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The Iranian Journal of Textile Nano-bio Modification

IJTNBM 1 (2022) 9–26

Systematic Review of Wound Dressings: A Movement from the Past to the Present

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Received 22 January2022; Revised 23 May 2022; Accepted 07 July 2022

Abstract

This systematic review aims at investigating different wound dressings commonly used for the healing process and skin repair. Five databases, namely SCOPUS, Web of Science, Medline, Google Scholar, and Cochrane Database of Systematic Reviews, up to 2020, were scanned for papers specific to the topic of concern. The blinded randomized controlled trials, in vivo and in vitro studies comparing common wound dressings, including traditional, natural/biological, and artificial ones were studied in the present review. Finally, the researchers selected 22 studies. From which the data related to the clinical features of wound dressings and their advantages and disadvantages) were derived. The review of literature suggests that many treatment combinations are utilized as wound dressings based on the wound type and hospital guidelines. Nevertheless, there are conflicting views about the most appropriate choice. The findings of the reviewed articles indicate that hydrogels are the most common wound dressing used for wounds and burns due to high thermal/mechanical stability and low water evaporation. However, it is suggested to apply hybrid hydrogel membranes to overcome the low mechanical strength of a single component.

Keywords: Medical textiles, Hydrogel, Skin, Wound, Wound dressing.

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1. Introduction

Skin is the widest organ of the human body and plays several significant roles. The main purpose of this multi-layered organ is to preserve the inner organs from the environment [1, 2]. It also acts as a shield against the entry of chemicals and microorganisms [3, 4] and forms an exterior shell against fluid and salt depletion resulting in the regulation of body temperature [5]. Histologically, skin is 1.5 mm thick and has three layers of epidermis, dermis, and the deepest layer of hypodermis [6]. Accordingly, a wound can be defined as an injury in any layers of skin that breaks the physical barrier, thus intervening in the normal structure of human body and physiology [7]. The wound may occur given to acute trauma, thermal trauma, genetic disorders, injuries, or surgical interventions [8].

Wounds can be classified based on their complexity, morphology, severity, thickness, level of contamination, and time elapsed since the trauma occurred. Acute wounds heal easily but chronic wounds, such as surgical incisions, need outside sutures or materials to assist the healing process. Other kinds of wounds, such as chemical, thermal, and electric burn wounds, require intense attention and can be life-threatening if left untreated. Therefore, a precise evaluation of the wound environment is necessary for its examination, diagnosis, management, and treatment. Accordingly, thorough and accurate assessment of wounds necessitate examining the extent and related features of the wound, host factors that impact the wound status, and environmental factors that influence the most favorable wound management [9, 10].

Wound healing involves a particular biological process that heavily relies on physiological parameters. When a wound healing process fails to help the skin properly, germs, such as bacteria and viruses, can easily invade our body freely [11]. Therefore, choosing the proper wound dressing material for a particular kind of wound necessitates a thorough understanding of the wound healing process which plays a crucial role in saving the patients' lives [12, 13]. In this regard, many studies have addressed a variety of physiological and biological stages involved in the wound healing process consisting of five sequential phases of hemostasis, inflammation, migration, proliferation, and maturation [14].

In the case of acute wounds and chronic non-healing wounds, the main goal is to heal the wound. Nevertheless, the optimum dressing material must facilitate wound healing, also, it must decrease the loss of electrolytes, fluid, and protein from the wound leading to less pain and infection [13, 15, 16].

This research aimed to address the efficacy of different wound dressings applied to different types of wounds. The findings of the present study may help emergency physicians to the best decision possible in terms of the required dressings.

2. Materials and Methods

This systematic review aimed to examine the classifications of wounds, proper wound dressings, and the advantages and disadvantages of commonly used dressings. In doing so, comprehensive research was performed to find the articles on the effectiveness of different types of wound dressings on the healing process of different types of wounds. Cochrane Handbook was used to design the research steps, namely question formation, inclusion criteria, search process, selection of studies, determination of article assessment criteria, extraction of information, and discussion [17]. Moreover, a protocol was specified prior to the beginning of the research.

2.1. Inclusion Criteria

This systematic review was carried out on the original studies only in the form of randomized controlled trials and *in vivo* and *in vitro* studies in which different types of wound healing were used on patients. Therefore, all parallel randomized, quasi-randomized, prospective observational, and retrospective studies were excluded from this research. The inclusion criteria consisted of 1) a clear description of the wound healing, 2) objective findings and measurements, and 3) publication in the English language. However, the exclusion criteria were insufficient data, and publications in different languages. Moreover, the current review study does not include qualitative studies as well as editorial letters, case reports or case series, meta-analyses, consensus statements, and expert opinions.

2.2. Wound Dressing Types and Interventions

Both surface and deep wounds and burns were treated with drugs plus wound dressings, such as natural polymers, hydrogels, polysaccharides, sulphated polysaccharides, electrospun dextran, antibacterial chitosan–nanosilver film, chitosan film plus an antioxidant agent, chitosan–cellulose–silver nanoparticle composite films, chitosan–alginate polyelectrolyte complex membranes, chitosan film/gel plus fucoidan, biocompatible composite, sodium alginate–chitosan, alginates pectins, proteoglycans, keratin, collagen, silk fibroin, ciprofloxacin hydrochloride, poly-L-lactide, ciprofloxacin hydrochloride, polyethylene glycol, and gelatine sponges. In all studies, emergency physicians or care providers, such as wound healing practitioners, provided the required medical treatments. Wound dressings are used individually or in conjunction with other medications to treat wounds.

