

A Review on Design and Development of Anti-Bedsores Bed for Patients

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Abstract : *Bedsores also called pressure ulcers are injuries to skin and underlying tissue resulting from prolonged pressure on the skin. Bedsores most often develop on skin that covers bony areas of the body, such as the heels, ankles, hips and tailbone. People most at risk of bedsores are those with a medical condition that limits their ability to change positions or those who spend most of their time in a bed or chair. This paper outlines an anti-bedsores bed which is a medical device that prevents or delays occurrence of pressure ulcers by alleviating contact pressure exerted on a patient due to a contact with a bed. In this work, a set of air bags are to be installed below a generic hospital bed to alleviate the bed to required direction to prevent pressure ulcers. The bed set consists of four air bags beneath the generic hospital bed in order to alleviate a patient's head, hip, thighs and heels which are generally the bedsores occurring areas. The air is filled in the air bags using air compressor. The air is filled in the air bags periodically as per required using controller unit. This can also reduce the effort of the person to tilt the patient manually.*

Keywords: *Pressure Ulcers, Bedsores, Hospital Bed, Anti-bedsores*

I. Introduction

Bedsores or pressure ulcers are localized injuries to skins and/or muscles caused by insufficient blood flow in weight-bearing areas, e.g., hip and heels, of bed-ridden patients. High moisture and high temperature increase the rate of occurrence of bedsores. Severity of bedsores depends on the magnitude and the duration of pressure exerted on a patient's body. Though curable if detected, pressure ulcers are a main cause of injuries for unassisted patients who are confined in beds or wheelchairs. A typical recommendation for prevention of bedsores is to roll over the patient every two hours to alleviate contact pressure. Some patients who recuperate at home need to expensively hire a personal caretaker to do this work. Such luxury is not available for poor patients. An alternative method to reduce the risk of pressure ulcers to develop a system that will help to relieve the pressure on the patient's body. A variety of anti-bedsores products are available in the market. Anti-bedsores products with active mechanism reduce risk of pressure buildup by moving points of contact between the patient and the support. A mechanism that gently rolls over the patients can be embedded in bed. Vertical movements of these separate partitions alternate points of contact between the body and the bed surface. The partitions can be driven by the air bags placed below the generic bed. The air bags are inflated by pneumatics. The objectives of this work is to design a new anti bedsores mechanism such that shortcomings of existing products, for example, leakage of inflatable bags or limited adjustability of rigid frame, are fully addressed. The proposed design is an extra bed on which air bags are stitched is to be installed below the regular hospital bed. It consists of four sections of air bags for four main weight carrying areas of the body: head, hip, thigh and heels. Each set can work independently, but its movement is controlled from a central automatic control board. Thus, all air bags work in a synchronized programmable pattern.

II. Literature Review

We studied the following from the Literature Survey

Siva Soonthornkitti and Petch Jearanaisilawong concluded that an anti-bedsores bed set is designed and manufactured to supplement standard hospital bed. An automatic anti bedsores bed can change the pressure point and support the patient's weight of more than 100 kg. Its ability to prevent pressure ulcers is verified by testing

pressure distribution in a test subject. The results show that the anti-bedsores bed must be set to a 15-minute cycle to successfully prevent pressure ulcers.

Atul B. Andhare, Anil M. Onkar from their survey conducted it is found that there is a need to design a new bed for bedridden healthcare. This bed should be designed as a single unit with facility of attaching commode, using the following design criteria

1. Design of bed should be simple and easy to operate
2. Movement of patient should be minimum
3. Design should take care of the bad odour
4. It should provide additional facility like racks to store medicines, was basins etc. which are required in daily use.
5. The design should reduce the amount of work / assistance required to manage bedridden patients.

Czar Czamwahyudy, Nur Dinah, Nurul Syahirah, Sharifah Nur Farehan, Siti Aishah, Siti Atiqah concluded that the product concept of Multi-Fowler Techno Bed is designed to assist both the patients that are bed-ridden as well as the workers at the health care. The product could prevent the risk of bed-ridden patients from having pressure ulcers as well as the possibility of health care workers of having musculoskeletal disorders (MSDs). Multi-Fowler Techno Bed acts as a prevention strategy is required to reduce the prevalence of pressure ulcers and also MSDs among health care workers especially nurses and physical therapists.

R. Yousefi, S. Ostadabbas, M. Faezipour, M. Nourani, V. Ng, L. Tamil, A. Bowling, D. Behan and M. Pompeo concluded that the Design and implementation of a proof-of-concept platform of a smart bed that will monitor a patient's in-bed body pressure and other parameters is presented. Machine intelligence is used to analyse data, assess the risk and alert care-givers to intervene at an early stage to prevent pressure ulcers. Specifically, the key algorithms for posture detection, limb tracking and risk assessment and also the architectural structure of the platform are discussed. In near future, we hope to report a life-scale sensor-actuator network with embedded computation, intelligence and networking capabilities that is ready for clinical trial.

Ladan Muhammad Awwal, GarbaSalehNgaski, SaniDalhatu Khalid, Sani Muhammad Hadiza, Muhammad Awwal Farouk The study showed that less than three quarter of the bed-ridden patients in the study wards had pressure ulcers while more than two third of the pressure ulcer were the advanced stages (Stage III and IV). Findings also showed that more than three quarter of the Nurses in the study wards had good awareness about pressure ulcer stages and good knowledge regarding stage-based treatment of pressure ulcer but this knowledge has not benefitted the clients as majority of them have advanced stages of the pressure ulcer. Finally, the results provided significant information about the prevalence and stages of pressure ulcer among bedridden patients as well as Nurses awareness and knowledge of pressure ulcer stage treatment in medical, orthopaedic and neurosurgical wards of Ahmadu Bello University Teaching Hospital, Shika.

