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Mob: +92 300 3008585, Fax: +92 41 8815544
E-mail: editorpjn@gmail.com

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Developments in Health Care and Medical Textiles - A Mini Review-1

Farooq Ahmed[1], Irfan Ahmed Shaikh[2], Tanveer Hussain[3],
Iftikhar Ahmad[2], Soniya Munir[2] and Mariyam Zameer[2]
[1]Department of Textile Engineering, Mehran University of Engineering and Technology, Jamshoro, Pakistan
[2]College of Earth and Environmental Sciences, University of the Punjab, Lahore, Pakistan
[3]National Textile University, Faisalabad, Pakistan

Abstract: This review intends to highlight the developments in medical and Health care textiles, current perspective and key challenges regarding the advancements of non-toxic and eco-friendly solutions for health care. This study provides an appraisal on the innovative, intelligent and smart textile products related to Health care and medical textiles. This review also intends to highlight the current state of the technologies as well as future advances and enhancements potential of new textile materials in antimicrobial, surgical sutures and wound dressings. A discussion on classification of antimicrobial textiles, types of surgical sutures and wounds management make this review interdisciplinary.

Key words: Antimicrobial, surgical sutures, wound dressings, polymer, textile fibres

INTRODUCTION

Textiles are common materials used in all Health care facilities. As the name suggests, a medical textile- usually used interchangeably with “Health care textile” is any textile product that offers a medical advantage. Since medical textiles present a great variety of opportunities for textile manufacturers, numbers of textile materials in the form of knits, woven, nonwoven and composite have been employed in various Health care and medical applications. For a particular purpose, these products must pass the requirements of particular end-use performances (White *et al*., 2010). Internal applications such as surgical sutures and implants and external applications like gauzes, bandages, gowns, surgical masks, hospital apparel, upholstery fabrics, tampons, adult briefs, nappies, face masks and arm and knee braces, etc. have to achieve utmost standard properties (Harrison, 2002).

New applications of medical textiles are directly related to the innovations in new textile fibres, novel materials and ultra modern manufacturing methods and technologies (Thilagavathi *et al*., 2007). Developments in medical textiles endeavour to improve the comfort for patient and end-users; consequently, development of all medical textiles is aimed to convert the painful days of patients and surgeons into the comfortable days (Patel and Desai, 2014). Among the important requirements for biomedical products, non toxicity, no allergenic response, strength, mechanical properties, durability, elasticity and biocompatibility are considered vital prerequisites for successful health products (Chinta and Veena, 2013).

Furthermore, the bulk of the products fall in medical and Health care sector is disposable, while the remainder can be reused after appropriate cleaning. Medical textiles utilize all major forms of textiles, i.e., fibre, yarn, roving, woven fabrics and nonwoven. All these can be classified in the following four different groups, non-implantable materials, extracorporeal device, implantable devices and hygiene products (Horrocks and Anand, 2000). Vast applications of Nonwovens are found in the area of non implantable devices and hygiene products. Range of new fibres as well as technologies makes it possible to introduce cheaper, better, compatible, innovative and biodegradable products. Cotton, viscous, polyester, polypropylene, polyamide, polyethylene, hollow, polysaccharides, elastomeric and others fibres are used predominantly in such medical textiles (Horrocks and Anand, 2000; Czajka, 2005).

This review intends to highlight the developments of textiles related to medical and Health care. Moreover, the present status and important challenges to develop non-toxic and eco-friendly solutions for health care are also covered in this write-up.

Antimicrobial textiles: The expression 'antimicrobial' suggests a wide variety of products and technologies that give different degrees of defense for textile materials against germs and microorganisms. Antimicrobials products very in their actions, chemical properties, impact on environment and people, durability, regulatory compliance, handling characteristics, costs and their interaction with microorganisms (White *et al*., 2010). Fungi, yeast, bacteria, mold, mildew and virus are part of human lives and they all are either good or bad types of microorganisms (Malek and Speier, 1982). Consumers worldwide has opted towards sanitation, hygiene and

Corresponding Author: Farooq Ahmed, Department of Textile Engineering, Mehran University of Engineering and Technology, Jamshoro, Pakistan

active lifestyle, which has not only stimulated extensive research and development in medical textiles, but also created a rapidly rising market for a large scope of textile products offered with anti-microbial properties (Borkow and Gabby, 2007; Gao and Cranston, 2008; Ramachandran *et al.*, 2004). Application of antimicrobial finishes is observed in clothing such as undergarments, protective apparels, home-furnishing and sportswear used in areas with high danger of infection and disease by pathogens, for example, operation theaters, medical laboratories and hospitals (Singh *et al.*, 2005; Zilberman and Elsner, 2008).

