ORIGINAL ARTICLE

Advanced textile materials and biopolymers in wound management

Salvinija Petrulyte, Doctor (Technological Sciences), Associated Professor

Kaunas University of Technology, Institutional Affiliation Department of Textile Technology.

Correspondence: Salvinija Petrulyte, Department of Textile Technology, Kaunas University of Technology, Studentu 56, LT-52424 Kaunas, Lithuania.

E-mail: salvinija.petrulyte@ktu.lt

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ABSTRACT

New generation medical textiles are important growing field with great expansion in wound management products. Virtually new products are coming but also well known materials with significantly improved properties using advanced technologies and new methods are in the centre of research which are highly technical, technological, functional, and effective oriented. The key qualities of fibres and dressings as wound care products include that they are bacteriostatic, anti-viral, fungistatic, non-toxic, high absorbent, non-allergic, breathable, haemostatic, biocompatible, and manipulatable to incorporate medications, also provide reasonable mechanical properties. Many advantages over traditional materials have products modified or blended with also based on alginate, chitin/chitosan, collagen, branan ferulate, carbon fibres. Textile structures used for modern wound dressings are of large variety: sliver, yarn, woven, non-woven, knitted, crochet, braided, embroidered, composite materials. Wound care also applies to materials like hydrogels, matrix (tissue engineering), films, hydrocolloids, foams. Specialized additives with special functions can be introduced in advanced wound dressings with the aim to absorb odours, provide strong antibacterial properties, smooth pain and relieve irritation. Because of unique properties as high surface area to volume ratio, film thinness, nano scale fibre diameter, porosity, light weight, nanofibres are used in wound care.

The aim of this study is to outline and review the latest developments and advance in medical textiles and biopolymers for wound management providing the overview with generalized scope about novelties in products and properties.

Advanced medical textiles are significantly developing area because of their major expansion in such fields like wound healing and controlled release, bandaging and pressure garments, implantable devices as well as medical devices, and development of new intelligent textile products. Present day society is undergoing changes such as ageing of the population, increase of life span of individuals especially in Europe and US, various situations and hazards of human activity and civilization including transport accidents, chemical materials, fire, cold, diseases, sports. Such factors stimulate the rapid movement of wound care product market with the requirement of novel technique and technologies to develop modern textile materials and polymers. The importance of textiles for wound care applications is determined by their excellent qualities, such as strength, extensibility, flexibility, air and moisture permeability, availability in 3-dimensional structures, variety in fibres (or filament's) length, fineness, cross-sectional shape and geometry, mechanical properties. Nowadays textile products are able to combine traditional textile characteristics with modern multifunctionality. The role of dressings in wound management is constantly evolving. Virtually new products are regularly being developed and approved.

Today's worldwide industry reports estimate the wound care market to exceed $ 11.8 billion by 2009 and yearly growth for all products (devices for wound closure such as sutures and staples, dressings, adhesives, etc.) projected in excess of 7%. European markets have accounted for about half of the spending [1].

An ideal wound dressing must be able to maintain warm and moist also should provide many specific functions depending on wound type, injury or infection, healing scenario, age of the patient, other. Specialized materials with determined functions can be included in dressing extending it into multifunctional system made from natural or/and synthetic materials. Researches in wound care dressings are especially technical and technological as well as functional and effective oriented because of regular scientific inquiry into many new aspects of wound healing process and novel developments that continually enrich the knowledge base.

KEY PROPERTIES OF ADVANCED POLYMERS AND TEXTILES

Textiles include fibres, filaments, yarns, woven, knitted, non-woven materials and articles made from natural and man-made materials as well as products utilize such raw materials. Table 1 shows the classification of fibres generally used in wound care. Such fibres group into natural (that occur and are found naturally in nature) or man-made ones (that don't occur in nature, although may be composed of natural materials). Most important natural fibres are cotton, silk, linen. Man-made synthetic polymers cover fibres manufactured from chemically synthesised polymers like polyester, polyamide, polypropylene, etc. Natural polymers include alginates, proteins, etc. Some non fibrous materials are used also.

