The rise of healthcare acquired infections (HAIs) has spurred innovations in healthcare products to combat this epidemic. Among those products are the very basic, but little noticed, of patient care: textiles.

Patient care textiles perform various functions: clothing, bedding, surgical draping and so on. The fact that textiles are in constant contact with patient skin, they provide a surface ripe with potential for harboring and transferring harmful microbes that can lead to HAIs. Logically, they have also become a prime target of new technologies to inhibit these microbes. One of these technologies is the use of nanoparticles to attack and neutralize microbes on textiles.

Deri Ross Pryor, is a staff writer & editor of the ALM Journal. Deri holds a Bachelor of Arts in English & Creative Writing from Eastern Kentucky University and is currently working towards her Masters.
Microbial contamination, i.e. bacterial growth, causes many problems within textiles, such as unpleasant odor, deterioration of the fabric, and of course the potential to cause HAIs. Efforts to reduce microbe growth on textiles has been in effect for decades. Antimicrobial treatments vary, but in general they “should be broad spectrum…and capable of performing in the intended end use, with limited exposure of the wearer and the environment.” In other words, any antimicrobial treatment of a healthcare fabric should not interfere with patient care, or cause any risk to patient or environment.

To that end, an in depth look at nanotechnology in antimicrobial textiles is warranted for decision-making purposes. Weighing the pros and cons must be undertaken to ensure positive outcomes.

In an effort to combat HAIs, healthcare staff meticulously work to keep all surfaces bacteria free through cleaning and disinfection practices. However, “even with these cleaning strategies, microorganisms can survive on most hospital surfaces from door handles and handrails to bed sheets and uniforms.” Antimicrobial treatments are desirable because they work to continuously destroy microorganisms through various means. They do not reduce over time, and will continue to be effective for some time after cleaning. In effect, they are a latent form of disinfection in that they are always present and go to work when needed.

There are two main categories of antimicrobial agents: leaching and non-leaching.

Leaching antimicrobials exist on the surface of the textile and attack microbes by actually entering into their cells and disrupting their structure. Examples of leaching agents include chitosan (derived from sea shells), micronized copper, and silver nanoparticles, among others. These agents migrate from the surface of the textile, thus reducing in number over time and disrupting the efficacy of the antimicrobial properties. Because of this migration, there is cause for concern of risks to patients and impact on the environment. Another concern is leaching and non-leaching.

Non-leaching agents are covalently bonded to the textiles. These agents are permanently affixed, which means they do not reduce over time nor pose risk to humans or environment. Non-leaching or bound antimicrobials kill “microorganisms by direct surface contact…this type of antimicrobial technology is used in textiles that are likely to have human contact or where durability is of value.”

In terms of human safety, there are pros and cons, as well as conflicting data regarding antimicrobial agents. Leading the charge in the antimicrobial war is nanosilver (silver nanoparticles), which is the subject of much debate. Silver ion has been widely used for decades in the medical field, “because it shows strong biocidal effects on many pathogenic bacteria.” However, there is concern that nanoparticles of silver can penetrate human cells, although it is not known how much someone has to be exposed to before there is actual damage.

Regarding the environment, silver has already been established as a danger due to the fact that it disrupts necessary bacteria and other aquatic organisms when it is released through wastewater. However, these findings are related to standard form silver; studies are still being conducted on nanosilver. Testing by Empa Swiss Federal Laboratories for Materials Science and Technology found that nanosilver coated textiles lose very little silver during washing, posing little risk of being absorbed by healthy skin or impacting the environment, and therefore should not be subjected to stricter regulations. A further study in Switzerland found that nanosilver does not remain in “its metallic form for very long; it is efficiently transformed into a silver sulfide salt” which poses few problems. Of course, this is all information pertaining to nanosilver; other antimicrobial nanotechnologies are under the same scrutiny.

The question then becomes: Do the pros outweigh the cons? Do these nanoparticles in antimicrobial textiles prevent HAIs to such a degree that any risks to patients and the environment are warranted? It is too early to predict long term outcomes. However, testing of treated textiles shows a significant reduction of HAIs causing organisms. Again, this cannot predict patient outcomes with 100% accuracy because those outcomes will vary from patient to patient depending on many factors. In short, only time will tell how effective these textiles will be in combatting HAIs. There is simply no way to know without long-term studies.

**What Is A Nanoparticle?**

A nanoparticle is a structure between 1 and 100 nanometers; “nano” means billionth, so a nanometer is one-billionth of a meter. To give you an idea of how small that really is, consider the following examples:

- A sheet of paper is about 100,000 nanometers thick
- A strand of human DNA is 2.5 nanometers in diameter
- There are 25,400,000 nanometers in one inch
- A human hair is approximately 80,000 - 100,000 nanometers wide
- A single gold atom is about a third of a nanometer in diameter

(Source: www.nano.gov)
Just as difficult to determine are the regulatory parameters of antimicrobial textiles. Currently, in the United States, they fall under the umbrella of the Food and Drug Administration (FDA) due to their medicinal qualities; however, they are also being monitored by the Environmental Protection Agency (EPA) due to their potential pesticide properties and impact on the environment.10 Because of these merging concerns and properties, it then becomes very important as to how these textiles are marketed in terms of claims.

Note: The FDA regulates antimicrobial fabrics, such as certain gauzes, which function as “medical devices.” Such fabrics undergo a thorough review of safety and efficacy prior to sale, and lie outside of the scope of this article.

As a condition of the exemption from registration with EPA, manufacturers and sellers of antimicrobial fabrics are limited in terms of marketing claims and the fabric must be treated with an EPA-registered antimicrobial.

The following are examples of appropriate marketing language for nonmedical antimicrobial fabrics given by EPA:
• Guards against degradation from microorganisms
• Treated to resist bacterial odors
• This product contains an antimicrobial agent to control odors

The following are examples of inappropriate (health-related) marketing language for non-medical antimicrobial fabrics:
• Antimicrobial
• Protects users from pathogenic microorganisms
• Helps prevent the spread of pathogenic microorganisms
• Kills pathogenic microorganisms

All of the claims allowed by EPA for antimicrobial fabrics highlight the function of the antimicrobial agent as protector of the textile, not the person.

From “Antimicrobial Fabrics – Issues and Opportunities in the Era of Antibiotic Resistance” by Benjamin Tanner, Ph.D.

While there are no clear cut answers to the questions raised by the use of nanotechnology in antimicrobial textiles, it is clear that its use is on the rise. As with any new technology, decision makers on both the healthcare provider side and the textile processing side must stay informed by keeping up with new information as it becomes available. These textiles could prove to be a boon to patient outcomes, a detriment to both patients and our environment, or simply a harmless fad that passes without incident. Whatever the case, forewarned is forearmed.

References