2.3. Data Collection

Five electronic databases, namely Web of Science, SCOPUS, Medline, Google Scholar, and Cochrane Database of Systematic Reviews, up to 2020, were scanned for papers specific to the topic of concern. The following keywords were used to search for related studies: “wound”, “wound dressing”, “hydrogel”, “collagen”, “skin damage”, and “injury” in combination with “healing procedure”, “physiological process”, and “infection”.

The first stage involved the evaluation of all titles and abstracts of the articles concerning the eligibility criteria. The next step included the retrieval of the full-text versions of the related studies and their evaluation The removal of the unrelated papers was accomplished by screening the titles of the articles. The remaining studies were carefully investigated. The data were objectively recorded through a standardized data form. The extracted data were then examined by two reviewers who selected the required data based on an agreement. The completion of data extraction took three months and the last search was performed on September 5, 2020. The recorded data included the used medications, type of wound, combination of wound healing plus drugs, recovery time, and painful procedure. Figure 1 describes the article selection process in a PRISMA flow diagram.

2.4. Properties of the Included Studies

The search process yielded 2,394 articles, out of which 1,831 were eliminated after initial assessment since they were irrelevant and redundant. Of the remaining 562 papers, 541 articles were not eligible; therefore, in total, 22 studies were nominated for the final analysis. The retrieved articles were then analyzed by two researchers who reached a consensus about the inclusion criteria. Those studies that had missing data were categorized as unclear. The included studies were performed on both animals and patients. The applied wound dressings were different depending on the studies, and in some cases, drugs were also used to enhance wound healing (Table 1).