WHY FIBRES AND TEXTILES?

High surface area, absorbency phenomenon, variety in product forms are advantageous properties of fibres, which are desirable using them in wound dressing applications. There are different types of wound care products, which are based on various fabrics and non-woven materials. The latter ones can be made directly from fibres or even from polymers, other are manufactured from yarns, which are made from fibres/filaments. To make fibres/filaments, the polymers are extruded by dry, wet or melt spinning processes, after that the desired texture, shape, size, physical, mechanical and other properties are imparted. Very important and unique quality of medical textiles is biodegradability. Fibres used as wound care textiles are classified as biodegradable and non-biodegradable. Biodegradable fibres are cotton, viscose, alginate, collagen, chitin, chitosan, and other ones that can be absorbed by the body in 2-3 months. Such synthetic fibres like polyamide, polyester, polypropylene, polytetrafluoroethylene take more than six months to degrade are non-biodegradable fibres (however this definition has still vague meaning because of existing differences between the authors interpreting the terms to express absorption, bioabsorption, and degradation processes).

Table 1. Classification of fibres generally used in wound care.

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

Some decades ago wound care products' market suggested only few kinds of wound dressings available apart from traditional ones like cotton, lint, gauzes. Later each year some new materials and products were allowed to enter this market, but nowadays the explosion in products variety, market size and segments is observed around the world. Virtually new products are coming but by the way, well known and widely used cotton and other natural fibres, such as silk, flax, hemp with significantly improved properties using enzymatic and other advanced biotechnological procedures as well as new methods of processing and modification of usual fibres with the aim to overcome their lacks, are in the centre of research.

FROM VISIBLE FIBRE CLOTHS TO MOLECULAR SHAPES

Nowadays the fibres enter into novel functions and applications. New potential is open to fibres that could well themselves possess biofunctions as well as have reasonable mechanical properties or possibility to carry medications.

Following moist healing concept, alginates which are able to absorb exudates from wound have become one of the most important materials for wound management [2-6]. Alginates have many advantages over other traditional dressings. Alginate based products form a gel on absorption of wound exudates to prevent wound from drying out on the contrary to traditional cotton and viscose fibres, which can entrap in the wound developing discomfort during dressing removal. [5] confirms the alginate fibres are non-toxic, non-carcinogenic, non-allergic, haemostatic, biocompatible, of reasonable strength, capable of being sterilized, manipulatable to incorporate medications, easy processable. Calcium alginate fibres [7-9] can be used to produce yarns and fabrics for medical applications, as drug carriers for wound healing.

Chitin is a valuable natural polymer indicating excellent bioactive properties. Potential sources for chitin production are shells of crabs, crustaceans, shrimp and lobster, insects, for example the wings of butterflies, also jellyfish, algae, fungi. Chitin products are anti-bacterial, anti-viral, anti-fungal, non-toxic, non-allergic. Three-dimensional chitin fibre products with qualities such as soft handle, breathability, absorbency, smoothness, and non-chemical additives are the ideal dressings with wound healing properties. The novel method [10] for making a chitin based fibrous dressing material uses a non-animal source, microfungal mycelia, as the raw material, and the resulting microfungal fibres are different from the normal spun ones. A method of chitin separating from bodies of dead honeybees has been developed with the goal to prepare soluble derivatives useful for manufacture of novel textile dressing materials [11]. Preliminary research of modificated honeybee chitin has been carried out and soluble mixed polyesters of chitin with bioactive properties have been obtained.

