A nanocomposite wound dressing with potential to sustain active chlorhexidine on a wound bed.

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INTRODUCTION

Chronic wounds are susceptible to infection and are increasing in prevalence. 14 days application of topical antiseptic is the initial recommended treatment.[1] An antiseptic eluting wound dressing which could deliver active antiseptic to the wound bed over two weeks would greatly aid in this bioburden management.

Chlorhexidine (CHX) is a topical antiseptic widely used in wound care due to its broad spectrum antimicrobial effect, rapid mechanism of action and low cytotoxicity.[2]

The purpose of this study is to investigate the feasibility of encasing novel antiseptic CHX-hexametaphosphate nanoparticles (CHX-NPs)[3] within an alginate matrix – widely used in wound dressings – to provide a sustained release of CHX and the impact this may have on the bioburden of a chronic wound.

EXPERIMENTAL METHODS

CHX-NPs synthesis[3]

10 mM aqueous solutions of CHX digluconate and sodium hexametaphosphate were combined (1:1 ratio).

CHX-NPs alginate nanocomposite

Powdered alginate was dissolved in the diluted CHX-NPs to give doping of 6, 3 & 0 wt%. These solutions were cast (55g alginate per m^2), and the water allowed to evaporate (RT, 3 days). These thin films were cross-linked in $CaCl_{2\ (aq)}$ (0.18 M) for 25 min, washed with distilled water and air dried. Disks (ø =10 mm) were cut from this material and used in subsequent work.

CHX elution

One alginate disk was immersed in distilled water (2.25 mL) and the [$CHX_{(aq)}$] monitored (λ = 255 nm) over two weeks (n=15 for each CHX-NPs doping; 6, 3 & 0 wt%).

Microbial growth inhibition

Single alginate disks were placed on an agar plate seeded with a bacterium (methicillin-resistant *S. aureus* (MRSA), *P. aeruginosa*, *E. coli*, *K. pneumoniae* or *A. baumannii*) by the spread plate method. The zone of inhibition was measured following 24 h incubation at 37°C (n=9 for each CHX-NPs doping; 6, 3 & 0 wt%).

Bioluminescent imaging[4]

Single alginate disks were placed on a petri dish seeded with *E. coli*, modified with the *Photorhabdus luminescens lux* operon, by the spread plate method. Light output across the petri dish was recorded for 16 h using an Andor iXon EM+ DU-897 back-illuminated EMCCD camera with a Tamron SP AF 17-35 mm F/2.8-4 lens.

RESULTS AND DISCUSSION

CHX elution was sustained over two weeks with the material tailorable with respect to delivery dose (Fig 1).

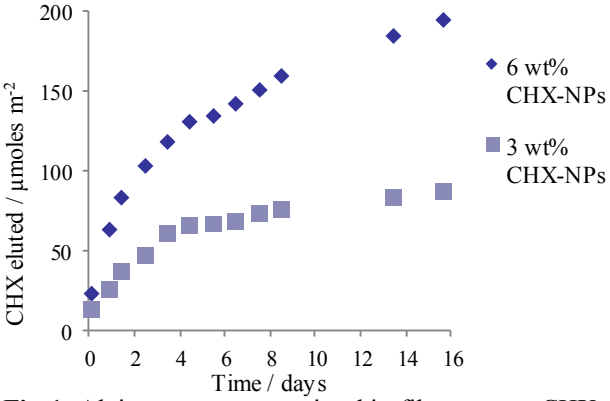

Fig 1. Alginate nanocomposite thin films at two CHX-NPs dopings sustain CHX elution for two weeks.

The initial CHX release (25.5 & 62.6 µmoles m^{-2} for 3 & 6 wt% CHX-NPs respectively at 21 h) was found to be effective against five common wound infecting microorganisms (Fig 2).

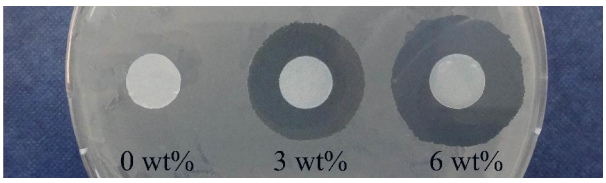

Fig 2. Inhibition zones (MRSA) produced by alginate thin film disks (ø =10 mm) containing a wt% CHX-NPs

Video imaging of bioluminescent *E. coli* allowed visualisation of the antiseptic effect in real time *in situ*.

CONCLUSION

CHX-NPs impregnated alginate facilitates the tailorable release of antiseptic at therapeutic concentrations, effective against common infecting microorganisms. *In vitro* cytotoxicity studies are planned on fibroblast cell lines which will provide an indication of any effect upon the healing pathways of a wound.

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