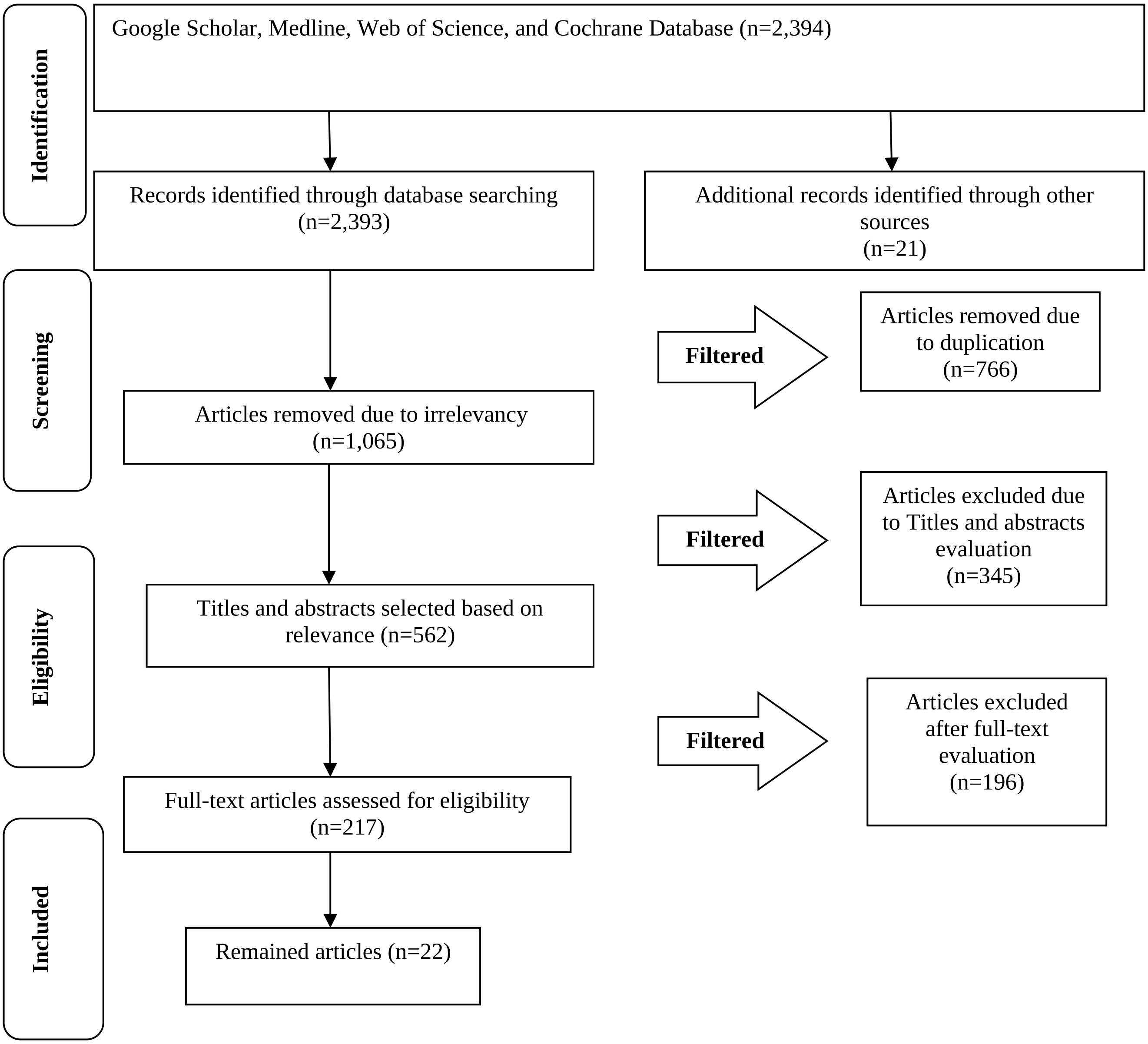

Figure 1. PRISMA flowchart representing the study selection process

Table 1. Characteristics of different research projects using various wound dressings

Type of wound	Wound dressing	Characteristics	Reference
Diabetic wound	bioactive compounds-loaded chitosan film	Moist wound environment Low the risk of dehydration Good antioxidant activity Proliferative effect	18
Skin inflammation	Hydrocortisone-loaded chitosan nanoparticles	Low severity of the pathological features of atopic dermatitis	19
Chronic wound	Activated charcoal silver dressings	Reduction of healing times Elimination of bacterial barriers	20
Osteomyelitis	Chitosan with gentamicin	Improvement of infection and anti-inflammatory	21
Second-degree burn wounds	Dendritic thioester hydrogel burn dressing	Prevention of bacterial infection On-demand dissolution for atraumatic removal	22
Second-degree burn wounds	Chitosan gel containing liposomes loaded with epidermal growth factor	High epithelization	23
Necrotic skin due to dermal burns	Hyaluronic acid sponge containing arginine and epidermal growth factor	Decreased size of the full-thickness skin defect Increased epithelization from the wound margin Moderate inflammation	24
Wound infection	Silver-containing wound dressings	Faster healing time	25
Keloids	Hyaluronic acid	Normalized keloid fibroblast characteristic features	26
Cutaneous wounds	Hydrogels with type I collagen	Faster wound healing	27
Surgery trauma	Polyvinyl alcohol–gelatin esterified hydrogel	Good potential to be hemo-compatible and moisture retentive	27
Excision wounds	Seed Husk of *Psyllium*	Remarkable antibacterial activity against both gram-positive and gram-negative selected bacteria Faster epithelialization and greater rates of wound contraction	28
Deep wounds	Collagen sponge	Shortened healing time Enhanced quality of the wound repair	29
Dermal burns	Fucoidan-chitosan films	Good potential to be a potential treatment system	23
Open wounds	Protein hydrogel	Faster wound healing of open wounds	12
Burn injury	Collagenous chitosan	Faster wound healing mechanism	30
Excisional splint wound	Aloe vera and curcumin loaded oxidized pectin–gelatin	Strong anti-inflammatory effect	31
Wound infection	Cyclodextrin-based hydrogels	Destroying bacterial cells preserving the gallic acid antibacterial activity	32
Partial- and full-thickness wounds	Poly(ethylene glycol)-protein hydrogels	Fast reepithelialisation	33

General wounds	Hydrogel dressing	Faster rate of closure and reepithelialisation	34
General wounds	PVA–clay nanocomposite hydrogels	Relatively good swelling Appreciated vapour transmission rate Excellent barrierity against microbe penetration and mechanical properties.	35
Infectious wounds	*Mentha pulegium* essential oil	Enhanced infected wound healing increase of antibacterial properties Decrease of inflammatory phase	36

3. 3. Wound Dressings Characteristics

Recently, many different materials are being used to produce wound dressings. Biopolymeric nanofibers have been studied to construct efficient wound dressings due to their properties of biocompatibility and eco-friendliness [30, 31, 37-40]. Polysaccharides, such as chitosan, chitin, hyaluronic acid, alginates, and cellulose, are the most studied biopolymers applied for wound treatment [41, 42].

Currently, with scientific and technological progress, more than 3000 types of dressings have been produced to improve the healing process. However, there is still no optimal product that cures chronic ulcers, including diabetes, pressure ulcers, and venous ulcers, which often are not fully healed [43]. It is expected that the global wound care market will involve more than USD 24.8 billion by 2024 from USD 19.8 billion in 2019, at a Compound Annual Growth Rate of 4.6% from 2019 to 2024 [9].

Wound dressing studies started with the ground-breaking study of Winter [44] who took the initial steps in designing the first wound dressing/film as a material that can keep the wound environment wet. In this regard, wound dressings were classified based on their wettability degrees in the eighties. Accordingly, dried wound dressings, such as woven cotton gauze lost their popularity, and hydrogels have been introduced as the best choice [45]. However, wound dressing selection depends on several factors, including wound site, surrounding skin, and exudate level. Therefore, depending on the type of wound (i.e., appearance, namely necrotic, sloughy, granulating, epithelializing [7]), the following characteristics should be present in an optimal wound dressing: the ability to a) preserve the moisture of the environment around the wound, b) enhance the transmission of good gases, c) eliminate unneeded exudates without reaching saturation on the outer surface of the wound, d) shield the wound from infections, contaminations, or micro-organisms, e) cease the desiccation of the wound, f) lessen the wound surface necrosis, g) trigger the growth factor, h) protect mechanically, i) be easily removed and changed, non-allergic, elastic, biocompatible, biodegradable, and non-toxic, j) decrease the pain of the wound and be cost-effective and commercially acceptable, and h) be easily sterilized [35].