Chitosan is a partially deacetylated form of chitin. Chitosan is biocompatible, biodegradable, non-toxic, is able to be used as gels, films, fibres, beads, support matrices and in blends as well. Chitin/chitosan fibres and chitosan derivatives [12-14] process excellent antibacterial properties and wound healing. The key properties of chitin and chitosan fibres as biomedical products also include that they are haemostatic, fungistatic [4]. Chitosan is used in a broad range wound healing, drug delivery, tissue engineering applications [15, 16]. Recent studies in medical textiles have resulted in progress in modification of traditional materials that are widely used as wound care products. Alginate filaments coated by chitosan are developed for advanced wound dressings [17]. Cotton fabric surfacely modified by chitosan absorbs antibiotic molecules from aqueous solution. The quantity of absorption depends on the degree of modification of the samples. The higher degree of modification the higher amount of antibiotic can be bonded by the textile. Such cotton textile finishing enables to achieve therapeutic new generation dressings for protection of surgical wounds against infections [18].

Branan ferulate is a carbohydrate polymer extracted from corn bran that may infiltrate the biological activities in the body and so accelerate the wound healing process [4, 19]. Hyaluronan is able to interact with various biomolecules [20]. Of course, because of solubility, rapid resorption and short tissue residence time the direct use of hyaluronan in wound care has limitations but the hyaluronan derivatives of different solubility and being of different forms including fibres, membranes, sponges, microspheres, have potential. [21] states hyaluronan and chondroitin sulphate chemically modified and made into hydrogel films with wound healing application as bio-interactive dressings.

Collagen, gelatin, casein, zein, elastin are proteins widely used in production of medical textiles. Collagen has been used for sutures for many years. It has controlled the biodegradation rate and is also biocompatible and highly pure. Collagen materials [22] have great potential in scaffolds for tissue culture, wound healing. Advanced product [23] in the generation of biologic dressings is a bilayered composite, a collagen sponge supporting live human allogeneic skin cells. Hybrid scaffolds for tissue repair have been produced from collagen and chitin [24].

Novel use for carbohydrates in textiles is modification of textiles with cyclodextrins. They can trap body odour compounds by inclusion complexation or can be used to release perfumes as well or to deliver pharmaceuticals/cosmetics on skin contact [25-27]. Specific potential in designing of advanced biomaterials for various applications give carbon fibres that have been used in the reconstruction of soft and hard tissue injuries [28, 29].

In recent years high attention has been given to the materials that are bioactive. Such quality along with biocompatibility, biosafety, and high absorbency is very desirable in drug delivery systems for surgical implants as well as in scaffolds for tissue regeneration. Bioactive fibres [30] manufactured from modified man-made fibres with introduced antibacterial additive in spinning process provide protection against cross transmission of diseases and infections.

MODERN TEXTILE STRUCTURES AND SPECIALIZED MATERIALS FOR WOUND MANAGEMENT

Main objectives in wound management practices and tasks of healing process are: fast and efficacious occlusion of the damaged tissue, effective management of exudates, elimination of bacteria and infections, aesthetic post recovery scars, high patient's health related quality of life. There are different kinds of wound management products: mechanical staples or sutures for wound closure, dressings or bandages for wound care, surgical sealants and adhesives, skin substitutes, and other biomaterials.

STRUCTURE AND SPECIFIC QUALITIES

Textile structures used for wound management are sliver, roving, yarn, woven, non-woven, knitted, composite materials, etc. processed using various technologies (see Table 2).

In skin healing mesh grafts are also used. Such grafts are made

Table 2. Textile structures applicable for wound management and technique used.

Structure	Technology, processes
Sliver	Carding, drawing
Roving	Roving (preliminary spinning)
Spun yarn	Spinning
Filament yarn	Formation of filament
Woven fabric	Weaving
Non-woven material	Bonding by friction or/and cohesion or/and adhesion forces
Knitted fabric, crochet	Knitting, crochet knitting
Braided material	Braiding
Embroidered material	Embroidering
Composite material	Compositing. For example, three-layered modern composite wound dressing is composed of contact layer, functional layer, and retention layer (for the layers the non-woven material, foam material, films, yarns, gels could be used)

