currency (Rupees) were investigated. The currency notes were collected randomly from various sources in Chennai city, Tamilnadu and placed aseptically by letting the individuals to drop the paper currencies and coins into a Ziplock cover. They were promptly sealed and the individuals were given a replacement equivalent to what they deposited in the polythene bags. The polythene bags were immediately transported to laboratory of microbiology of Ragas Dental College.

The collected currency notes were divided into five groups with three notes in each group. The five various household disinfectant methods like iron box, vinegar, chlorhexidine, sunlight and greenhouse effect were used and the currency notes were examined for bacterial contamination before and after disinfection. Disinfection with iron box was done in cotton mode for 15 seconds, a cotton pellet was soaked in 5% vinegar and was applied over the currency notes, and the same method was followed for chlorehexidine also. Currency notes of sunlight were kept for 6 hours (10 am to 4 pm).

Microbiological Analysis

Standard Loop Technique

Swabs collected from each rupee note were placed in 1ml of nutrient broth separately and incubated for 15 minutes with vigorous shaking. Using standard loop (2mm), the sample from each tube were planted onto nutrient agar and incubated at 37°c for 24 hrs aseptically. The colonies were counted manually. The counted colonies were expressed in colony forming units (cfu/ml).

Results

Fifteen number of currency notes were subjected to microbiological evaluation before and after decontamination which showed that chlorehexidine group exhibited 70% reduction in microbial count after decontamination and greenhouse effect was found to be lesser effective in reducing the microbial count. Table 1 shows the mean colony forming unit per ml in each groups before and after intervention and reduction percentage.

Table 1: Distribution of mean colony forming unit per ml in each groups before and after intervention and reduction percentage

Groups	Mean±SD		Reduction Percentage
	Before Intervention	After Intervention	
Iron Box	4.09 ± .667	2.50 ± .460	53%
Vinegar	4.29 ± .241	2.76 ± .662	51%
Chlorhexidine	4.48 ±. 000	2.36 ± .318	70%
Sun Light	3.62 ± .290	2.26 ± .241	45%
Green House Effect	3.42 ± .037	2.16 ± .275	42%

Discussion

The bioreceptivity of paper currency to bacterial contamination is due to its hygroscopicity and composition like cellulose, hemicelluloses, lignin, adhesives and sizings. Hence disinfection of paper currency is a prudent precautionary measure that will ensure that contamination will not build up to the point that it becomes an exposure concern.

Despite the efficacy of the other methods of disinfection, the expected 99.9% reduction of bacterial count was not obtained with either of the household method. However, there was 70% reduction of micro-organisms with chlorhexidine induced damage. This was due to its positively-charged molecule that binds to the negatively-charged sites on the cell wall of bacteria wherein it destabilizes the cell wall and interferes with osmosis. The bacterial uptake of the chlorhexidine is very rapid, typically working within 20 seconds which is consistent with previous studies.[10]

Temperature influences the rate of metabolic activity of microorganisms and thus their rate of growth. Heat has been used for ages as a method of sterilization that helps to reduce their moisture content. On the other hand, the exposure to high temperatures can accelerate deterioration rates and cause dimensional changes on paper currency. Sunlight had been shown to kill tuberculous bacteria[11] and also E. coli bacteria in twelve feet of seawater and in waste stabilization ponds.[12,13,14]

The use of high temperatures to eliminate insect pests from heritage objects has been studied by several authors.[15] Literature shows that insect pests are killed by being exposed to 55-60°C for one hour.16 Similarly, the greenhouse effect reduced the level micro-organism but to a limited extent by the use of its latent heat.

When the currency notes were exposed to UV radiation in sunlight, it caused degradation of the genetic material of microbes by forming dimmers

between adjacent thymine nucleotides in DNA chains, which inhibited the correct replication and transcription of this nucleic acid.[11] But due to its low energy content, this kind of radiation has poor penetration power.[15] For sterilization purposes, UV light is used in the range of about 260 nm, since this is the wavelength that causes the highest damage in DNA molecules.[11]

With vinegar, it was observed that the acetic acid content in vinegar can effectively kill mycobacteria by passive diffusion through the bacteria cell wall and internalizing into neutral pH dissociating into anions and protons. Release of the protons caused the internal pH to decrease which exerted inhibitory effects on the bacteria.[16] Vinegar is used for the disinfection of semi-critical articles, control of oral and throat inflammatory processes, and antisepsis of sores.[17]

However, the antimicrobial activity of a microbicide is affected by several factors like, namely the period of contact, concentration, temperature, pH, presence of organic soiling matter and type of microorganism.[18] Knowing the pros and cons of the available methods to disinfect paper allows conscious decisions adapted to different situation.

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