4. 3.1. Traditional Wound Dressings

Wound dressings are commonly categorized as traditional, artificial, and natural/biological dressings [46]. Traditional wound dressings were introduced in the mid-1970s. Some problems, such as fast dehydration, bacterial growth, and difficult removal, led to the development of cotton gauze coated with Chitosan-Ag-ZnO nanocomposites [47]. However, such cotton gauzes expanded the capacity of swelling and enhanced antibacterial activity against *Escherichia coli* and *Staphylococcus aureus*.

5. 3.2. Natural/Biological Wound Dressings

Biological dressings are found to be an excellent treatment that can heal deep and chronic burns and wounds completely. This dressing is composed of collagen-type structures, such as lipids and elastin. Collagen and gelatin (the denatured form of collagen) are the most suitable natural macromolecules that can be used to produce wound dressings and biomaterials that are biomimetic to human skin. Collagen extraction in water-soluble, acid-neutral, or neutral forms is dependent on simple chemical or enzymatic hydrolysis [29]. Gelatin is a combination of collagen-derived peptides extracted from tissues via the same collagen techniques but are supplemented by heat treatment or acquired via acid or alkaline collagen. Collagen type I can be simply extracted from different mammalian connective tissues, including tendon, cornea, and skin [27]. Gelatin and collagen have the same properties and amino acid sequence repeats of Gly-X-Y, in which X and Y are mostly proline and hydroxyproline, respectively [31]. The main drawback of biological materials is the lack of donated skin for profound or extensive wounds, which leads to the need for new tissue donors [48]. Common natural wound dressings have two elements, gelatin or collagen and plant extracts or plant-based compounds [49]. The compounds responsible for the bioactivity of wound dressings are frequently from natural sources. Due to their nature, they are unstable under environmental conditions, and encapsulation strategies are needed to ensure their activity.

It is possible to use plant bioactive compounds in hydrogels, films, electrospun nanofiber matrices, and sponges. Likewise, micro particles and microspheres of gelatin or collagen are established as novel drug delivery systems. Sponge-like collagen and hyaluronic acid materials filled with epigallocatechin gallate were produced to treat chronic wounds. They had inhibitory activity against main wound enzymes, myeloperoxidase, and collagenase, as well as strong biocompatibility [26, 29]. Wound dressings composed of hyaluronic acid sponge with arginine and epidermal growth factor can reduce the extent of full-thickness skin defects, improve epithelization from the wound edge, and maintain moderate inflammation [24].

This type of wound healing presents multifunctional biomaterials induced dermal regeneration and exhibits anti-inflammatory properties. Collagen/chitosan scaffolds were filled with gelatin microspheres including ginsenoside Rg1, a natural compound isolated from *Panax notoginseng* [49]. The findings of different studies on chitosan-based wound dressings (loaded with fucoidan, liposomes, gentamicin, and hydrocortisone) indicated that chitosan can reduce healing time, promote epithelization, and improve antibacterial activity [19, 21-23, 50].

Bioactive compounds, including minerals, omega-3-fatty acids, probiotics, vitamins, polyphenols, and bioactive proteins or peptides, have been scrutinized for their possible usages in functional foods nutraceuticals and pharmaceuticals [26]. The antimicrobial activity of wound dressing is vital in preventing infection. There are many different natural compounds with antifungal and antibacterial activities. *Curcuma longa L.* (*Zingiberaceae* family) and its polyphenolic compound curcumin have been extensively investigated. This compound is widely used traditionally as an antimicrobial and it has low side effects. A combination of curcumin and other antimicrobial agents or silver can improve the quality of wound dressings and skin protection [20, 25, 50]. In fact, the wound healing process is faster due to the quickened epithelialization and greater rates of wound contraction [28].

There are several encapsulation strategies used to improve the bioactivity of wound dressings. Different structures, such as nanoparticles, nanospheres, or nanocapsules, can be used based on the production technique. Nanoparticles can be produced through various methods, among which the nanoprecipitation method is usually favoured due to its simplicity which leads to unimodal distribution with desirable reproducibility. Since some drugs, such as Ciprofloxacin, are water-soluble drugs, encapsulated nanoparticles were prepared by multiple emulsion solvent evaporation methods [52].

Recently, a lot of attention has been paid to lipid nanoparticles (LNPs). Nanostructured lipid carriers (NLCs) and solid lipid nanoparticles (SLNs) are two main types of Lipid-based nanoparticles [53].

