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Role of Knit Spacer Fabrics in Treatment of Pressure Ulcers

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Abstract

The article highlights some significant trends in the use of knit spacer fabrics in treatment of pressure ulcers. Healing of pressure ulcer wound is complicated and time consuming. Not only affecting the lives of patients and caretakers, but pressure ulcer also becomes the burden to the government. With the developing wound management techniques, companies have launched different wound dressing designed for pressure ulcer. However, regardless for their high price, it is rare that the wound dressing can provide good wound management and cushioning to the wound. Because of the excellent air permeability and compression performance of weft knitted spacer fabrics, it has been applied in different aspects including medical. A theory has been proposed to design a 3D knit spacer bed sheet that will allow patients with pressure ulcers to be comfortable by ensuring a low friction coefficient between their skin and the material. The friction coefficient will be reduced by not only the structure but by the 70 percent polyester, 22 percent polypropylene and eight percent spandex blend.

Keywords: Pressure ulcer; Spacer fabric; Immobility; Warp knit; Weft knit

Introduction

Pressure ulcer is the damage of skin or underlying tissue caused by prolonged pressure or pressure integrated with sheer and friction over a bony prominence which heel is one of the most common sites for pressure ulcer development [1-5]. Although wound dressings have been in use for many years, wound management is becoming more and more complicated [6,7]. The aim of modern wound dressings is to improve the healing of wounds [8,9]. Moreover, the prevention and treatment of pressure sores need a significant amount of time and care. This not only greatly affects the lives of patients and their caretakers, but also the hospital services and costs of government as prolonged and expensive hospitalizations are required. Previous research has proven that the health costs of pressure ulcers are undoubtedly high [3,10,11]. It is difficult for pressure ulcers to heal and wound dressings that provide both good absorption and a cushioning effect are rare.

The purpose is to create a bed sheet which reduces the discomfort to those who have pressure ulcers as well as significantly reduce the risk of developing a pressure ulcer. Many hospitals use paper thin bed sheets with high friction coefficients which are not ideal for patients with pressure ulcers and who are at risk of developing. These patients suffer a great deal of pain, which could have been prevented. Lying on a weak bed sheet with no regards to regulating micro-climate is a clear promoter of pressure ulcers. Another key factor of a hospital bed sheet is they are to be easily washed or disposed of because of all the unknown fluids that could seep onto the sheet. Therefore, the sheet must not only be to comfort those with pressure ulcers but to be easily washable and reusable. Again, in a hospital setting being able to easily wash the sheet and for it to hold its form is significant for reducing the cost of throwing away sheets less often. Pressure ulcers are a preventable but growing problem. Every year roughly 60,000 people die due to a direct result of pressure ulcers and are only growing [12]. There is many factors which pertain to the development of pressure ulcers from a bed sheet.

These include and are not limited by having a high friction coefficient from not only the material but by the wrinkles made from tossing and turning. These wrinkles due to additional friction to the area exposed to the wrinkled area and are generally located next to a bony part of the body where pressure ulcers are commonly formed [13]. Other problems of typical hospital bed sheets consist of regulating the micro-climate and ensuring regulated moisture content. The micro-climate ensures the sheet has sufficient air permeability to help in regulating temperature which in turn reduces perspiration and regulating the moisture moves through the fabric is extremely important because if

the fabric is wet the frictional coefficient value doubles [14]. Therefore, the bed sheet must have a high wicking value but a reasonably high evaporation rate to disperse of the moisture. All factors is considered, the bed sheet will greatly aid against the protection of developing and existing pressure ulcers.

Weft Knit Spacer Fabric as Wound Dressing

Spacer fabrics is a kind of three-dimensional knitted fabrics composited of top and bottom fabric with filament yarn in between to connect them together by tuck loop stitching [15,16]. Recently, weft knitted spacer fabric has gained great attention due to their versatile physical properties [17]. Based on the previous research, physical properties of spacer fabrics can be easily adjusted by adopting various types of spacer yarn, fabric density, thickness and fabric structure [18,19]. Therefore, it has been proven to have a wide area of applicability, including in medical products, due to their versatile physical, mechanical and thermal properties [20,21]. Their excellent ventilation and cushioning properties are also important for pressure ulcer prevention and the healing process [22].

