Efficacy of NVC-422, a Novel Derivative of N-Chlorotaurine, in Controlling Proteus mirabilis Biofilm Formation on Urinary Catheters

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Abstract

Background: Infection by Proteus mirabilis can provoke complex care patient with long-term indwelling bladder catheters. These urinary tract infections (UTIs) contribute to precipitation and stone formation on catheters, resulting in a significant burden on healthcare systems. In an in vitro catheterized bladder model, we have previously reported that a new chlorinated compound, NVC-422, inhibits biofilm formation and prevents calcium carbonate precipitation. In the present study, we aimed to investigate whether NVC-422 could be used to manage catheter encrustation and to control the accumulation of other crystalline biofilms.

Objectives: The present study investigated the potential of NVC-422 to inhibit biofilm formation on catheters and to control the accumulation of other crystalline biofilms.

Setup: The study was conducted in a catheterized bladder model, which was inoculated with Proteus mirabilis and irrigated with artificial urine and artificial urine with NVC-422. The effectiveness of NVC-422 was evaluated by measuring the pH of the effluent urine and monitoring the times to catheter blockage.

Results: The pH of the effluent urine increased from 6 to 9 in the control models, indicating continued formation of crystalline biofilm. The catheters treated with NVC-422 remained free from biofilms for the 144 h experimental period. The urinary pH remained at 6, and no biofilm blockage was observed.

Conclusions: The results suggest that NVC-422 is effective in controlling biofilms on catheters and in preventing the accumulation of crystalline biofilms. These results support the use of NVC-422 as a potential treatment for catheter blockage and the associated complications of UTIs.

Keywords: NVC-422, Proteus mirabilis, Catheterblockage, Biofilm formation, Crystalline biofilm

Materials & Methods

The catheterized bladder model used was designed to simulate conditions found in human cystitis. The model was designed to provide a continuous flow of urine from the bladder, allowing for the accumulation of biofilms on the catheter surface. The model was inoculated with Proteus mirabilis, and the pH of the effluent urine was measured.

Results

Day 1: The pH of the effluent urine increased from 6 to 9 in the control models, indicating the formation of crystalline biofilm. The catheters treated with NVC-422 remained free from biofilms for the 144 h experimental period.

Day 2: The pH of the effluent urine remained at 6, and no biofilm blockage was observed.

Day 3: The pH of the effluent urine remained at 6, and no biofilm blockage was observed.

Day 4: The pH of the effluent urine remained at 6, and no biofilm blockage was observed.

Day 5: The pH of the effluent urine remained at 6, and no biofilm blockage was observed.

Day 6: The pH of the effluent urine remained at 6, and no biofilm blockage was observed.

Day 7: The pH of the effluent urine remained at 6, and no biofilm blockage was observed.

Fig. 1. Catheterized bladder model. The model was designed to simulate conditions found in human cystitis. The model was inoculated with Proteus mirabilis, and the pH of the effluent urine was measured.

Fig. 2. Catheter blockage regimen for daily irrigation and inoculation: Day 1, catheter blockage; Day 2, catheter blockage; Day 3, catheter blockage; Day 4, catheter blockage; Day 5, catheter blockage; Day 6, catheter blockage; Day 7, catheter blockage.

Fig. 3. Efficacy of NVC-422 irrigation. The pH of the effluent urine remained at 6, and no biofilm blockage was observed.

Fig. 4. Stereoscopic images of NVC-422 treated and control catheters. The control catheters were removed from the model, and the pH of the effluent urine was measured.

Fig. 5. Scanning electron microscopy images of NVC-422 treated and control catheters. The control catheters were removed from the model, and the pH of the effluent urine was measured.

References


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