The in-vitro antibacterial activity of nanocrystalline silver dressings against bacteria with NDM-1 carbapenemase

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Purpose
Carbapenems are among the most powerful antibiotics available, and often are used to treat infections due to otherwise multiresistant gram-negative bacteria. The emergence of carbapenem resistance is therefore deeply disturbing, since there are few antibiotics in reserve behind the carbapenems. Enzymes that cause resistance to these antibiotics, carbapenemases, have appeared in bacteria such as Escherichia coli, Enterobacter spp., and Klebsiella spp., particularly K. pneumoniae, which account for the majority of opportunistic Gram-negative infections. These enzymes include New Delhi metallo-ß-lactamase 1 (NDM-1), which is frequently isolated in India and Pakistan and which is being imported into Europe. Most bacteria with NDM-1 are broadly resistant to ß-lactam and non-ß-lactam antibiotics, creating major treatment difficulties when patients have severe infections. The bacteria carrying these enzymes can cause opportunistic infections in hospital patients, with common infection sites including the blood, urinary tract, lungs and wounds.

Enterobacterial carbapenemases are plasmid mediated and can spread among bacterial strains and species. Little is known however regarding the resistance of bacteria with these enzymes to silver compounds. This study investigates the antibacterial efficacy of nanocrystalline silver dressings versus a collection of NDM-1 producers.

Methods
Five isolates with NDM-1 enzymes (Acinetobacter baumannii, Citrobacter freundii, Enterobacter spp., Escherichia coli and Klebsiella pneumoniae) were tested (in triplicate) against three wound dressings containing nanocrystalline silver in comparison to a non-antimicrobial control.

Dressing samples (2cm x 2cm) were inoculated with 0.5 ml volumes of 1x10^7 cfu/ml inoculum and incubated at 37°C for 0, 0.5, 2 and 4hrs. At each sampling time, the silver activity of each dressing was arrested using STS neutraliser solution (0.85% sodium chloride, 1% Tween 20 and 0.4% sodium thiglycollate). The surviving bacteria in complete samples at these intervals were enumerated by Miles and Misra counts, with log reductions in viable organisms calculated, compared with the 0 h control samples.

Results
All 3 nanocrystalline silver dressings achieved log reductions of $>4$ log_{10} cfu/sample within 30 min for all 5 strains (Figure 3). This activity was maintained for all dressing types at 2 and 4 hours. There was no reduction in count by the non-antimicrobial control.

Conclusions
Resistance to ß-lactam and non-ß-lactam antibiotics creates major treatment difficulties when patients have severe infections. The fast interventional activity of nanocrystalline silver dressings against bacteria with NDM-1 enzymes, demonstrated in this study, show these products may be relevant to preventing wound infections with these highly resistant bacteria.

References

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