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Pressure Injury Prevention Device

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Abstract: The paper aims at designing equipment for the prevention of pressure injuries in bedridden people. Pressure ulcers, also known as decubitus ulcers, pressure lesions, or bedsores, are lesions that occur on the skin of patients by the pressure caused by the contact of a bone surface with, in the case of bedridden, a hospital bed. Some factors aggravate the risk of developing these lesions and require special care, such as nutrition, hydration, mobility, moisture, and the use of certain medications. For decubitus ulcer prevention, the most suitable method is to change the person's position every two hours, as this procedure will relieve the pressure in the places of most significant contact, thus reducing the chances of developing ulcers. However, in hospitals, nurses are responsible for checking the patient's skin and changing the position of the patient, an activity that requires strength, making the process stressful, and increasing the time a bedridden stays in the same location. Pressure injuries can be aggravated by increasingly weakening the health of the patient suffering from the injury. Thus, the search for a means to prevent such lesions is undoubtedly possible. Investigation on the injuries and motors that used to solve the problem occurs. The movement of the equipment happens since the machine would change the points of highest pressure in the patient's body through the change of height in parts of the hospital bed. After research, the device was scaled and designed virtually in Autodesk Inventor 2018 software. The theoretical results possibility equipment construction. It is not possible to affirm the efficiency of the equipment in the prevention of pressure injuries, since the project did not leave the literature, not being built prototype and not being performed tests to prove its effectiveness.

Keywords: Pressure Ulcers, Prevention, Hospital Bed.

I. INTRODUCTION

Pressure ulcers, also known as decubitus ulcers, pressure injuries, or bedsores, are injuries that occur on the skin of patients, causing tissue death by pressure caused by contact of a bone surface with, in the case of bedridden, a hospital bed. [1]. Pressure injuries caused by the prolonged deficiency of blood circulation and the lack of nutrients in some areas of the body when there is external pressure caused by the continuous contact between a surface and a bone or cartilaginous region [2].

The inadequately treated, pressure injuries can worsen, increasingly weakening the patient's health. Pressure ulcers represent a highly relevant problem in medical practice [3]. Despite advances in health care, pressure ulcers continue to be a significant cause of morbidity and mortality, with an impact on the quality of life of patients and their families, creating a social and economic problem [4].

Many factors can increase a patient's likelihood of developing pressure injuries, such as immobility, malnutrition, infections, old age, diabetes, excessive humidity, urinary incontinence, and the use of some medications [5]. For prevention, care taken with the patient's nutrition and hydration, both by drinking fluids, and hydrating the skin through body creams/moisturizers, and with the other risk factors [5]. The most suitable method to prevent ulcers is to change the person's bedtime position every two hours, as this procedure will relieve pressure in the places of most significant contact, thus decreasing the chances of developing pressure ulcers [6]. However, there are obstacles to changing patients' decubitus in hospitals. Nurses are responsible for checking the patient's skin and improving the patient's decubitus. An activity that requires strength, making the process more difficult, and increasing the time that a bedridden remains in the same position [7].

As can be seen, the importance of preventing pressure ulcers is undoubted, given the complex changes in a person's everyday life. Therefore, the research aims to design equipment for the prevention of pressure injuries in bedridden people, with a technological methodology, but without a physical prototype, being only designed virtually in Autodesk Inventor, which is suitable software for this type of project [8-9].

II. BIBLIOGRAPHICAL REVIEW

Pressure ulcers are injuries that occur on the skin, beginning with prolonged tissue ischemia, that is when there is tissue death due to an absence of blood supply. The injuries happen when a patient is in the same

position for an extended period, something quite common in bedridden patients. Lesions occur, especially in tissues in regions with bone prominence, as they are regions that do not have much subcutaneous tissue [10]. About 95% of pressure ulcers occur in the lower region of the body, with the sacral region being the most common, occurring in about 31% of cases. Buttocks in 27% and heel in 20% are other regions that are very affected [11]. Several factors contribute to the development of pressure ulcers, such as friction or friction, shear, humidity, blood pressure, mobility, temperature increase, medications, among others. Resistance or friction reduces the tolerance of organic tissue to pressure by abrasion and the injuries that occur in the superficial layers of the skin, epidermal, and dermal. Conflict also contributes to pressure ulcers in the sacral region in patients [11]. The shear will act as a parallel force that will cause ischemia in the organic tissue when there is a stretch in some blood vessels.

