Designing a synthetic spider silk based coating for urinary catheters to reduce the risk of CAUTIs

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BACKGROUND

- Catheter-associated urinary tract infections (CAUTIs) are a leading cause of morbidity and mortality in patients with life-threatening conditions.1
- Foley catheters are the most common urinary catheters used but can become burdened with microbes which lead to CAUTIs, the most common source of hospital acquired infection (HAI).1
- The attached bacteria can form biofilms on the catheter which are difficult to treat using oral antibiotics and can lead to chronic infections.2
- Synthetic spider silk as a catheter coating shows great promise because of its mechanical properties.
- Chlorhexidine can enhance the antimicrobial properties of coatings.3

OBJECTIVES & DESIGN CRITERIA

Objectives
- Design coating and test protocols that provide optimal antimicrobial and mechanical properties.
- Create a synthetic spider silk coated Foley catheter that meets design needs dictated by catheter usage in nursing clinical practice guidelines.

Design Criteria
- Needs to be significantly smoother than an uncoated catheter.
- Needs to require significantly less force to insert than an uncoated catheter.
- Needs to exhibit a significantly larger bacterial zone of inhibition.
- Coating needs to refrain from flaking when the catheter is bent and bunched.
- Final process needs to be easily up-scaled to mass manufacturing.

DESIGN STEPS

DESIGN REVIEW

Table 1. Design criteria scores for 6% synthetic spider silk coating methods. For antimicrobial testing, coating methods were given a zero if there was no significance, one for significance against one bacteria, two for significance against two bacteria, and three for significance against all three bacteria. Coating methods that did not significantly improve insertion force were given a zero while any that did score a one. A qualitative roughness score was given based on SEM images. A zero represents a rough surface and a one indicates smooth. Coating methods that scored during bend/bunch testing were given a zero and methods that did not were given a one. The final scores for feasibility were qualitatively awarded based on how easy the methods are for production.

Table 2. Design criteria scores for 6% synthetic spider silk + chlorhexidine coating methods. Scoring system is the same as described above.

FINAL DESIGN

- Based on the design criteria scores, dip with chlorhexidine and dip and aerosolize with chlorhexidine are the two best coating methods.
- The feasibility score is qualitative; therefore, the team recommends the dip and aerosolize with chlorhexidine coated catheter as the final product.
- Statistically significant zones of inhibition were recorded during both the average and max insertion force that is required for insertion.
- The chosen coating method showed statistically significant decrease in both the average and max insertion force that is required for insertion.
- SEM images showed a smooth coating for catheters coated with the dip and aerosolize + chlorhexidine coating method.

FUTURE WORK

- Test for surface fouling with proteins to see if it jeopardizes any of the antimicrobial or mechanical properties.
- Investigate the antimicrobial properties of nanoparticles.

REFERENCES


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