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Efficacy of Copper and Silver as Anti-Viral and Anti-Microbial Agents in the Health Care System

The evolution of new and reemerging historic virulent strains of respiratory viruses from animal reservoirs is a significant threat to human health. Inefficient human-to-human transmission of zoonotic strains may initially limit the spread of transmission, but an infection may be contracted by touching contaminated surfaces. Enveloped viruses are often susceptible to environmental stresses, but the human coronaviruses responsible for severe acute respiratory syndrome (SARS) and Middle East respiratory syndrome (MERS) have recently caused increasing concern of contact transmission during outbreaks. Human coronavirus 229E was rapidly inactivated on a range of copper alloys (within a few minutes for simulated fingertip contamination) and Cu/Zn brasses were very effective at lower copper concentration. Exposure to copper destroyed the viral genomes and irreversibly affected virus morphology, including disintegration of envelope and dispersal of surface spikes. Cu(I) and Cu(II) moieties were responsible for the inactivation, which was enhanced by reactive oxygen species generation on alloy surfaces, resulting in even faster inactivation than was seen with nonenveloped viruses on copper. Consequently, copper alloy surfaces could be employed in communal areas and at any mass gatherings to help reduce transmission of respiratory viruses from contaminated surfaces and protect the public health [1].
Destruction of human coronavirus viral genome on copper and copper alloy surfaces. (A) Analysis of a small fragment (136-bp region of the nsp4 gene) of the coronavirus genome revealed a reduction in copy number from virus exposed to copper and cartridge brass surfaces in reverse transcriptase real-time PCR. There was some reduction on stainless steel but none in viral suspension (lightest gray bars), suggesting that this was due to sample drying. (B) Analysis of the entire viral genome is represented in electrophoretic separation of viral RNA extracted from virus exposed to copper (lanes 1, 4, and 7), cartridge brass (lanes 2, 5, and 8), and stainless steel (lanes 3, 6, and 9) for 0 min (lanes 1 to 3), 120 min (lanes 4 to 6), and 240 min (lanes 7 to 9). The genomic RNA from virus exposed to copper and brass degraded with increased contact time. This did not occur on stainless steel; the genomic RNA remained as fragments too large to pass through the gel. However, the total amount of intact RNA was reduced at 4 h, possibly due to drying damage as seen in panel A. Lane 10 represents untreated virus, and the unmarked lane is a Bioline marker (Hyperladder I). The same procedure was used with mock-infected cells, revealing the same pattern of RNA breakdown following application to copper surfaces (not shown) [1].

Novel human coronavirus that is now named severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2) (formerly called HCoV-19) emerged in Wuhan, China, in late 2019 and is now causing a pandemic. The stability of SARS-CoV-2 and SARS-CoV-1 in aerosols and on various surfaces and estimated their decay rates was evaluated. SARS-CoV-2 was more stable on plastic and stainless steel than on copper and cardboard, and viable virus was detected up to 72 hours after application to these surfaces [2].
Viability of SARS-CoV-1 and SARS-CoV-2 in Aerosols and on Various Surfaces [2].
Influenza A virus is responsible for numerous hospitalizations. In addition, hospitalized patients with weakened immune systems are susceptible to influenza infection. Influenza A is a viral pathogen that causes significant mortality and morbidity in the elderly and other groups at high risk [3]. These researchers also reported that copper samples inactivated 75% of influenza A (H1N1) in 1 hr and almost 100% after 6 hr. Viruses are referred to as obligate parasites. Thus, they can’t complete their life cycle without exploiting a suitable host and thus are not considered to be alive. They contain a set of instructions that, when introduced into the host, can generate pathobiological consequences. However, copper alloys can inactivate influenza A [3] and thus may have the potential to significantly decrease its pathobiological consequences [4].

Copper dents the crown-shaped virus and then slowly releases ions that interact with oxygen and generate free radicals, or uncharged molecules that typically are highly reactive. Those free radicals create a figurative grenade that goes off and destroys the virus’ RNA. When copper-silver ionization units are inactivated, residual protection may be sustained for several months, whereas cleaning does not provide the same possibility [5]. Copper seems to be better and more proven than silver, especially considering that Copper works dry, where silver needs to be made wet to be effective. High humidity (>90% RH) and high temperature (35°C) utilized in Japanese Industrial Standard (JIS Z 2801) produced measurable efficacy in a silver ion-containing material, it showed no significant response at lower temperature and humidity levels typical of indoor environments [6].

The effectiveness of alloys made of copper have been shown in a variety of health care applications demonstrating anti-microbial and anti-viral properties. In one study Schmidt demonstrated a 99% reduction of live bacteria in a laboratory test [4]. Similarly in a clinical trial, 83% reduction of live bacteria was observed, compared to standard materials used for hospital surfaces [4].
The use of copper has been shown to reduce healthcare acquired infections (HAIs), especially in intensive care units (ICU) [7], [8], [9], [10], [11]. HAIs were reduced from 0.081 to 0.034 (P=.013) [7]. Similar results were observed in reducing HAIs in a pediatric ICU on 3 surfaces [8]. The introduction of copper was found to suppress the microbial burden recovered from objects assess in the control rooms by 73%.

Copper surfaces were consistently able to limit the concentration of bacteria associated with commonly touched surfaces within the PICU and PIMCU. The antimicrobial consistency of copper surfaced objects was assessed by determining the frequency at which bed rails, cradles, or faucet handles fabricated from U.S. Environmental Protection Agency-registered antimicrobial copper alloys were able to limit the concentration of bacteria associated with those surfaces to <500 CFU/100 cm². The frequency that the microbial burden was below the limit of detection (green bars), above the limit of detection but less than the risk threshold (<500 CFU/cm²; yellow bars), or exceeded the risk threshold (>5 CFU/cm²; red bars) was determined by scoring the number of occasions that the ACC for individual samples from both the PICU and PIMCU was observed (N ≥ 460 copper arm; N ≥ 446). The limit of detection for the bed rails was 30 CFU/100 cm²; cradles, 30 CFU/100 cm²; and faucet handles, 30 CFU/100 cm². ACC, aerobic colony forming units; CFU, colony forming units; PICU, pediatric intensive care unit; PIMCU, intermediate intensive care unit [8].
References