Moisture makes the skin more fragile and contributes to increased shear and friction strength. Blood pressure can interfere because when the systolic pressure is below 100 and the diastolic pressure below 60 can delay the healing of a wound. And mobility can lead to the susceptibility of developing pressure ulcers, because a bedridden person with physical problems or problems to move, makes him stay in the same position for an extended period [12]. Especially in the elderly, there may be a delay in healing when there is a change in body temperature over prolonged periods. Medications, on the other hand, can increase or reduce the healing time of wounds.

According to the redefinition of the National Pressure Ulcer Advisory Panel - NPUAP, pressure ulcers are divided into four stages of injury severity. Specifying the characteristics of each, namely: Stage 1: Erythema no whitening of intact skin: The skin remains intact, but with ton-writeable erythema, which may have dark pigmentation. In addition to the presence of erythema, changes in temperature and skin firmness occur. Color changes do not include purple or brown discoloration; these may indicate injury to deep tissue pressure. Partial-thickness skin loss with exposed dermis: Partial skin thickness loss occurs with the exposed dermis. The wound is reddish, moist and may have blisters of serum, intact or ruptured. The layer of adipose tissue (fat) and the deeper tissues are not visible. These injuries are usually the result of moisture and friction or shearing on the skin. Loss of skin in full-thickness: Total loss of skin thickness occurs, the adipose and granulation tissue are visible in the ulcer. Bedsores may be visible, and the depth of the lesion in the tissue varies, for example, areas with a concentration of fat may develop deep wounds. However, muscles, ligaments, tendons, cartilage, and bones are not visible [13].

Total loss of skin and tissues: It is in the last stage that complete loss of skin and tissues occurs, leaving the muscles, ligaments, tendons, cartilage, and bones exposed or touchable in the lesion. The depth also varies by anatomical location. To facilitate the care of suitable patient scales to facilitate the assessment of each patient according to the risk of developing pressure ulcers happen. According to Borghardt et al. (2014), among the most commonly used scales, Braden's and Waterlow's [12] are found.

The Braden scale is the most used in hospitals, as it is the simplest, presenting six factors. The Braden scales divided into situations of risk of developing pressure ulcers, namely: a degree of sensory perception, humidity, physical activity, mobility, nutrition and friction, and shear. The patient's status in each situation results in a value, and these added values result in the score. The score assessed so that if the result is ≤ 16, the patient is at risk [12].

The Waterlow scale provides the score utilizing seven risk factors for the development of pressure ulcers, namely: weight/height ratio (BMI), visual assessment of the skin in risk areas, sex/age, continence, mobility, appetite, and medications [12]. The patient's status in each situation results in a value, and these added values result in the score. The score on the Waterlow scale, unlike the Braden scale score, is assessed so that the higher the score, the higher the risk of developing pressure ulcers. If the result is ≥ 15, the patient is already at high risk.

Projects developed using 3D modeling software, simulation, and computational support are suitable for Assistive Technology (AT) [14] or improvements in hospital devices and devices and to support people with disabilities [15-16].

III. MATERIALS AND METHODS

The construction of the prototype in the Autodesk Inventor 2018 software divided into several stages, being separated by each part of the hospital bed, the first step was to make the bed base (Fig. 1), with support for the wheels and the part top of the bed. The wheels that used in the project are from a version of Grabcad - Online community of professional designers, engineers, manufacturers, and students - made by Mohammad Reza Amiri. Some details added and insertion in the equipment set happens.