The NLCs control drug release and enhance drug stability, safety, and bioavailability. Concerning drug encapsulation capacity and stability, lipid nanoparticles have advantages over the rest of the lipid-based nanocarriers (e.g., nano-emulsions) and nanovesicles (e.g., liposomes). Crystalline materials, like menthol, tend to be crystallized in a solid lipid structure and leak from it when it is stored. Therefore its amount in NLC is less, compared to SLN.[53] The exceedingly unordered lipid structured matrix of NLC increased drug stability and encapsulation. Their good release profiles led to their desirability in the nano pharmaceutical studies as well as other usages. They are also developed through various advanced techniques. It is possible to produce these systems and other lipid nanoparticles in the laboratory and on a large scale. Understanding the dynamics of LNPs on a molecular phase *in vivo* and *in vitro* requires further efforts [53].

Encapsulation in nanostructured lipid carriers can improve antibacterial properties. The required pharmacokinetic and pharmacodynamic characteristics can be designed through the encapsulation of the drugs in lipid vesicles. Liposomes as antibiotic carriers have some benefits: enhanced biodistribution and pharmacokinetics, low toxicity, target selectivity, and improved activity against extracellular pathogens. They are particularly used to overcome bacterial drug resistance[53] and enhance the treatment of infected wounds through prevention of bacterial growth, reduction of the inflammatory phase duration, and enhancement of the fibroblasts proliferation and collagen biosynthesis [36].

The food industry has shown interest in the nanofibers created by electrospinning due to their potential as vehicles for the encapsulation and controlled delivery or release of bioactive compounds [50]. Jiang et al., reported that coaxial electrospinning is a powerful method for one-step encapsulation of fragile, water-soluble bioactive agents, such as living organisms, DNA, and growth factors, into core-shell nanofibers [55]. The incorporation of bioactive oil in an encapsulation system can preserve these compounds (Figure 2).

Various methods used for preparing micro particles are: spray chilling, spray drying, fluidized bed, coacervation, extrusion, and interfacial polymerization. Some of the mentioned methods (e.g., spray drying and extrusion) depend on the preparation of emulsions before the encapsulation. Therefore, the production of the emulsion is essential for desirable encapsulation. Spray drying is one of the most used methods in the food industry [32].

Cyclodextrins (CDs) can also be used as a structuring material in the production of hydrogels. Functionalization using hydrogels, which can preserve the moist environment and increase the drug delivery capabilities of cotton, can overcome the limits of cellulosic wound dressings [32]. The hydrogel component preserves the moisture required for the healing process, and the cyclodextrin moiety can protect and modulate the release of bioactive molecules. Therefore, the conjugation of cyclodextrins with hydrogels can lead to the development of ideal wound-dressing material [56]. Pinho et al., obtained hydrogels with beta-cyclodextrin (b) or hydroxypropyl-beta-cyclodextrin (HPb) and hydroxypropyl methylcellulose by crosslinking with 1, 4-butanediol diglyceryl ether under mild conditions. The hydrogels were firm and transparent, with a desirable swelling capacity and gel-HPb had a more hydrophilic surface, in comparison to the gel-b. They reported that gel-b and gel-HPb combined with gallic acid have proved to be a practical choice for antibacterial wound dressing [57].

