Determination of the microbiological performance of a nanocrystalline silver dressing and silver-containing hydrofiber in a 7 day repeat challenge assay

Kiersten Driffield, Emma Woodmansey, Jessamine Walter and Helen Floyd; Smith & Nephew Research Centre, York, United Kingdom

Introduction

Why are silver dressings important?
Silver is a broad spectrum anti-microbial with efficacy against bacteria, fungi and yeast[3].

There are many different silver dressings that claim clinical efficacy in the management of burns, chronic wounds and problematic surgical wounds.

Understanding the effect of clinically relevant media on silver-containing dressings and how this may influence their antimicrobial performance is limited.

What do clinically relevant fluids contain?
Clinically relevant fluids such as wound fluid are complex and contain excess levels of chloride ions, in addition to molecules such as sugars and proteins.

In this study, a complex release media composed of 50% Foetal Calf Serum and 50% physiological saline (0.9% NaCl) was used to reflect the composition of wound exudate as it contained similar levels of proteinacous material and physiological levels of chloride.

Are silver dressing effective in clinically relevant fluids?
A key question surrounding silver-containing dressings is whether they are truly effective when they are in contact with clinically relevant physiological fluids

This question is often driven by the concept of the chloride barrier, which infers that the excess levels of chloride ions will react with the available silver to form silver chloride, rendering the dressings inactive. In addition, the sugars and proteins in wound fluid will also influence dressing performance.

This study determined the antimicrobial activity of ACTICOAT° 7 and Aquacel™ Ag in a simulated wound fluid, using a log reduction method.

Methods

Bacteria
Pseudomonas aeruginosa, *Staphylococcus aureus* and epidemic methicillin resistant *S. aureus* (EMRSA-15) were tested in a 7 day repeat challenge assay.

Dressings
ACTICOAT 7 (nanocrystalline silver dressing), Aquacel™ Ag (silver-containing hydrofiber dressing) and their non-active controls (Aquacel™ and 7 layer Delnet/Sontara) were prepared as 24mm discs and challenge in this assay.

Repeat challenge assay

Each test dressing was placed into cell strainers composed of a nylon mesh with 80mm holes. The cell strainers containing the dressings were then placed into 60mm petri-dishes.

10 ml of fresh complex media containing 1 x 10^7 cfu/ml of test bacteria were added to each petri-dish containing the cell strainers and test dressings.

Cell strainers and dressings were left in place for 30 seconds before being transferred. The remaining media was used as time 0 hrs.

Cell strainers and dressings were transferred into new petri-dishes containing another 10mls of fresh complex media and 1 x 10^7 cfu/ml of bacteria every 24 hrs for 7 days. Dressings were incubated at 32°C with gentle shaking.

At each time point 1 ml of the resulting media was processed to determine the number of viable bacteria. This was achieved by neutralising silver activity and numerating the number of bacteria present.

Results

Mean bacterial log reductions over the 7 day period achieved by each dressing are shown in Figure 1 and Table 1.

Both ACTICOAT 7 and Aquacel Ag achieved log_{10} reductions against *P. aeruginosa*, *S. aureus* and EMRSA-15 on day 1; however Aquacel Ag achieved limited log_{10} reductions against EMRSA-15 (Table 1).

Aquacel Ag did not achieve any log_{10} reductions greater than 0.36 from day 2 onwards (Figure 1) with bacterial counts similar to those in the presence of the non-silver controls.

ACTICOAT 7 continued to demonstrate sustained antimicrobial activity over the 7 day period against all three bacterial strains, achieving greater log reduction than Aquacel™ Ag at all time points (Figure 1 and Table 1).

SEMs of Aquacel™ Ag after the 7 day repeat challenge assay (Figure 1) show bacterial aggregates attached to the dressing's fibres and matrix indicating biofilm formation within the dressing.