R. Roaf concluded that the factors which predispose to bed sores -poor general health, anaemia, infection, shock, anaesthesia, impaired sensation, paralysis, incontinence and immobility. We are therefore in a position to recognise patients who are at risk. The question is how such risks can be minimised in a reasonably economical fashion.

Chava Weiner, Leonid Kalichman, Joseph Ribak, Deborah Alperovitch-Najenson found out that their laboratory study indicates a clear preference for the sliding sheet over a traditional cotton sheet and even over a carrier. It has been confirmed that the methods (e.g., technique/ assistive devices) used by nursing personnel have a significant influence on the back, upper limbs, shoulders and neck loading while repositioning a passive patient in bed. According the focus group, while using the sliding sheet, it can be kept under the patient. Unlike the sliding sheet, using a carrier requires extracting it out, after every repositioning of the patient. We found no evidence in the literature to risk of bedsores using sliding sheets. However, we believe that keeping the sliding sheet under the patient for extended periods, requires strict surveillance after the patients skin condition.

Yu-Wei Liu, Yeh-Liang Hsu, Wei-Yi Chang concluded that the design concept of BCTS is to integrate telehealth functions into something that already exists in the home, namely the bed. Future extensions of the BCTS to include other telemonitoring functions are discussed.

M. Ciliberti,, F. De Lara, G. Serra, F. Tafuro, F.M. Iazzetta, V. De Martino, A. Filosa, R. Scognamiglio, G. Ciliberti, M.R. Veneri Concluded that the results of their study show that Aquacel® Ag was a safe, effective and easy-to apply treatment for patients with bedsores and eliminated the need for local or systemic antibiotic therapy, thus avoiding the potential problem of bacterial resistance. These results are only preliminary and further studies will be required to confirm the role of Aquacel® Ag SCHD in the management of patients with bedsores.

Snarska K, Jarocka I, Sierzantowicz R, Łagoda K, Jurkowska G concluded that

1. The level of knowledge among studied nurses on bedsores prevention is insufficient.

2. This is probably caused by insufficient number of units where preventive actions are coordinated by suitable organizations or persons, and insufficient number and frequency of workshops and lack of hospital training on modern preventive measures and techniques.

Papaioannou G, Mitrogiannis C, Nianos G, Fiedler G, Baradaki V concluded that the prototype presented superior performance when compared to a standard clinical mattress. A significant reduction of pressure ulcer incidence was observed with the SMART surface bed for the more aggressive clinical protocols. Future work will focus on further discretization of the surface, further tuning of the fibre optics sensors and improvements in the optimization of the control software towards more efficient and locally improved pressure distribution profiles.

Zachary Govier Brush concluded that this work details the design, modelling, simulation, and open loop testing of the actuating mechanism for a smart hospital bed manufactured to prevent the development of bed sores. The steps taken to augment an unfinished, immobile prototype of the mechanism with the use of theoretical models and practical analysis are illustrated, and the resulting mechanism control program and hardware are provided. First, a dynamic model of the system is created in order to select the motors and related components based on torque-speed constraints for each motor provided by the manufacturer. Next, the model is used to determine control equations capable of making the plate follow desired operational space trajectories. These equations are then simplified, taking into account the speed, memory, and processing capacity of the microcontroller in order to make them actually usable. After altering the equations further to better model the actuating system, the capability of these simplified control equations is verified in simulation. Finally, an open-loop test of the mechanism hardware and some aspects of the microcontroller code is conducted to qualitatively assess the functionality of the hardware. With the conclusion of these tests, all aspects of the mechanism and control system designs are considered successful, with only the encoder feedback and closed-loop control feedback equations left unverified on the prototype. The novelty of this work lies in the successful application of an ideal control system developed in simulation to an actual mechanical device. The use of polynomial curve fitting techniques, trapezoidal velocity propagation, and lead screw dynamics in the model transform the dynamic modelling and computed torque equations from a simple academic exercise into a viable, applicable control system. Further work on this project would be focused on the implementation of position sensing, more complex user input, and closed-loop feedback on the mechanism. In addition, modelling and design of the pneumatic system is necessary in order to account for the air bladders on top of each plate. Finally, a control system would have to be developed to combine the 84 rods and 28 air bladders into one coordinated patient-manipulating Smart bed system. With this complete, the bed could be built in its entirety and move on to testing with real patients.

Rachel Schofield, Alison Porter-Armstrong and May Stinson concluded that none of the studies investigating functional activity and seating interface pressures explored the impact of these postural movements on the pressure around the vulnerable ischial region. Therefore, although it can be ascertained that functional activity influences the pressure at the seating interface, the positive or negative implications of such movements on seating interface pressures are currently not known. This is particularly concerning as pressure ulcers are most likely to develop around the bony ischial tuberosity region and as the effect of activities on the pressure around this area is unknown, the performance of certain seated activities may aggravate the development of pressure ulcers for populations at most risk of developing such wounds. Hence further investigation into the effect of seated activities on interface pressures is necessary.

Parag Garg, Roopak Patel, FJ Taraporvala, Aniruddha Pispati concluded that it is recommended to use air mattress for all at risk patients for decubitus ulcers and also to include air mattress as an essential part of the treatment protocol of bed sores.

III. Conclusion

An anti-bedsores bed set is designed and manufactured as an alternative for standard hospital bed. An automatic anti bedsores bed can change the pressure point and support the patient's weight of more than 100 kg. Using appropriate sensors to change the position of the patient to avoid the bed sores. This also minimises the number of people required to change the position of the patient. This set is non-hazardous for the patient & easy for maintenance.

Acknowledgement

We would like to thank Dr. S. B. Satpal for their valuable guidance.

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