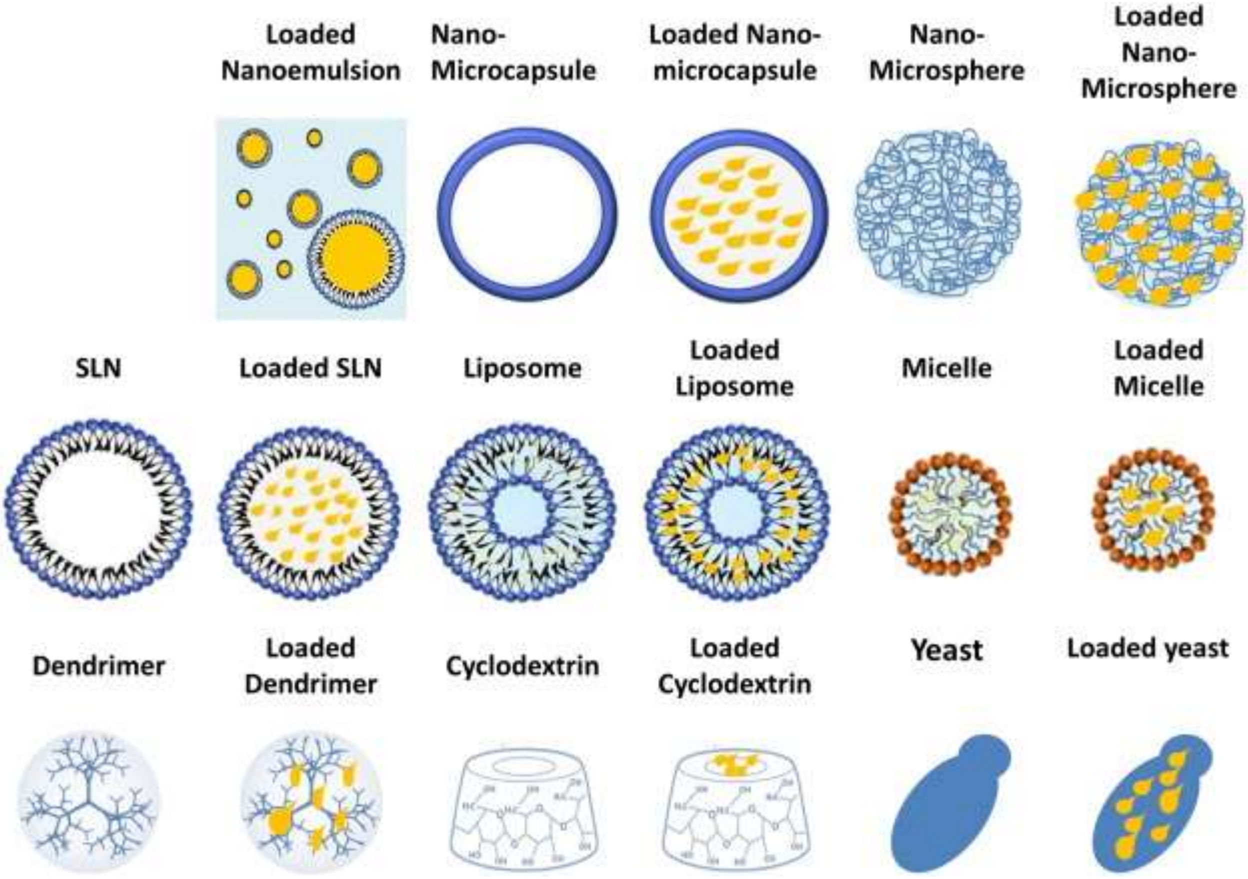

Figure 2. Different encapsulation structures for bioactive oils. The small drops inside structures represent bioactive oil in loaded systems [32]

It was also reported that the functionalization of cotton fibers with cyclodextrin-hydroxypropyl methyl cellulose-based hydrogel can improve cotton water uptake and surface characteristics and improve its function as a wound dressing. The best conditions were achieved, only the 1-step and pretreatment methodology created composites with stable cross-linking. They produced a composite material according to the cotton textile substrates functionalized with cyclodextrin-hydroxypropyl methyl cellulose-based hydrogel and controlled the drug delivery mechanism for developed composites by Fickian diffusion, according to the experimental data fitting to the Peppas-Sahlin model. Based on the findings, the produced composites can be used to prevent or treat chronic wounds [58, 59]. In another study, hydroxypropyl methylcellulose and 2-hydroxypropyl-beta-cyclodextrin hydrogel were developed and utilized as a delivery system that releases its content in a pH-dependent manner, controls the spread of microorganisms on the wounded area, and prohibits wound infection [60].

3.3. Artificial Wound Dressings

Synthetic materials, including non-biological materials and polymers not found in skin components, are used to make artificial dressings [48]. Synthetic dressings must be non-toxic, biodegradable, physically stable, and have a condition conducive to tissue repair. There has been a surge in demand for polymeric membrane products for wound dressings.

3.3.1. Semi-Permeable Film Dressings

This type of wound dressing consists of adherent and transparent polyurethane-type film which enhances the transference of CO_2, O_2, and water vapour from the wound and allows the adherence of the dressing to the skin [61]. This transparency feature of semi-permeable films provides the chance for assessing wound closure without the need to remove the wound dressing. Vapour transmission rates are within the range of 300-800 $g/m^2/24$ hours. The semi-permeable film dressings, impermeable to bacteria and liquids, contain autolytic debridement of eschar. The flexibility of this type of dressings makes them appropriately practical for shallow, superficial, and epithelializing wounds with low exudates. However, the available film dressings have different adhesive characteristics, extensibility, conformability, and vapor permeability [62]. Since adhesiveness of dressings can affect the epidermal layer of the skin, caution must be exercised when trying to remove film dressings

3.3.2. Semi-Permeable Foam Dressings

Foam dressings consist of hydrophilic and hydrophobic foam with adhesive borders [63]. The hydrophobic characteristics of the outer layer preserve the liquid; however, they enhance gaseous transference and water vapor. Silicone-based rubber foam (Silastic) easily forms to wound shape. Foam can absorb different amounts of wound drainage based on the thickness of the wound. Foam dressings are usually used as primary dressings for absorption and eliminate the need for secondary dressings due to their high absorption and moisture permeability of steam [64, 65]. Foam dressings have a major downside which necessitates frequent dressing; moreover, they are not ideal for dry wounds, dry cuts, and low exuding wounds since they require exudates for healing [64].

3.3.3. Hydrogels dressing

The hydrogel-based wound dressing is among the most favorable wound care materials and meets the requirements for dressing, including a) sensitive subcutaneous, (b) pain reduction through cooling, and (c) the possibility of active intervention in the wound healing process [33, 34, 65]. They promote healing faster than traditional gauze dressings [66].

Hydrogels, because of high level of water, porosity, and soft consistency, naturally simulate natural living tissues more closely than any artificial biological class [27, 67, 68]. If molecular collisions or secondary forces, including ions, hydrogel bonds, or hydrophobic forces have a major impact on the network formation, hydrogels are called as reversible or physical gels. Physical gels can be solubilized by altering the environmental circumstances, like temperature or pH, and the ionic strength of the solution. Chemical hydrogels are usually made using two various methods, namely three-dimensional polymerization, in which a hydrophobic monomer is polymerized in the presence of a multifunctional crosslinking agent or by direct cross-linking of water-soluble polymers.