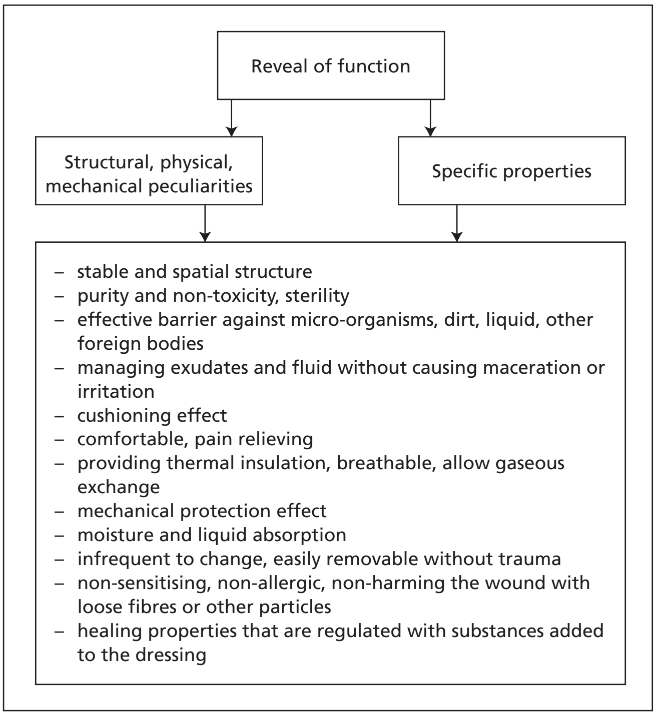

Figure 1. Functions of modern wound dressings.

from textiles with evenly spaced holes. The neomembrane is formed in the place of implanted mesh grafts during its absorption process. In recent years great attention has been given to more sophisticated multifunctional systems. Advanced microtechnologies and microfibres are coming.

Modern wound dressings are increasingly demanding textile products. Figure 1 shows the functions connected with development of new applications of modern wound dressings.

Specialized materials or/and additives with special functions can be introduced in advanced wound dressings. Such materials (additives) absorb offensive odours from bacteria infected wounds, provide antibacterial properties (silver metals or their salts), include antiseptics, antibacterial constituents, antibiotics, zinc pastes used to sooth pain and relieve irritation, sugar pastes as deodorizing agent, provide honey therapy, etc.

ATTEMPTS TO REINFORCE STABILITY AND COMPACTNESS OF MATERIAL

Majority of traditional textile dressings is made of cotton bleached gauze. Its construction characterized by dimensional instability, flying edges, wooliness and flat surface has undesirable features. New generation dressing consists of a bleached cotton fabric of leno weave structure, onto which a layer of soft paraffin material is applied. The paraffin makes the dressing hydrophobic, so that wound secretion easily penetrate to the absorbing dressing which is placed on the paraffin dressing. Paraffin eliminates the problem of loose fibres getting caught in the wound as well as dressing is chemically neutral, so the agents shortening healing can be applied to it [31]. Fibrin bandages are developed using blood clotting chemicals and an enzyme to prevent excessive blood loss in injures like gunshots, automobile accidents [32].

Alginate wound dressings in form of non-woven material are made for flat wound and of a sliver (rope) as well as pads for packing cavity and deep cavity. Rope alginates are easy to apply; several of them have good wet strength and can be removed in one peace. Alginate dressings require a second dressing by the way [2, 3]. In many situations, due to uptake of the wound exudates and gelling process, fibre structure disintegrates and leads to the loss of its structure, so that the used alginate dressings cannot be removed in one piece. Alginate dressings reinforced with clinically acceptable non-gelling materials enable a complete and clean removal. Such web can be generated using weaving, braiding, and knitting. Reinforced fancy slub yarns composed of core, sheath, and binder component should hold the alginate fibres loosely for maximum absorbency and also give necessary strength to facilitate the removal of dressings. Alginate fibres in twistless drawn sliver or slightly twisted roving form are used as the sheath in the structure of yarn with improved quality. The absorbency varies according to the alginate fibre content in the dressing as well as to the compactness of the fibres in the yarn and fabric and could be controlled by specifying the fabric parameters [3]. Branan ferulate cannot be spun into fibres in its pure or unaided state but can be blended and carried by an alginate based fibre designing advanced wound dressing material. Depending on the method of fabric conversion also on area of application (woven, knitted, non-woven), the branan ferulate content could be adjusted to attain desired mechanical properties, such as tensile [4, 19]. Collagen in wound dressings could be in different physical forms, such as extruded fibres, films, and sponges.

