

## BASIC SCIENCE

## Inflatable Penile Prosthesis Implantation: Does Antibiotic Exposure Matter?



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## ABSTRACT

**Background:** Inflatable penile prosthetic (IPP) infections are unusual but carry high patient morbidity and healthcare costs.

**Aim:** To increase the bactericidal effect of IPP tubing material to prevent future bacterial infections and to determine whether this effect is time-dependent.

**Methods:** A modified disk diffusion assay was developed to measure the zones of inhibition against *Escherichia coli*, *Proteus mirabilis*, *Staphylococcus aureus*, and *Staphylococcus epidermidis* when tubing was immersed in gentamycin, ampicillin, tetracycline, kanamycin, erythromycin, or ciprofloxacin. To further assess the efficacy of this approach, IPP tubing was exposed to ampicillin or ciprofloxacin for 30 seconds, 2 minutes, 10 minutes, or 60 minutes.

**Outcomes:** Bacterial zones of inhibition against IPP tubing material exposed to various treatments.

**Results:** IPP tubing was more effective against Gram-positive bacteria (*S aureus* and *S epidermidis*) than Gram-negative bacteria (*E coli* and *P mirabilis*). Immersing IPP tubing material in ampicillin or ciprofloxacin increased bactericidal effect of tubing material against Gram-positive and Gram-negative bacteria, respectively. The observed inhibitory effect was time dependent.

**Clinical Translation:** Exposing IPP to a specific antimicrobial directly before implantation increases the bactericidal properties of the material, potentially decreasing the likelihood of infection.

**Strengths & Limitations:** This study is limited in that it is in vitro experimentation observing the effect of a single strain of each bacterium. Although the strains used were clinically relevant, further analysis is required to determine whether these results were strain specific.

**Conclusion:** Immersing IPP material into an antibiotic solution, such as ampicillin or ciprofloxacin, increases the bactericidal properties and may aid in the prevention of infection. **Chanyi RM, Alzubaidi R, Leung EJY, Wilcox HB, Brock GB, Burton JP. Inflatable Penile Prosthesis Implantation: Does Antibiotic Exposure Matter? Sex Med 2018;6:248–254.**

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**Key words:** Inflatable Penile Prosthesis; IPP; Infection; Antibiotic Use; Infection Prevention

## INTRODUCTION

Any foreign material that is inserted into the body is at risk of increasing a patient's chance of developing a bacterial infection. If a bacterium binds to an abiotic surface, the methods our body uses to resist an infection are diminished. There has been a great deal of advancement in the development of biomaterials that prevent bacterial infections. Earlier literature showed infection rates of 3% for nondiabetic virgin, 8% for diabetic virgin, and 10% for revision operations.<sup>1</sup> Infection rates for virgin IPPs have typically been approximately 1% to 3%, but published rates have been significantly higher in revision surgery or when reconstructive procedures are involved.<sup>2</sup>

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IPP as a treatment option for erectile dysfunction provides a high rate of patient satisfaction and success in salvaging erectile function among a cohort of men unresponsive to phosphodiesterase type 5 inhibitors or other pharmaceutical options or for whom they cannot be used. One would surmise that a device that remains in a patient for years would regularly become infected. Surprisingly, IPPs have an incredibly low infection rate (1% to 3%) despite remaining in a patient for more than 10 years.<sup>3</sup>

Perfecting surgical techniques and implementing standardized preoperative cleaning procedures have been key features in preventing infections, yet they still occur.<sup>4</sup> This risk of device infection drastically increases if the implant requires a redo-corrective surgery: rates are as high as 21.7% if the surgery also includes penile reconstruction.<sup>5</sup> Therefore every measure is taken to prevent infection, and the material used in the prosthesis have been developed to inhibit bacterial growth and adherence.