Polymerization typically begins with free radical-generating compounds, including benzoyl peroxide, 2,2-azo-isobutyronitrile (AIBN), and ammonium peroxodisulphate, or using ultraviolet, gamma-ray, or electron beams [69]. Figure 3 illustrates this polymerization.

Hydrogels and hydrocolloids are developed as products to manage the moist wound healing process. Both produce autolytic debridement, which eases the removal of dead tissues [67]. Hagan (1992) suggests a transparent wound dressing as a thin film that has a non-adhesive central portion including hydrogel material that contained polypropylene glycol or polyethylene glycol and isophorone diisocyanate [70]. Due to the transparency of this product, it is possible to observe the wound healing process and it is also easy to remove [70].

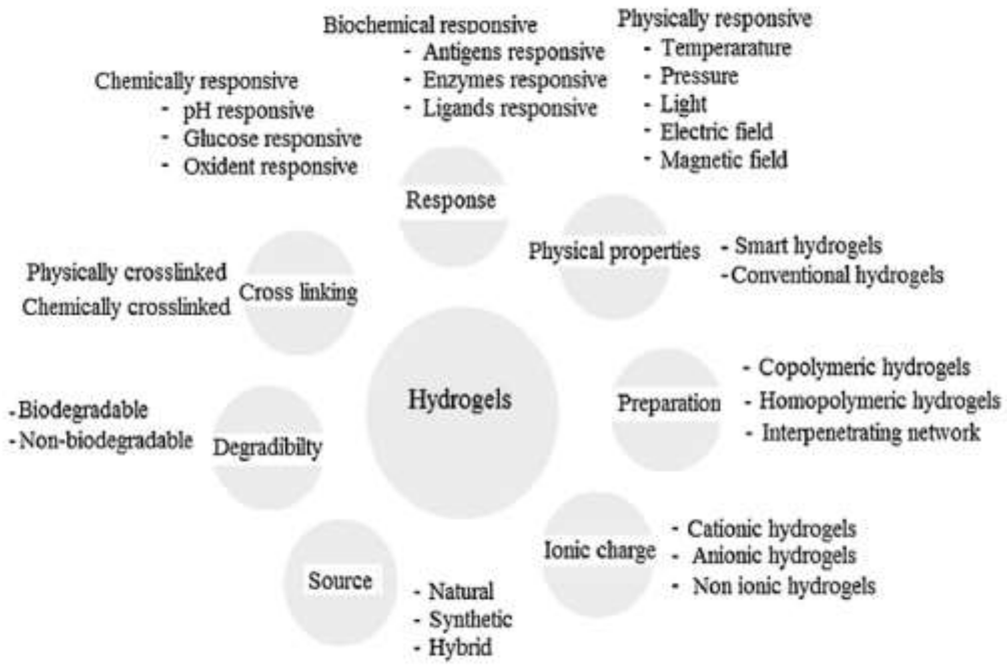

Figure 3. a) Synthesis of hydrogels by three-dimensional polymerization. b) Synthesis of hydrogels by cross-linking of ready-made water-soluble polymers [69]

3.3.3.1 Types of Hydrogels

Hydrogels are categorized based on their physical characteristics, such as preparation method, swelling, origin, ionic charges, degree of biological degradation, and observed nature of the crosslinking. In physical gels, the nature of the process is physical interaction. In a chemical process, the crosslinking of chemical covalent (simultaneous or subsequent polymerization) is used to produce chemical hydrogels. Physical hydrogels are reversible because of structural alterations, while chemical hydrogels are permanent and irreversible due to configured alterations. Double-network hydrogels are the other class of hydrogels. Double-network hydrogels are developed through combining physical and chemical cross-hydrogels by electrostatic interaction. In recent years, double-network hydrogels with high liquid absorption capacity in a wide range of pH have been used to overcome the shortcomings of using only chemical or physical hydrogels.

As can be seen in Figure 4, hydrogels can be classified according to their stimuli response as pH-responsive, temperature-responsive, glucose-responsive, protein-based, and antigen-responsive hydrogels [72].

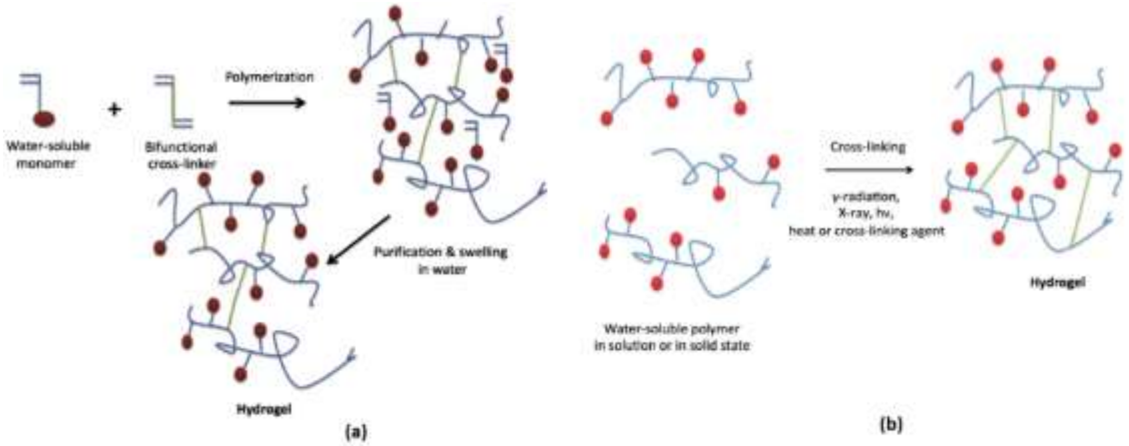

Figure 4. Classification of hydrogels based on the different properties [70]