Spacer fabrics that consist of two textile layers held by spacer threads in defined and flexible spacing provide interesting textile solutions for medical use. The mechanical, micro-climate features with excellent air-permeability, thermoregulation allow to use such textile structures preventing chronic wounds [33, 34].

TEXTILE STRUCTURES WITH INTRODUCED SUBSTANCES

When discussing wound management the dressings that cover wounds to the outer surface of the body are often assumed. But wound care also applies to materials like foams, hydrocolloids, hydrogels, and matrix (tissue engineering). Introduction of medical substances into textile structure is developed by immobilization of medical products upon the polymer.

Soft silicone mesh is a non-adherent, porous dressing with a wound contact layer consisting of a flexible polyamide net coated with silicone [6]. The porous nature allows fluid to pass through the secondary dressing. The role of artificial skin substitutes and the treatment of chronic wounds are constantly evolving [35]. A bioartificial skin has been produced from gelatin and D-glucan homopolysaccharides [36]. Skin substitutes are very important in burn care and are used for early burn coverage increasing survival and leading to a better recovery of function and appearance as well as for chronic wounds [37]. Coated mesh fabric is used in skin substitutes for wound coverage [38].

The prospective study assessing the clinical performance of hydrogel dressings concludes the effectiveness for chronic wounds treating [39]. Research [40] is focussed on modifying the collagen-glycosaminoglycan matrix through the incorporation of antibiotics. Bacterial cellulose is a natural polymer consisting of microfibrils containing glucan chains bound together by hydrogen bonds. Bacterial cellulose/chitosan wound dressings [14] are innovative because of good antibacterial and barrier properties as well as good mechanical properties in wet state, high moisture keeping properties. Such features make modified bacterial cellulose an excellent dressing material for treating various kinds of wounds, also burns and ulcers. This modified bacterial cellulose consists of microfibres with diameters in the order of tenths of micrometer, which form a three-dimension network.

Besides that it was estimated that chitosan has a favourable impact on the mechanical properties of modified bacterial cellulose. High elongation at break indicates good elasticity, so such dressing fits the wound site well and therefore provides good protection against external infection. Bioactive material made from chitosan modified bacterial cellulose provides optimal moisture conditions for rapid wound healing, stimulates wound healing without irritation or allergization. Such composite structures have applications in management of burns, bedsores, skin ulcers, hard-to-heal wounds as well as wounds requiring frequent dressing change [41].

Bacterial cellulose modified with chitosan combines properties such as bioactivity, biocompatibility, and biodegradability of the two biopolymers creating an excellent dressing material greatly isolating the wound from environment and stimulating the healing of wound [42]. The clinical trial evaluates the efficacy and safety of new absorbent dressing impregnated with silver salts [43]. It was well tolerated and accepted and compared with baseline, the mean reduction in ulcer area was 35.0±58.0% (median 33%, $p<0.001$) after treatment in four weeks. Meanwhile authors in [44] state that median number of visits and treatment duration was higher, also the interval between visits was shorter using silver dressing on chronic wounds versus other dressings after study of 2687 patients (received 3716 episodes).

PHENOMENON OF ABSORPTION IN TEXTILE STRUCTURES

Many non-woven structures used for absorbent wound dressing exhibit anisotropic fluid transmission characteristics in-plane or in the transverse plane of the fabric structure. Such characteristics can significantly influence performance in application. Fibre orientation distribution in such materials is the main factor that has major influence on anisotropic fluid transmission, so it can be manipulated to design desirable transport properties. The directional permeability and the anisotropy of permeability are determined by fabric porosity, fibre diameter and the fibre orientation distribution [45].

