# Hydrogel Dressings for Chronic Wounds

The Use of Electrospun Gelatin-Dendrimer Nanofibers for the Controlled Release of Doxycycline and Silver: **Drug Release Kinetics Study**

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## Introduction

Decubitus ulcers, commonly called bedsores or pressure ulcers, are a result of constant pressure, friction, or shear force. This is most often a result of impaired mobility. The pressure causes a reduced blood flow, which can lead to cell death, skin breakdown, and eventually the development of an open wound. If these wounds become infected, they become more difficult to heal as well as can risk spreading infection to the bone or blood stream [1]. Treating open bedsores is difficult, as they are slow to close and the skin and other tissues are damaged or destroyed. The first step in treating bedsores is relieving the pressure that caused it by changing positions often and using supporting cushions. Often, removal of damaged tissue is necessary to allow for proper healing. Currently, a variety of dressings are available to protect these wounds and speed healing. Topical antibiotics are available to prevent infection [2].

Current treatment of bedsores can include hydrocolloid (gelatin and pectin based) dressings to facilitate and speed healing. Hydrocolloid dressings are effective because they absorb wound fluid while maintaining the desired moist environment. These dressings are left in place for up to five days (Hydrocolloid dressings). For this reason, it is necessary for topical antibiotic to be included in the dressing and released over an extended period of time[3].

Dendrimers are a unique class of polymer with characteristics that make them a useful drug delivery vehicle, allowing for an extended, controlled release of medicine over time. Dendrimers are highly branched molecules, giving them the ability to carry drugs in two typical ways. One way is to encapsulate guest molecules in their internal hydrophobic cavity. Another way is to covalently attach drugs onto the dendrimer surface [4].

Doxycycline (DC) is a tetracycline drug, which commonly used to treat bacterial infections. It works by binding to the small subunit of bacterial ribosomes at the A site to inhibit protein synthesis. Doxycycline also has anti-collegenolytic properties, inhibiting proteases. Proteases naturally occur at the sites of chronic wounds like pressure sores [5]. This dual action of DC makes it a viable treatment option for pressure sores. Because of its hydroxyl functional groups, it is possible to conjugate it to carboxylic acid surface groups of PAMAM dendrimers. Silver ions, which have antimicrobial properties, can be encapsulated into the DC-PAMAM conjugates, creating a dendrimer complex capable of delivering both drugs over a period of time. Further, this complex can be included into a gelatin electrospun nanofiber hydrogel. Once created, a study must be completed to test the release of the drugs from the dendrimer complex as well as from the hydrogel.

## Methods

In order to test the release, it is necessary to synthesize and characterize the dendrimer/DC/silver complex. The characterization of the complex will be accomplished using H-NMR and perhaps SEM. The drug release will be tested using UV-Vis, finding the concentration of the drugs (DC and silver) in filtrate over time during dialysis. This will be compared to the free drugs diffusion into filtrate. The test of the rate of release of the DC should be complete by June 27 and the test of the release of the silver from the dendrimer should be complete by July 11. Some of the product will go on to be electrospun into the nanofiber gelatin hydrogel. The release of the drugs from the hydrogel will also be tested using the same means, and the tests should be completed by July 25.

## Possible results and their implications

It is possible that while UV-vis will work for quantifying doxycycline concentration, it may not work for quantifying silver ions. In this case, it may be necessary to find another means of quantifying the silver ions, i.e. atomic absorption spectroscopy or precipitating the silver ions and finding the mass. The same problem could apply to the dendrimer, in which case some other sort of assay would be necessary.

In the event that a method to quantify the doxycycline and silver is found, it is possible that the result of the drug release kinetics study is the drugs are slowly released from the dendrimer over the course of a few days. This would be optimal. It is also possible that the drugs will not be released fast enough or too fast. In both of these cases, the method of conjugating/encapsulating the drugs to the dendrimer would need to be modified, i.e. perhaps using a different silver salt or a different type of linkage between the dendrimer and the doxycycline.

## References


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