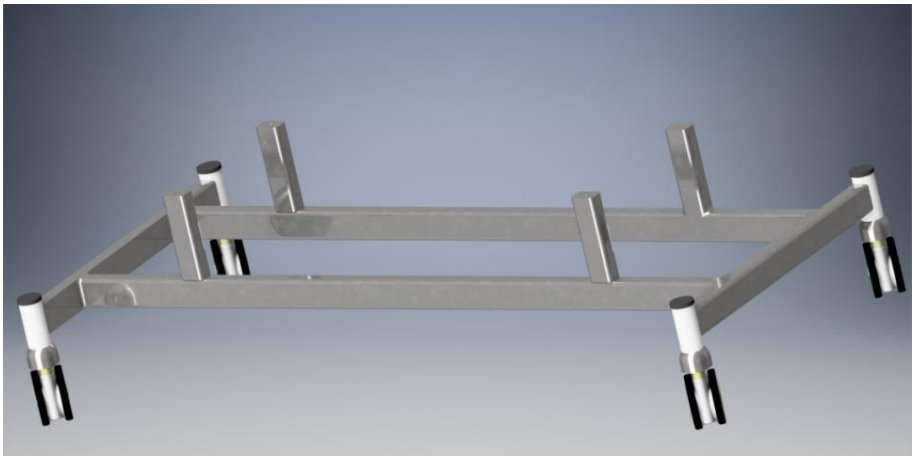

Figure 1 - Base of hospital bed.

A base building happens to support the engine and the system of mechanical jacks applied to the height changes in the parts of the hospital bed. After the construction of the base in Autodesk, the method of mechanical jacks made, using a mechanical jack created by RF Design, also removed from GrabCAD. However, it is only part of the system created by RF Design to adapt to the functioning of the bed. The method of mechanical jacks was composed of three mechanical jacks that move simultaneously through the same axis, the latter connected to an engine that was also removed from the GrabCad. A modification made to this engine: an optical sensor molded by the researches inserted. The motor shaft connected to the axis of the mechanical jacks, where supports inserted to help support the motor. The support has a bearing that removed from Grabcad. To adapt the bearing to the shaft, the bearing underwent modifications so that it could fulfill its purpose in the project (Fig. 2).

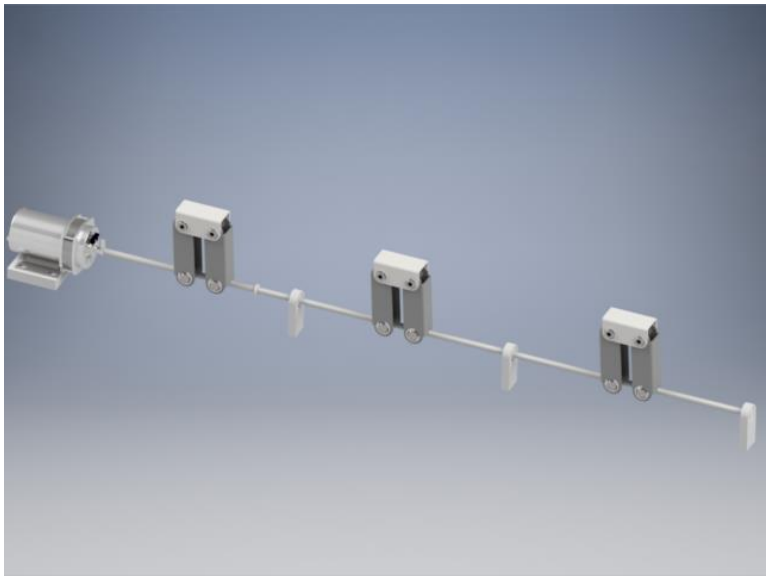

Figure 2 - Motor shaft with jacks.

With the base of the equipment and the mechanical jacks system ready, the last step was taken before the assembly, being the creation of the mattresses, plates, and supports. Divided into two categories, fixed and movable the fixed sets containing the plate and cushion fixed by screws on the base of the hospital bed using supports and the movable ones having metal support on the plate to help the fixation between the plates and the mechanical jacks (Fig. 2).

IV. CONCLUSION

With the sizing and design of the equipment in Autodesk Inventor 2018 software, dimensions occurred, and the possible prototype format. Theoretical results establish a proposal for the construction of the equipment. It is not possible to affirm the efficiency of the equipment in the prevention of pressure injuries.

From the results obtained by projecting the equipment in Autodesk Inventor software, it is possible to conclude that the design is following indications in the literature. However, it is not possible to affirm its effectiveness since no practical tests have occurred.

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