RESEARCH STUDIES

INFECTION OF BANKNOTES

INVESTIGATION INTO THE PREVALENCE, PERSISTENCE AND ANTIBIOTIC RESISTANCE PROFILES OF STAPHYLOCOCCI ISOLATED FROM EURO CURRENCY

Journal of Applied Microbiology [2013] 115 (2) : 565-571 (E.M.Gabriel, A.Coffey, J.M. O'Mahony) Complete abstract : http://www.ncbi.nlm.nih.gov/pubmed/23679680

AIMS: The study set out to sample € 10 banknotes for the presence of coagulase-positive staphylococci (CPS) such as Staphylococcus aureus (S. aureus) and coagulase-negative staphylococci (CoNS) in Southern Ireland, to assess the levels of antibiotic resistance among those isolated, and determine the persistence of S. aureus on € 10 banknotes and € 2 coins.

METHODS AND RESULTS: We report that 97% of € 10 banknotes screened (n = 155) harboured multiple species of staphylococci. From the generated bank of strains, a total of 150 representative staphylococci isolates were used for further study, 71 were CPS and 79 were CoNS. Of these, we found that 62% of the staphylococci demonstrated resistance to at least one of the first-line antibiotics (52.11% of CPS isolates and 76.71% of the CoNS isolates). Resistance to multiple antibiotics was seen in 31.18% of the resistant isolates. In relation to persistence studies, S. aureus was shown to remain viable on euro banknotes and coins for significant periods (on average, 19.33 days on € 10 banknotes and 16.67 days on € 2 coins) as determined using bioluminescence.

CONCLUSIONS: We advocate the expansion of antibiotic surveillance programs, with a view to tracking/monitoring antibiotic resistance dissemination among environmental contaminants. Additionally, we propose that 'cashless transactions' should be encouraged in high-risk environments such as hospitals and healthcare settings, as well as stricter infection controls.

SIGNIFICANCE AND IMPACT OF THE STUDY: Although it is accepted that circulating currency has the potential to harbour disease-causing pathogens, studies investigating prevalence and persistence of such pathogens on euro currency are virtually nonexistent. In an attempt to rectify this, we examined the prevalence of staphylococci on € 10 banknotes in Ireland and reported relatively high levels of antibiotic resistance among the isolates. Furthermore, we have established the persistence of S. aureus on euro currency for the first time.

DIRTY MONEY: AN INVESTIGATION INTO THE HYGIENE STATUS OF SOME OF THE WORLD'S CURRENCIES AS OBTAINED FROM FOOD OUTLETS

Foodborne Pathogens and Disease [2010] 7 (12) : 1497-1502 (F.Vriesekoop, C.Russell, B.Alvarez-Mayorga, K.Aidoo, Q.Yuan, A.Scannell, R.R.Beumer, X.Jiang, N.Barro, K. Otokunefor, C.Smith-Arnold, A.Heap, J.Chen, M.H.Iturriage, W.Hazeleger, J.DeSlandes, B. Kinley, K.Wilson, G.Menz)
Complete abstract : http://www.ncbi.nlm.nih.gov/pubmed/20704502

A total of 1280 banknotes were obtained from food outlets in 10 different countries (Australia, Burkina Faso, China, Ireland, the Netherlands, New Zealand, Nigeria, Mexico, the United

Kingdom, and the United States), and their bacterial content was enumerated. The presence of bacteria on banknotes was found to be influenced by the material of the notes, and there was a strong correlation between the number of bacteria per square centimeter and a series of indicators of economic prosperity of the various countries. The strongest correlation was found with the "index of economic freedom," indicating that the lower the index value, the higher the typical bacterial content on the banknotes in circulation. Other factors that appear to influence the number of bacteria on banknotes were the age of the banknotes and the material used to produce the notes (polymer-based vs. cotton-based). The banknotes were also screened for the presence of a range of pathogens. It was found that pathogens could only be isolated after enrichment and their mere presence does not appear to be alarming. In light of our international findings, it is recommended that current guidelines as they apply in most countries with regard to the concurrent hygienic handling of foods and money should be universally adopted. This includes that, in some instances, the handling of food and money have to be physically separated by employing separate individuals to carry out one task each; whereas in other instances, it could be advantageous to handle food only with a gloved hand and money with the other hand. If neither of these precautions can be effectively implemented, it is highly recommended that food service personnel practice proper hand washing procedures after handling money and before handling food.

