Influence of chlorides and phosphates on the antiadhesive, antibacterial, and electrochemical properties of an electroplated copper-silver alloy

Antimicrobial surfaces such as copper alloys can reduce the spread of pathogenic microorganisms, e.g., in healthcare settings; however, the surface chemistry and thus the antibacterial activity are influenced by environmental parameters such as cleaning and disinfection procedures. Therefore, the purpose of the present study was to assess how copper-complexing compounds (chlorides and phosphates), common to the clinical environment, can affect the surface chemistry and the antiadhesive and antibacterial properties of a newly developed antibacterial copper-silver alloy and the single alloying metals. The authors demonstrated that the antiadhesion efficacy against S. aureus 8325 was the highest when the copper-silver alloy and copper surfaces (four- and two-log bacterial reduction compared to stainless steel controls, respectively) were exposed to chloride-containing suspensions. This was explained by the electrochemical activity of copper that dissolved as Cu+, highly toxic to the bacterial cells, in the presence of Cl- and eventually formed a chlorine- and oxygen-rich layer with the incorporation of phosphorus, if also phosphates were present. If chlorides were omitted from the wet environment, there was no difference (P > 0.05) in bacterial counts on copper-silver alloy, copper, silver, and AISI 316 stainless steel control surfaces, due to the fact that no oxidizing conditions were established and therefore there was no dissolution of copper ions from copper-silver alloy and copper surfaces. However, under dry conditions, copper-silver alloy and pure copper surfaces were antibacterial also in the absence of chlorides, suggesting a marked difference between dry and wet conditions in terms of the interactions between surfaces and bacteria. The authors conclude that an attentive design of control policies integrating disinfection interventions and antimicrobial surfaces, such as the copper-silver alloy coating, can be a beneficial solution in fighting the spread of antibiotic resistant bacterial strains and potentially reducing the number of disease outbreaks.