One of the more popular devices, developed by American Medical Systems (AMS, Minnetonka, MN, USA, now owned by Boston Scientific Corp, Marlborough, MA, USA), uses tubing material containing InhibiZone.<sup>6</sup> This is an antibiotic-impregnated material that elutes a mixture of rifampin and minocycline over time. The most prevalent bacteria found to cause infection in IPP implants are Gram-positive, coagulase-negative *Staphylococcus* species. Overall, the use of antimicrobial-impregnated materials decreases the incidence of infection by 50%.<sup>7</sup> Due to the high cost associated with infection, monetary and patient morbidity, as well as the decreased efficacy against Gram-negative organisms, devices are treated with antibiotics either in the factory as ready to use (AMS) or just before the insertion at the day of surgery (Coloplast Corp, Minneapolis, MN, USA). The goal of this study was to determine whether additional antibiotic use increased efficacy against urinary pathogens. It was also assessed whether bacterial inhibition increased the longer the material was immersed in the solution.

## MATERIAL AND METHODS

### Bacterial Strains, Media, and Culture Conditions

*Escherichia coli* 67, *Staphylococcus aureus* Newman and *Staphylococcus epidermidis* 3399 were maintained on 1.5% LB agar. Due to the swarming motility of *Proteus mirabilis* 296, it was maintained on non-swarming agar plates (10 g/L tryptone, 5 g/L yeast extract, 0.4 g/L sodium chloride, 20 g/L agar; NSA). When required, all bacterial cultures were grown overnight in liquid LB medium at 37°C, with shaking at 180 rpm.

### Modified Disk Diffusion Assay (M-DDA)

To assess the antimicrobial activity of the penile tubing material, a modified disk diffusion assay was developed. Tubing material was sectioned into uniformly thin, 1-mm disks. Tubing material was briefly sterilized with anhydrous ethanol and immediately dried under ultraviolet light to remove residual ethanol. Preliminary experiments demonstrated this did not alter

the antimicrobial properties of AMS tubing nor the ability for Coloplast tubing to bind ciprofloxacin or ampicillin. Bacterial cultures were grown overnight in LB medium at 37°C. Cultures were spread onto 1.5% LB agar plates except for *P mirabilis* 296 that was plated onto NSA using a cotton swab. Sections of tubing material were immersed for 5 minutes in gentamycin (15 µg/mL), ampicillin (100 µg/mL), tetracycline (10 µg/mL), kanamycin (50 µg/mL), erythromycin (25 µg/mL), or ciprofloxacin (10 µg/mL). Sections were blotted to remove residual liquid and placed onto the inoculated agar plates. To assess bacterial sensitivity to the antibiotic, cotton discs were immersed in the same antibiotic solution. Tubing material placed in sterile phosphate buffered saline solution was used as a negative control to demonstrate the bactericidal effect of tubing material alone. Plates were incubated overnight at 37°C, and the zone of inhibition was analyzed.

### Time-Dependent M-DDA

The modified disk diffusion assay described above was performed with some minor changes. Tubing sections were treated with either ampicillin (100 µg/mL) or ciprofloxacin (10 µg/mL) for 30 seconds, 2 minutes, 10 minutes, or 1 hour. After soaking, the excess antibiotic solution was removed, and the disks were pressed lightly onto the agar. As a bacterial growth control, 1 disk was soaked for each time point in LB medium. Each time point consisted of 3 replicates for each bacterium; this was repeated in triplicate. Zones of inhibition were measured after plates were incubated overnight at 37°C.

### Statistical Methods

GraphPad Prism software (GraphPad Software, La Jolla, CA, USA) was used to determine statistical significance by either 1- or 2-way analysis of variance (ANOVA) with the appropriate post-hoc test depending upon the distribution of the data.

## RESULTS

### Antimicrobial Activity of Inflatable Penile Prosthesis Tubing

The AMS 700 IPP tubing is an antibiotic-impregnated material containing InhibiZone (Boston Scientific Corp), a mixture of minocycline and rifampin. To assess the antimicrobial activity of the material, 2 Gram-negative and 2 Gram-positive bacteria were chosen. *E coli* 67 and *P mirabilis* 296 are both Gram-negative uropathogens used previously in the laboratory to assess bacterial adherence to abiotic surfaces. *S aureus* Newman is a Gram-positive pathogen isolated from tubercular osteomyelitis,<sup>8</sup> whereas *S epidermidis* 3399 is a commensal human skin isolate. The tubing material was more effective at inhibiting the growth of the Gram-positive bacteria and did not appear to inhibit the Gram-negative uropathogens (Figure 1). There was no statistical significance in the ability of the tubing to inhibit *S aureus* more than the non-pathogenic *S epidermidis*.

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