PAPER MONEY AND COINS AS POTENTIAL VECTORS OF TRANSMISSIBLE DISEASE

Future Microbiology [2014] 9 (2) : 249-261 (E.Angelakis, E.I.Azhar, F.Bibi, M.Yasir, A.K.Al-Ghamdi, A.M.Ashshi, A.G.Elshemi, D.Raoult) Complete abstract : http://www.ncbi.nlm.nih.gov/pubmed/24571076

Paper currency and coins may be a public health risk when associated with the simultaneous handling of food and could lead to the spread of nosocomial infections. Banknotes recovered from hospitals may be highly contaminated by Staphylococcus aureus. Salmonella species, Escherichia coli and S.aureus are commonly isolated from banknotes from food outlets. Laboratory simulations revealed that methicillin-resistant S.aureus can easily survive on coins, whereas E.coli, Salmonella species and viruses, including human influenza virus, Norovirus, Rhinovirus, hepatitis A virus, and Rotavirus, can be transmitted through hand contact. Large-scale, 16S rRNA, metagenomic studies and culturomics have the capacity to dramatically expand the known diversity of bacteria and viruses on money and fomites. This review summarizes the latest research on the potential of paper currency and coins to serve as sources of pathogenic agents.

MONEY AND TRANSMISSION OF BACTERIA

Antimicrobial and Resistance Infection Control [2013] 2 (1) : 22 (H.Gedik, T.A.Voss, A. Voss) Complete abstract : http://www.ncbi.nlm.nih.gov/pubmed/23985137

Money is one of the most frequently passed items in the world. The aim of this study was to ascertain the survival status of bacteria including Staphylococcus aureus, Escherichia coli, and Vancomycin-Resistant Enterococci (VRE) on banknotes from different countries and the transmission of bacteria to people who come in contact with the banknotes. The survival rate was highest for the Romanian Leu yielding all three microorganisms used after both three and six hours of drying. Furthermore, the Leu was the only banknote to yield VRE after one day of drying. Other currencies either enabled the survival of Extended-Spectrum Beta-Lactamases

(ESBL) and VRE (e.g. Euro), but not of MRSA, or the other way round (e.g. US Dollar). While a variety of factors such as community hygiene levels, people's behaviour, and antimicrobial resistance rates at community level obviously have influence on the transmission of resistant microorganisms, the type of banknote-paper may be an additional variable to consider.

MICROBIAL CONTAMINATION IN 20-PESO BANKNOTES IN MONTERREY

Journal of Environmental Health [2012] 75 (2) : 20-23 (J.Rocha-Gámez, P.N.Tejeda-Villarreal, P.Macías-Cárdenas, J.Canizales-Oviedo, E.Garza-González, E.G.Ramírez-Villarreal) Complete abstract : http://www.ncbi.nlm.nih.gov/pubmed/22984731

The authors' aim was to isolate and identify bacteria or yeast that may be present on the surface of 20-peso banknotes from the metropolitan area of Monterrey, Mexico. They randomly studied a total of 70 20-peso banknotes for the presence of bacteria and species of Candida by conventional methods. Out of the 70 banknotes, 48 (69%) were found to be contaminated. The most prevalent species observed was Candida kruseii (19 bills, 27%) followed by Burkholderia cepacia (9 bills, 13%); 22 (31%) bills showed no growth. Of the 48 contaminated bills, four (5.7%) yielded bacteria considered pathogenic and the other 44 bills (63%) yielded bacteria considered potentially pathogenic. Eleven bills showed more than one microbial species. The results of the authors' study show that contamination occurs on paper currency in the metropolitan area of Monterrey. The authors' findings provide evidence that currency banknotes may represent a threat to human health.

SURVIVAL OF INFLUENZA VIRUS ON BANKNOTES

Applied and Environmental Microbiology [2008] 74 (10) : 3002-3007 (Y.Thomas, G.Vogel, W.Wunderli, P.Suter, M.Witschi, D.Koch, C.Tapparel, L.Kaiser) Complete abstract : http://www.ncbi.nlm.nih.gov/pubmed/18359825

Successful control of a viral disease requires knowledge of the different vectors that could promote its transmission among hosts. We assessed the survival of human influenza viruses on banknotes given that billions of these notes are exchanged daily worldwide. Banknotes were experimentally contaminated with representative influenza virus subtypes at various concentrations, and survival was tested after different time periods. Influenza A viruses tested by cell culture survived up to 3 days when they were inoculated at high concentrations. The same inoculum in the presence of respiratory mucus showed a striking increase in survival time (up to 17 days). Similarly, B/Hong Kong/335/2001 virus was still infectious after 1 day when it was mixed with respiratory mucus. When nasopharyngeal secretions of naturally infected children were used, influenza virus survived for at least 48 h in one-third of the cases. The unexpectedstability of influenza virus in this nonbiological environment suggests that unusual environmental contamination should be considered in the setting of pandemic preparedness.