In this study, the required physical properties of the absorbent layer of wound dressings, including air permeability, thermal conductivity, water permeability, absorbency and compression, are examined in 3-dimensional weft knitted spacer fabrics, and then evaluated and compared with those of wound dressings from the market. It aims to have a deeper understanding of the particular physical properties of weft knitted spacer fabrics tailored for use as the modern wound dressings. The critical and necessary requirements of wound dressings for pressure ulcer are considered. Being a good wound dressing for pressure ulcer, not only require good absorbency property, but also breathability, thermal regulation and cushioning properties. Therefore, in this study, the air permeability, thermal conductivity, water vapour permeability, absorbency and compression of weft knitted spacer fabrics are investigated and compared with existing wound dressings in order to evaluate whether the former can be used as a substitute for the latte [23]. Based on the results, it proves that both air permeability and water vapour permeability of spacer fabrics are much better than that of wound dressings due to their structure. Although the thermal conductivity of spacer fabrics is not as good as all dressings, they are still comparable with Dressings 1,2,4 and 5. This is also true for the absorbency performance. Their absorbency property is comparable with Dressings 3,5,6 and 7. The results also prove that both compression resistance and compression resilience of some weft knitted spacer fabrics are better than that of wound dressings.

Use of 3D Warp Knit Spacer Fabric

Many hospitals use paper thin bed sheets with high friction coefficients which are not ideal for patients with pressure ulcers and who are at risk of developing. These patients suffer a great deal of pain, which could have been prevented. Lying on a weak bed sheet with no regards to regulating micro-climate is a clear promoter of pressure ulcers. Another key factor of a hospital bed sheet is they are to be easily washed or disposed of because of all the unknown fluids that could seep onto the sheet. Therefore, the sheet must not only be to comfort those with pressure ulcers but to be easily washable and reusable. Again, in a hospital setting being able to easily wash the sheet and for it to hold its form is significant for reducing the cost of throwing away sheets less often.

Therefore a theory has been proposed to design a 3D knit spacer bed sheet that will allow patients with pressure ulcers to be comfortable by ensuring a low friction coefficient between their skin and the material. The friction coefficient will be reduced by not only the structure but by the 70 percent polyester, 22 percent polypropylene and eight percent spandex blend. The friction coefficient will stay low due to a high wicking and evaporation capability to ensure the skin stays dry as well as the material. The 3D knit spacer bed sheet also has a higher compressibility which distributes pressure more evenly as well as enabling a care giver to easily rotate an immobile person into a new position. The proposed bed sheet will be easily washable to ensure all bodily fluids such as vomit, blood, and others have been removed. This blanket will be slightly more expensive but is expected to last longer than a typical hospital bed sheet.

Prospect of 3D Warp Knitted Spacer Fabric and its Effect on Pressure Relieve for Reducing the Prevalence of Pressure Ulcers for Immobile Patients turn reduces perspiration and regulating the moisture moves through the fabric is extremely important because if the fabric is wet the frictional coefficient value doubles [24]. Therefore, the bed sheet must have a high wicking value but a reasonably high evaporation rate to disperse of the moisture. All factors is considered, the bed sheet will greatly aid against the protection of developing and existing pressure ulcers.

Scope

The 3D knit spacer bed sheet will allow patients with pressure ulcers to be comfortable by ensuring a low friction coefficient between their skin and the material. The friction coefficient will be reduced by not only the structure but by the 70 percent polyester, 22 percent polypropylene and eight percent spandex blend. The friction coefficient will stay low due to a high wicking and evaporation capability to ensure the skin stays dry as well as the material. The 3D knit spacer bed sheet also has a higher compressibility which distributes pressure more evenly as well as enabling a care giver to easily rotate an immobile person into a new position. The proposed bed sheet will be easily washable to ensure all bodily fluids such as vomit, blood, and others have been removed. This blanket will be slightly more expensive but is expected to last longer than a typical hospital bed sheet.