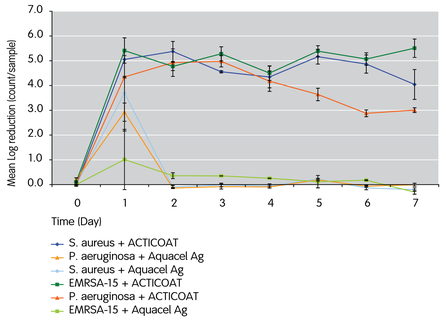


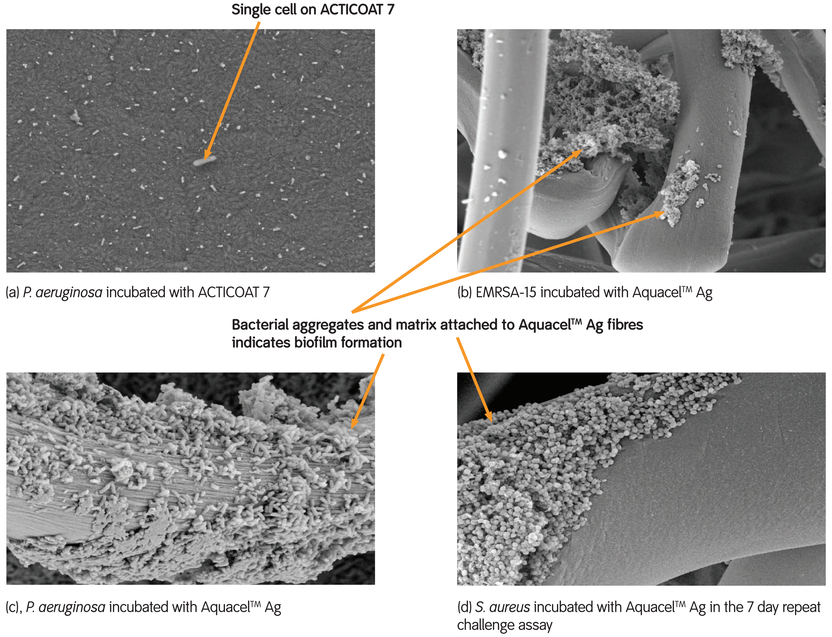
Figure 1. The antimicrobial performance of ACTICOAT 7 and Aquacel™ Ag in a 7 day repeat challenge assay against *S. aureus*, *P. aeruginosa* and EMRSA-15 measured by log reduction.

Results are expressed as mean log_{10} reduction cfu/ml per sample ± standard deviation.

Log Reduction Day	Day 1	Day 1	Day 2	Day 3	Day 4	Day 5	Day 6	Day 7
*S. aureus** + ACTICOAT	-0.01	5.05	5.37	4.55	4.34	5.16	4.87	4.04
*S. aureus** + Aquacel™ Ag	0.00	3.69	-0.09	-0.02	-0.06	0.22	-0.14	-0.20
EMRSA-15 + ACTICOAT	0.11	5.41	4.77	5.28	4.50	5.39	5.07	5.51
EMRSA-15 + Aquacel™ Ag	0.00	1.01	0.36	0.35	0.26	0.12	0.18	-0.30
*P. aeruginosa** + ACTICOAT	0.01	4.35	4.92	4.98	5.05	3.64	2.88	3.01
*P. aeruginosa** + Aquacel™ Ag	0.21	2.92	-0.14	-0.08	5.05	0.19	-0.07	0.00

Table 1. Summary of the mean log_{10} reductions (log_{10} cfu/sample) achieved by ACTICOAT 7 and Aquacel™ Ag against *S. aureus*, *P. aeruginosa*, and EMRSA-15 over 7 days.

Figure 2. SEMs of (a) *P. aeruginosa* incubated with ACTICOAT 7, (b) EMRSA-15 incubated with Aquacel™ Ag (c), *P. aeruginosa* incubated with Aquacel™ Ag and (d) *S. aureus* incubated with Aquacel™ Ag in the 7 day repeat challenge assay.



(a) *P. aeruginosa* incubated with ACTICOAT 7

(b) EMRSA-15 incubated with Aquacel™ Ag

(c), *P. aeruginosa* incubated with Aquacel™ Ag

(d) *S. aureus* incubated with Aquacel™ Ag in the 7 day repeat challenge assay

Conclusions

ACTICOAT 7 maintained an antimicrobial activity of at least 3 log_{10} reductions (exception of day 6 for *P. aeruginosa* which achieved a 2.8 log reduction) demonstrating sustained bactericidal activity[2].

Aquacel™ Ag did not demonstrate bactericidal antimicrobial activity beyond 24 hrs using this *in vitro* assay.

ACTICOAT 7 achieved a greater log reduction against all three bacterial strains than Aquacel™ Ag at all time points (day 1 - day 7).

Reduction of bacterial load in colonised/infected wounds may influence wound healing[1].

ACTICOAT 7 may reduce the bacterial load and prevent further colonisation of wounds.

References

1. Dow, G., Browne, A., Sibbald, R.G., (1999) Infection in chronic wounds: Controversies in diagnosis and treatment. OWM. 45:23-40
2. Hall RE, Bender G & Marquis RE. 1987. Inhibitory and cidal antimicrobial actions of electrically generated silver ions. J Oral Maxilloac Surg 45:779-784
3. Landsdown, ABG. Silver‖: Its antimicrobial properties and mechanisms of action. J Wound Care. 11. Apr 2002.