Variety of antimicrobial compounds for textiles are used, such as ammonium compounds, triclosan, quaternary, polybiguanides, N-halamines and metals like silver and naturally derived antimicrobials such as chitosan are being experimented (Gao and Cranston, 2008; Purwar and Joshi, 2004; Simoncic and Tomsic, 2010). Antimicrobial compounds used in textiles must comply vital consumer requirements such as effectiveness against microorganisms, appropriateness for textile processing, stability and a favourable safety and environmental properties (Gao and Cranston, 2008). Ongoing topics of research include the development of novel and improved antimicrobials (Dastjerdi and Montazer, 2010; Bshena *et al.*, 2011) and development of antimicrobial products based on naturally-derived products (Joshi *et al.*, 2009).

The effectiveness of antimicrobial textiles is attained by numerous different methods. The most commonly and widely used product having antimicrobial property today is 2,4,4'-trichloro-2'-hydroxydiphenyl ether, also called Triclosan (Harrison, 2002; Orhan *et al.*, 2007). The chemical structure is shown in Fig. 1.

Triclosan inhibits the growth of microbial by affecting fatty acid biosynthesis through stopping lipid biosynthesis and by reacting with the residues of amino acid of the enzyme-active site within a membrane (Orhan *et al.*, 2007).

Quaternary ammonium compounds (QAC), for instance are those having chains of 12 to 18 atoms of carbon, had been extensively tried as disinfectants and anti-septic antimicrobial agents (Gao and Cranston, 2008; Schindler and Hauser, 2004). Chemical structure of QAC is displayed in Fig. 2. QAC's antimicrobial activity is relied on the number of quaternary ammonium groups and length of the alkyl chain present in the molecules that bear a positive (+ve) charge on the N atom. The antimicrobial action comes from the attractive interactions between the cationic (+ve charged) ammonium group of the QAC and the negatively charged cell membrane of microbes. This creates the disruption of all vital functions of the cell membrane and, as a result, the break of protein activity. QAC also attacks DNA multiplication ability of microbes (Simoncic and Tomsic, 2010).

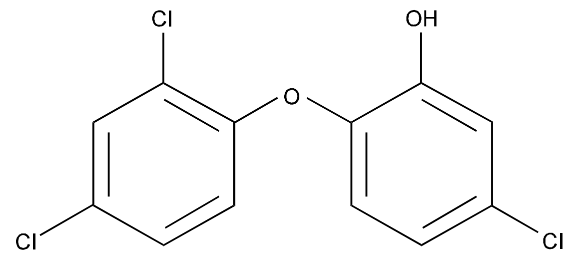

Fig. 1: Chemical structure of Triclosan

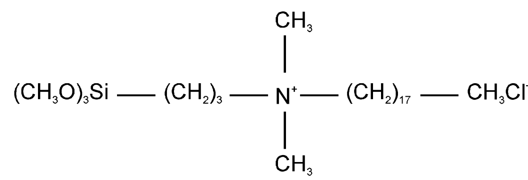

Fig. 2: Chemical structure of 3-trihydroxysilyl propyldimethyloctadecyl ammonium chloride

Another commonly used biocide, Polyhexamethylen biguanide (PHMB), is used in various antimicrobial applications. It has been experimented as a disinfectant for swimming pools, food industry and as an antiseptic agent in hospitals to control wound infections. PHMB is also utilized in cosmetics business as an important preservative, fabric softeners, personal care products, hand-wash detergents and contact lens solutions (Thilagavathi *et al.*, 2007).