Research Challenge to be Addressed

The human skin typically produces up to 1000cm^3/hour perspiration to maintain a balanced body temperature of 33

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°C to 35 °C [25]. This certain condition needs to be maintained while designing or manufacturing 3D spacer fabric to be used as medical bed sheets for the minimum level of comfort for the patients of pressure ulcer. And it is expected the porous structure of warp knit and 3D spacer structure will assist faster water vapour permeability; in order to reduce prevalence of ulcer by dissipate metabolic heat [26]. Even the coefficient of frictions (COFs) of human skin against medical bed sheets differs from the moisture condition of skin; such as COFs may increase from very dry to normally moist skin by 33%. Hence the 3D fabric should possess low coefficient of friction of fabric surface to facilitate the patients to change their body positions smoothly with less friction & shear which can be achieved due to its superior porous knit structure, elastomeric spandex yarn and pressure redistribution mechanism [26]. Pressure between bony prominence of human skin and external surface such as, bed sheets shouldn't exceed 33mm Hg (mercury) pressure range in order prevent pressure ulcer; which is also a major challenge to be maintained by the 3D spacer fabric [27].

Application of Innovative Idea to Lead the New Knowledge and Technology Development

a) The reason behind using a multifilament PET in the top and bottom surface instead of monofilament is that these multifilament yarns will enable easy gliding impart soft contact to human skin for improved comfort properties. In short, it will provide low friction or shear to human skin [28].

b) The current density of commercial 3D warp knit spacer fabric is approx. 55mm. However, in this project, the density is kept 205kg/m3. Higher the density, higher the thermal conductivity and faster the heat transfer [29].

c) Polypropylene has been imparted for high wicking capacity to keep the human skin as dry as possible; which is rarely used in current commercial 3D spacer fabric.

d) Monofilament is used as spacer yarn for higher compression recovery as of monofilament has higher recovery % than multifilament.

e) Anti-creasing finishing and anti-static finishing will be done after dyeing.

f) Anti-microbial finishes will be applied after dyeing so as to control the contamination.

Outcome Anticipated

a) The 3D structure itself will provide a smoother surface as well as create an acceptable micro-climate for the skin to breathe and perspire effectively to ensure a low friction coefficient. This includes high wicking and evaporation abilities as well as a reasonable air permeability to ensure a proper temperature between the skin and fabric.

b) Having a higher density will greatly improve the thermal conductivity to keep the patient comfortable and the sheets drier from excess perspiration.

c) The compressibility of this fabric allows for a more even pressure distribution over the person's body. The compression recovery is high which increases the dimensional stability.

d) Anti-creasing finishes will help against wrinkling of the sheet which reduces the chance of creating additional high friction points.

e) Anti-microbial finishes will help control against contaminants.

The bed sheet can be outsourced to provide a cheaper product which is economical for North America. No extra machinery cost will be required because knitting machines can produce many different structures out of various materials with little to no modifications [30]. By creating a new fabric opens opportunities of starting a business and creating new jobs which would be taxed to benefit the North American economy. If the hospital does not want to completely implement these bed sheets at the very least, they should be made available for those who are immobile [31]. These people are in the exact same position for hours at a time before being rotated by nurses. The bed sheet will allow for an easier time rotating the patient but will also protect against the development of pressure ulcers.

Conclusion

Many hospitals use paper thin bed sheets with high friction coefficients which are not ideal for patients with pressure ulcers and who are at risk of developing. These patients suffer a great deal of pain, which could have been prevented. Lying on a weak bed sheet with no regards to regulating micro-climate is a clear promoter of pressure ulcers. Another key factor of a hospital bed sheet is they are to be easily washed or disposed of because of all the unknown fluids that could seep onto the sheet. Therefore, the sheet must not only be to comfort those with pressure ulcers but to be easily washable and reusable. Again, in a hospital setting being able to easily wash the sheet and for it to hold its form is significant for reducing the cost of throwing away sheets less often. Because of the excellent air permeability and compression performance of weft knitted spacer fabrics, it has been applied in different aspects including medical. This paper reports on experimental study of the requirements of pressure ulcer wound dressing and the performance of weft knitted spacer fabrics in order to verify the potential for using it as the wound dressing for pressure ulcer. Fifteen weft knitted spacer fabrics and seven wound dressings designed for burns and ulcers have been chosen from the market. The air permeability, thermal conductivity, water vapour permeability, absorbency and compression of spacers and wound dressings are evaluated. The results show that the air permeability, thermal conductivity and water vapour permeability of weft knitted spacer fabrics are comparable with the existing wound dressings. The compressional resistance and resilience of them are good for providing protection as wound dressing. The absorbency of them is somewhat better than some

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wound dressings; however, they are suitable for pressure ulcer wounds with no heavy extrude.

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