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**REVIEW ARTICLE:**

# Possible application of bacteriophage cocktails in anti-bacterial absorbable sutures to prevent SSIs

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## ABSTRACT

Surgical site infections occur in 2-4% of patients post-surgery, and remain a leading cause of morbidity and mortality. Mainly caused by bacteria, SSIs most commonly follow a course of treatment comprising of antibiotics and steroids to treat the infection and reduce inflammation respectively. Moreover, the growing use of antibiotics has led to an increase in antibiotic resistance. Some estimates predict that drug resistant infections will be the leading cause of death by 2050. This also means that the incidence of drug-resistant SSIs will also go up. These changing dynamics might force us to change how we approach SSIs. We would need to look for alternatives to antibiotics. This paper aims to explore the development of sutures that will prevent the proliferation of the most common infection-causing bacteria on and around the post-op wound.

**Key Words:** Infections, SSIs, Bacteria, Proliferation, Interventions, Bacteriophage

## Introduction

A surgical site infection is an infection that develops following surgery in the area of the body where the procedure was performed. Several interventions have been used to prevent SSIs throughout the last couple years. These include skin cleansing protocols, hair removal, intraoperative normothermia maintenance, preoperative antimicrobial prophylaxis administration, the use of plastic adhesive skin barriers, high flow oxygen supplementation, wound protection, instrument sterility, bowel preparation, incision length, and delayed primary incision closure.

By using bacteriophages (viruses that are pathogenic to bacteria), we can attribute antibacterial properties to surgical sutures. A phage particle is made up of one form of nucleic acid (DNA or RNA) and a protein capsid that protects the genetic material. The great majority of bacteriophages also have a tail (composed of proteins) that allows them to specifically recognize a receptor on the host bacterium's surface.

Bacteriophages are already being used in a number of experimental alternative treatment approaches for individuals suffering from antibiotic-resistant illnesses.

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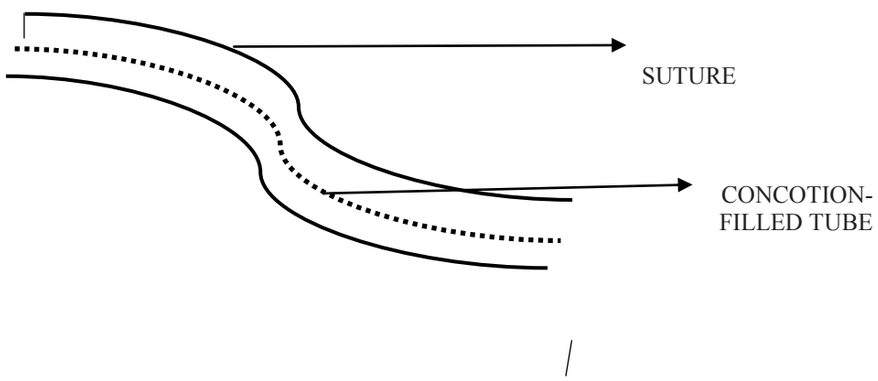
Maddocks and colleagues present a case with multilobar cavitary very drug-resistant Pseudomonas VAP worsened by an infected bronchopleurocutaneous fistula that responded significantly to intravenous and aerosol treatment with a tailored four-phage cocktail. Not only did the patient respond clinically, but repeat sampling indicated no P. aeruginosa. A favourable reaction of this size is nearly unheard of in regular antibiotic treatment.

A similar process can be used with sutures to take advantage of the potency of bacteriophage combinations against bacteria to prevent SSIs, particularly drug-resistant ones. Furthermore, bacteriophages may penetrate biofilms, something antibiotics cannot do.

## Design

The most common SSI-causing bacteria include Staphylococcus, Streptococcus, Pseudomonas, Enterococcus, and Escherichia coli. To get maximum protection from all these organisms, we will take a cocktail of bacteriophages that affect each one of them. A few examples have been listed in the table below.

| Bacteria | Bacteriophage |
|---|---|
| Streptococcus pyogenes | **Bacteriophage T12** |
| S. aureus | **Phage 80 alpha** |
| S. epidermidis | **S. epidermidis phage vB_SepS_SEP9** |
| Pseudomonas aeruginosa | **Pseudomonas virus phi6** |
| Pseudomonas maltophilia | **Pseudomonas virus phi6** |
| Escherichia Coli | **Escherichia virus T4** |




- To avoid altering the structural integrity of the suture, the concoction of viruses will be filled in a hollow tube inside the suture which would be sealed off at both ends.
- The sutures would be stored in temperature-controlled units to prevent the destruction of the tertiary structure of the protein by denaturation.

- The seals would be thin-layered to allow release of the fluid concoction at the surgical site within 1-2 days.
- The design is simple, can hold a high volume of the concoction, and does not alter the structural integrity of the suture.
- This design can be applied to a variety of monofilament and braided absorbable sutures such as Monocryl, PDS, and Vicry[1].

## Discussion

As drug-resistant infections rise, our current approach toward treating bacterial infections will change as antibiotics will be rendered ineffective in many cases. This paper offers insight into how bacteriophage cocktails can be used in the future as a replacement and/or addition to current suture modifications to act as a deterrent to surgical site infections.

Furthermore, this novel approach has never been tried but the fact that bacteriophages inhibit and control the growth of bacteria has been widely accepted by the scientific community since the beginning of the 20$^{th}$ century.

As far as side-effects are concerned, a possible implication could be alteration of the gut microbiome however; a recent case study has found a relatively unchanged gut microbiome in a patient undergoing bacteriophage therapy. Still, more research is required to affirmatively say that the sutures would have no effect on the gut microbiome.

Currently, drug-resistant SSIs and SSIs in general have a low incidence and thus do not call for immediate intervention. However, the situation could drastically change as we progress into the 21$^{st}$ century.

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