Surgical sutures: Sutures are foreign body materials which are implanted into human tissues. Although sutures are the most common implants used by doctors and surgeons worldwide, their biological and physical characteristics are usually not fully understood and appreciated (Capperauld, 1989). Sutures are normally grouped according to their physical format, origin of raw material and their capacity to absorb, desorp, or not to absorb (Capperauld, 1989). Common rules for the choice of suture mainly depend on the past experience of the surgeon, surgical method, wound curing rates of the tissue and the size of suture used (Ingle and King, 2010).

An absorbable type suture decomposes in the human body because it degrades as a wound heals. These types of sutures are made from the materials which are broken down in body tissue after a certain period of time, normally from 10 to 30 days, depending on the composition of suture (Martin and Williams, 2003). On the other hand, non-absorbable type sutures are designed to either be left permanently in the human body, or they have to be taken out after a particular healing time (Almarzouq *et al.*, 2014). These permanently placed non-absorbable sutures are usually applied in tissue where curing and healing may take place but the new body tissues may never have the

Table 1: Relative tensile strengths of materials used in common sutures

Relative tensile strength	Non-absorbable suture materials	Absorbable suture materials
High	Steel	Polyglycolic acid
	Polyester	Polyglactin 910
	Nylon (monofilamentous)	Polydioxanone
	Nylon (braided)	Catgut
	Polypropylene	
Low	Silk	

Table 2: Classification of textile fibers commonly used in wound care

Origin	Source	Examples
Natural	Animal	Silk (spider, silkworm)
	Vegetable	From seed (cotton)
		Bast (linen, hemp)
Man-made	Synthetic	Polyester
	Polymers	Polyamide
		Polypropylene
		Polyurethane
		Polytetrafluoroethylene
	Natural	Regenerated cellulose
	Polymers	Proteins (collagen, catgut, branan ferulate)
		Alginates
		Polyglycolic acids
		Polylactic acids
		Chitin
		Chitosan
		Hyaluronan
	Other (non-fibrous material)	Carbon
		Metals (silver, etc.)

required strength to support themselves (Yorifuji *et al*., 2014). The useful tensile strength of such sutures usually remains effective over time. When they are used to secure skin, non-absorbable type sutures are normally removed within 10-14 days of use, but this could differ by situation and location (Im *et al*., 2007). Table 1 (Bennett, 1988) displays the order of tensile strengths of most commonly available suture materials.

Wound dressings: From very ancient times to present modern era, some suitable material had to be used to cover the wound in order to prevent any infection and to achieve effective healing of a wound (Zahedi *et al*., 2010). Historically, plant fibers, animal fats and honey pastes were used as dressing materials for wound (Majno, 1991). Presently, with the availability of new biopolymers and fabrication technologies, a wound dressing material is expected to provide best properties to improve the healing and curing process of a wound. For an efficient design of a functional wound dressing, wound healing time, characteristics of the wound type, mechanical, physical and chemical properties of the dressings must be considered. Eventually, the chief purpose is to accomplish the highest rate of curing and healing and the best aesthetic fix and repair of the wounds (Thomas, 1990). Table 2 (Petrulyte, 2008) presents the categorization of textile fibers normally used in the wound care and management. These textile fibers are grouped as either natural, which occur naturally in nature, or man-made fibers which do not appear in nature and made synthetically using petroleum products, although they are also manufactured from of natural materials such as wood pulp. Some important natural fibers include cotton, silk and linen. Man-made or synthetic polymers include polyester, polyamide, nylon, polypropylene, etc. Important natural polymers include proteins and alginates. Furthermore, several non-fibrous materials are also used in wound care (Petrulyte, 2008).

Because of the discovery of moist healing concept, alginates are found to be one of the most vital materials used in wound care and management, because they are capable to absorb exudates from wound (Eaglstein, 2001; Rajendran and Anand, 2006). Alginates offer several advantages over other counterpart conventional dressings. Products based on Alginate produces a gel on absorption of wound exudates to avoid wound from drying out. On the other hand, traditional viscose or cotton materials can be entangled in the wound and could develop pain and discomfort during the removal of dressing material (Brown and Muri, 2005).

Conclusion: This study reviewed the developments in the field of medical and health care related to textiles. This review provided an appraisal on the innovative, intelligent and smart textile products related to medical textiles, particularly antimicrobial textiles, surgical sutures and wound dressings. This review also highlighted the current state of the technologies as well as future advances and enhancements potential of new textile materials.

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