Phenomenon of absorption is significant for various characteristics of the textile, such as skin comfort, static build-up, water repellence, shrinkage, wrinkle recovery. The absorbency of alginate fibre can be improved by 120 times its own weight [46]. Superabsorbent fibres [4] are made from superabsorbent polymers, which absorb up to 50 times their own weight of water (conventional wood pulp and cotton filler absorbents absorb only six times their weight). Superabsorbent fibres also present advantages such as high surface area, flexible handle, availability to form soft product of different shapes to fit the surface of the wound. Compared with the powders, the superabsorbent fibres absorb fluids much faster and to a very high level. Besides that, the fibre absorbing body fluid does not lose its fibre structure and returns to its original form.

TEXTILE ARCHITECTURES FOR CELL CULTURE SCAFFOLDS

The purpose of tissue engineering is to culture viable human tissues outside the body. The novelties in the repair of large deep wounds over recent years have needed advanced skills in tissue engineering. Introducing of biomaterials into cells and tissues if to reconstruct and repair the living organisms extended the field of tissue engineering. Manufactured structures made from natural or synthetic materials provide stabile scaffolds and allow tissues to regenerate the damaged as well as missing organs. Three-dimensional textile structures are widely used as scaffolds in tissue engineering applications. Such textile scaffolds demonstrate the ability to provide necessary conditions for cell maintenance. The scaffold should have a certain shape, porosity, and volume if to fill the wound.

Transplanted scaffolds holding a three-dimensional cell culture should copy the cartilage characteristics. Looking for regeneration of injured cartilage the scaffold material should disappear while real cartilage is healing the wound. While biodegradation is occurring the spider silk textile is overgrown with real cartilage and eventually the wound will recover without any synthetic implants [47]. Collagen and hyaluronans which are extracted from human or animal tissues could be used as natural scaffolds for assistance of healing process and such scaffolds subsequently disintegrate and are absorbed by the body [48]. Similar properties of synthetic biodegradable materials have also been developed but their assessments in vivo and in vitro practices are still limited [49]. Polyglycolic, polylactic acids, and also their derivatives are successful materials used for these applications. Tissue engineered skin is indicated for wounds that are difficult to heal, such as diabetic foot ulcers. In this case the scaffold is a crocheted mesh manufactured from multifilament yarn on which human dermal fibroblasts are seeded and to which they attach [50, 51]. The result is a dermal tissue containing metabolically active cells and a dermal matrix. Tissue engineering provides viable alternatives to autograft skin which may be used in various clinical scenarios: from covering raw areas as in burns to stimulating the healing in the chronic wounds [6]. Such products could be single layered or bilayered.

Mechanical behaviour of medical fabrics changes upon implantation while it is desirable to use the textiles that do not alter their mechanical properties when tissue grows in and forms a vital-avital composite. The potential of embroidery technique was investigated for the development of textile scaffold structures for tissue engineering. An experimental study about the influence of ingrowing tissue on the mechanics of the thereby formed vital-avital composite was fulfilled. The results show that the embroidered textile does not undergo stiffening, whereas in the knitted fabric a raise of tensile force is observed [52].

The use of alginate in textile scaffolds that may be knitted, woven, non-woven, braided, embroidered or combined has certain specialized uses. Flexibility provides versatility and so alginate fibre systems are ideal for encouraging cells to reconstruct the tissue structure in three dimensions [5]. Scaffold structure and porosity are key properties that will guide the formation of new tissue [53]. There is a need for structural biocompatibility of the scaffold and the host tissue. Three-dimensional embroidered textile architecture that combines different kinds of pores and holes and also stiff elements are designed for effective wound treatment [54].

