In vitro study of the efficacy of a novel antimicrobial dressing with soft silicone adhesive in a diffusion model mimicking a catheter insertion site

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ABSTRACT

Biomaterial-associated infection is a common and serious complication in long-term tissue-biomaterial interactions. For example, an established bacterial biofilm at the insertion sites of central venous catheters may lead to catheter-related bloodstream infections with attributable mortality rates.¹² There is a need for novel products/strategies to prevent and treat soft tissue infection. That in turn requires relevant in vitro models to reduce the distance between in vivo models and the real clinical setting, during product development.

This poster describes the results of a study that was undertaken to assess the in vitro efficacy of an antimicrobial dressing with soft silicone adhesive* against bacterial growth at the insertion site of a catheter. Pieces of intravenous catheters were covered with dressing and evaluated to establish if the antimicrobials from the dressing had been released and could prevent bacterial growth where the dressing had been in contact with the agar surface and outside of that zone. Two different agar were tested, one that mimics the insertions site containing serum proteins and the other was Mueller Hinton (MH) agar which is commonly used in antimicrobial assays. The dressing was found to be effective on both MH agar and the clinical relevant blood agar.

METHODS

A diffusion model was established inspired by Schwab et al.¹ Pieces of intravenous catheters (length 2 cm) were placed on horse blood agar plates containing serum proteins to mimic an insertion site. A circular dressing piece (18 mm in diameter) was applied on top of the catheter. The assemblies were then incubated at 35°C ± 2°C for 24 hours. For comparison, the same test was performed using Mueller Hinton agar, the type of agar specifically used for testing diffusion of antimicrobial compounds (Figure 1).

On the following day, the dressing and catheter were removed and Staphylococcus epidermidis (ATCC 14990, 1.5–3.0 X 10⁶ CFU/ml) was spread over the plate and incubated for an additional 24 hours at 35°C (25 µl bacterial solution to 4.5 cm agar plates). The plates were photo-documented and the diameter of the zone of inhibition (ZOI) was measured. The mean value and standard deviation (Stdev) were calculated for three replicates and their duplicate perpendicular measurements.

RESULTS

Lack of growth below the catheter and a ZOI indicate diffusion of antimicrobial substances through agar. No bacterial growth was detected under the catheter and a clear ZOI was observed on both horse blood agar containing serum proteins (HB + SWF) and Mueller Hinton agar (Figure 2).

The diameters of the zones were markedly reduced on the blood agar compared to Mueller Hinton agar (Table 1).

Table 1. The diameter of the zone of inhibition was measured and the mean and standard deviation (Stdev) were calculated for three replicates and their duplicate perpendicular measurements.

<table>
<thead>
<tr>
<th>Agar</th>
<th>Mean (mm)</th>
<th>Stdev (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8 % HB + SWF</td>
<td>18.7</td>
<td>2.0</td>
</tr>
<tr>
<td>0.8 % MH</td>
<td>27.3</td>
<td>5.0</td>
</tr>
</tbody>
</table>

*Mepitel Film IV AM (Mölnycke Health Care, Gothenburg, Sweden)
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DISCUSSIONS

The test method developed is called “Diffusion method” and is a modification to the Kirby Bauer method, which is widely used to study antibiotic susceptibility.¹ This method assesses the antimicrobial activity qualitatively, i.e. it offers rapid visual screening. Zones of inhibition of bacterial growth can be seen as clear zones on the agar plates. In this present study, two different agar types were used; Mueller Hinton agar (used in the Kirby Bauer method) and horse blood agar containing serum proteins. The antimicrobial dressing with soft silicone adhesive* was found to inhibit bacterial growth on both agar types tested. The zones were clearly smaller on blood agar than Mueller Hinton agar plates, showing that the choice of medium is crucial to the test result. The blood agar plates with added serum proteins more closely resemble the environment of an actual intravascular insertion site than Mueller Hinton agar. Clinical relevant methods will have a better predictability which is fundamental for products with antimicrobial activity, since lack of activity in the clinical setting can contribute to the rise of microbial resistance.

CONCLUSIONS

This in vitro study demonstrates that the antimicrobial dressing with soft silicone adhesive* has the ability to prevent bacterial growth on the surface mimicking an IV site and also under the catheter covered by the dressing (i.e. even where the dressing is not in direct contact with the surface). This was shown on both Mueller Hinton agar and blood agar containing serum proteins. The latter was developed to study antimicrobial activity in a more clinically relevant “tissue” condition to increase the predictability that the dressing will work as intended in the clinical setting.

REFERENCES


*Mepitel Film IV AM (Mölnlycke Health Care, Gothenburg, Sweden)