3.3.4. Hydrocolloid Dressing

Hydrocolloid dressings are another type of interactive dressings which are commonly used. They are composed of two layers, the inner colloidal layer and the outer water impermeable layer. Hydrocolloid dressings are produced by combining gel-forming agents (carboxymethylcellulose, gelatin, and pectin) with other substances, like adhesives and elastomers [72]. Hydrocolloids can be penetrated by water vapor but not bacteria. They also allow debridement and absorption of wound exudates [73]. Hydrocolloid dressings can be properly used for mild to moderately exudating wounds, including traumatic wounds, minor burn wounds, pressure sores, and management of pediatric wounds. The main advantage of these dressings is that the patients do not suffer from the removal pain [74]. However, hydrocolloid dressings are commonly applied as a secondary dressing and they are not recommended for the management of highly exudating wounds or neuropathic ulcers [72].

6. 3.3.5. Alginate Dressing

Alginate dressings, mainly derived from seaweed, are highly absorbent and are used for moderate to large amounts of exudate. The fluid absorption of alginate is accompanied by sturdy hydrophilic gel formation that maintains the wound environment moisturized. Similar to hydrocolloid dressings, alginate dressings are used along with a secondary dressing to stay in place. It is not recommended to use alginate dressings for the management of severe wounds with exposed bone, third-degree burn wounds, and dry wounds [72]. Table 2 summarizes various polymeric dressing materials available in the global market and their brand names, their preferred usages, and the utilization percentages in wounds and burns care.

7. Table 2. List of polymeric wound dressing materials currently available in the global markets [66]

Dressing type	Commercial names	Description	Application	Global use (%)
Polymeric Films	Tegaderm Blister Poly skin II Silon-TSR Opsite, Aluderm	Films were synthesized from polyurethane or any other polymeric materials	–Superficial wounds – Laser wounds – Surgery defect sites – Skin tears	8
Polymeric Foams	Flexzan Biopatch Crafoams Biatain Cutinova Reston Lyofoam Ivalon	Foam dressings were produced by combination of hydrophilic foams and hydrophobic backing or semi-permeable with nonabsorbent membranes, such as polyoxyethylene glycol surrounded with polyurethane or silicone/ polyester	– Chronic wounds – Burns – Mohs surgery and wounds – Laser resurfacing wounds	5
Polymeric Hydrogels	Cultinova Gel, Biolex, TegaGel, Carrasyn, NuGel, Skin Flexderm, Exu Dry Dressing, CarraSorb, and GRX wound Gel	Hydrogels were made by the combination of crosslinked hydrophilic polymers, such as polyethylene oxide, polyvinyl pyrrolidone, polyvinyl alcohol	–Chemotherapy peels – Ulcers – Laser resurfacing –Average thickness wounds –Graft donor sites and artificial – Organs wounds	44
Polymeric Alginates	AlgiSite AlgiDerm Sorbsan Kaltostat Omiderm	Alginate hydrogels were produced by the combination of chemical crosslinking of sodium alginate algae with Mg, Ca, or Zn salt solutions	– Thickness burns – Surgical wounds – High exudates wounds – Chronic ulcers	20
Polymeric Hydrocolloids	Iodosorb (Cadexomer), Debrisan (Dextranomer), and Sorbex, Duoderm (Polymer blend)	Hydrocolloides were synthesized by immobilization of iodine onto water-soluble modified starch based on cadexomeriodine beads; the gel was formed by iodine exchange between polymeric material and wound exudates. The second form is Dextranomer, where crosslinked dextran is grafted with polyethylene glycol	– Chronic ulcers – Burns – Average thickness wounds – Donor graft sites	24

4. Conclusion

The awareness of the available wound dressings, their appropriate use, and their side effects is fundamental for wound management. The main concern of wound care practitioners in this field is to find a fast-acting medication that is both appropriate and safe and causes the lowest possible pain for the infected patients. Over 3000 wound dressings have been introduced in the market for different types of wounds and burns. The present work provided a review of common trends and materials used for wound management to allow the development of a wound dressing that can tackle the main disadvantages of each type and accelerate the healing process of patients. Since conventional wound dressings usually do not show a suitable performance in the treatment, researchers had recently paid attention to nanoparticles and nanofibers due to their biocompatibility and eco-friendliness. Based on the results, there are still no one-fits-all wound dressings and even those fabricated using nanoparticles have their deficiencies and restrictions in use. For instance, nanofibers can enhance drug delivery while nanoemulsions can improve drug penetration to the wound. Accordingly, there is a need to conduct future studies on fabricating wound dressing that could fulfil the needs of patients the most. (

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