Novelties made in genetic technology have increased growth factor availability and their potential therapeutic role in wound healing and care [6, 55]. Engineered growth factors capable of proving speed and safe healing in all types of injuries including wound-related leg amputation and the like are actively being developed and improved [55].

NANOMATERIALS FOR ADVANCED APPLICATIONS

Nanotechnique has acquired tremendous impulse in the last decade. Coated products like smart clothing as well as nanocoated materials are present innovations.

Nanofibres are very attracted due to their unique properties: high surface area to volume ratio, film thinness, nano scale fibre diameter, porosity of structure, lighter weight [56]. Nanofibres are porous and the distribution of pore size could be of wide range, so they can be considered as engineered scaffolds with broad application in the field of tissue engineering. There is a high potential for nanofibres to be the carrier of various drugs to the specific sites. If to incorporate drugs into the nanofibre matrix drug must be encapsulated into the nanofibrous structure [57].

There are a number of materials, like metals, metal oxides at nano scale, biological materials such as enzymes, drugs, etc. that can add functionality to nanofibres. Such value added nanofibres can be used effectively in tissue engineering and biomaterials, drug delivery, protective clothing, etc. Natural tissue can be weakened or lost by injury, disease, etc., so the artificial supports are required to heal wounds and to repair damaged tissues. Nanofibre scaffolds having enough mechanical and biological stability can be very important as a degradable implant [57]. Wound dressings composed of electrospun polyurethane nanofibrous membrane and silk fibroin nanofibres are developed. Such materials are characterized by range of pore size distribution, high surface area to volume ratio and high porosity, which are proper qualities for cell growth and proliferation [58, 59].

Among the antimicrobial agents silver has long been known to have strong antimicrobial activities, so antibacterial disinfection and finishing techniques are developed for many types of textiles using treatment with nanosized silver [60]. The prospective evaluation results in the effect of nanocrystalline silver dressing for ulcers that completely healed after 1-9 weeks of treatment, however, the further studies with larger number of patients are required [61]. Silver impregnated textiles are used as wound dressings for infected wounds also for wounds at high risk of infection [62]. Antimicrobial yarns [63] can be produced from cotton, linen, silk, wool, polyester, nylon, and their blends having nanosilver particles. Electron microscopic studies indicated that the yarns contained nanosilver particles mostly below or about 10 nm size with silver content 0.4-0.9% by weight. Such treated yarns showed effective antimicrobial activity against various bacteria, fungi, etc. Silver containing antimicrobials have been incorporated into wound care devices as safe and effective means in improved healing [64]. It is known that silver in contact with wound enters it and becomes absorbed by undesirable bacteria and fungi, so silver ions kill microbes resulting in treatment of infected wound.

Functionalized nanofibres are nanofibres with specific foreign materials for adding special functionalities and capabilities to nanofibres and so their application possibilities are unlimited. By improving mechanical stability of biodegradable nanofibrous structures and finding novel ways to incorporate functional materials it would make functionalized nanofibres as potential candidates for highly efficient biomaterials [57]. Currently the research has started investigated the interaction between cell and nanofibre matrices.

CONCLUSION

The data present an overview which reflects on important developments in advanced wound management materials from fibres to finished products and technique as well that are likely to refresh and enlarge the concept. Wound care textiles and products are recognized, understood, and evaluated. The information indicate that the significant properties of advanced fibres and dressings for wound management include that they are bacteriostatic, fungistatic, haemostatic, non-allergic, non-toxic, high absorbent, biocompatible, breathable, manipulatable to incorporate additives, of reasonable mechanical qualities. The advantage is that the materials are able to be used as gels, films, sponges, foams, beads, fibres, support matrices and in blends as well. The main structures used for modern wound care are: sliver, rover, yarn, woven, non-woven, knitted fabrics, crochet, braided, embroidered, composite materials. Specialized additives providing special functions can be introduced in advanced wound dressings. Up-to-date overview of latest innovations in the field of wound care materials confirms importance that modern technique like tissue engineering and nanoapplications has the great impact on advanced wound structures.

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