Design and Evaluation of Patient Transfer Device

Mohammed Rahat Anwar, Varun Thandy, Mohammed Aburmishan
Department of Industrial and Systems Engineering
Northern Illinois University
Dekalb, IL, USA
Z1831321@students.niu.edu, Z1853360@students.niu.edu, Z1856673@students.niu.edu

***Abstract*— The project aims to design, assemble, and evaluate a patient transfer device within the budget of $200. The objective was to reduce lower back stress on healthcare workers through the implementation of a new device. The device was then evaluated using 3D Static Strength Prediction Program(3DSSPP) and Rapid Entire Body Assessment (REBA). REBA showed posture results to be reduced by half when compared to devices like pivot disc, sliding board. 3DSSPP predicted the lower back compression for the 50th percentile male to be 469 pounds and the 50th percentile female to be 333 pounds. A significant decrease in low back stress was found with our prototype in comparison to devices requiring manual lifting.**

Keywords-TRANSFER DEVICE, 3DSSPP, REBA, AUTOCAD

I. INTRODUCTION

Patient transfer devices are mechanical or electromechanical apparatuses that help move patients with upper or lower disabilities or a combination of both. These transfer devices help to reduce stress on major body extremities for the operator while ensuring a safe transition for patients to and from set locations. Devices include but are not limited to sliding board, pivot disc and E-Tac turner a turn aid device with standing support. Transfers can happen over a range of places like hospitals, clinics or can take place in private households. However, current devices in the market lack the features to reduce physical stress for healthcare workers.

II. PROBLEM DESCRIPTION

Nurses and healthcare workers are prone to work-related lower back and shoulder injuries due to frequent cycles of manual patient transfers. Patient transfer devices are not widely used in hospitals for constraints such as cost, space and set up time. Studies show that a majority of lower back pain or musculoskeletal disorders for healthcare workers comes from manual transfer of patients and are increasing at a rate of 8.8% every year. Incorrect posture like bending, stoop lifting over repeated cycles are the main driving factors of the problems.

III. PROJECT OBJECTIVES

The aim of our project is to design, build, and evaluate an easy-to-use and portable patient transfer device within a budget of $200. The project team aims to reduce the lower back stress of healthcare workers and improve the adoption rate of a low-cost, high-quality patient transfer device.

IV. METHODS

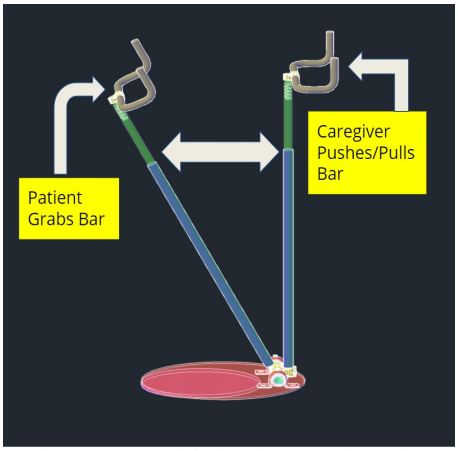

Figure 1. 3D Model of Patient Transfer Device

A. Design

The team had to research existing products in the market to find devices with the best functionality and cost closer to the allocated budget. The pivot disc, sliding board and the E-TAC turner were benchmarked. Multiple sketches were made from which the best functionality was used on the final design. The final 3D modeled design was made using AUTOCAD 2021 (Computer Aided Design).

- Detailed drawings to show dimensions, tooling requirements, materials, and quantity needed were created for design and assembly.
- Prototype device consists of rotation disc on the bottom followed with bearings in housing that hold the lifting mechanism for the device. The handlebar has a spring subassembly providing an initial momentum towards patients.

- Anthropometric static data were used for the seating height, foot length and the center of wrist grip length for the targeted population.

B. *Analysis of Transfer Tasks*

3D Static Strength Prediction Program: Spinal compression forces and distribution of the center of gravity for the four different tasks were to be determined using 3DSSPP.

Rapid Entire Body Assessment (REBA): REBA assessment worksheet as well as the Ergo Plus software to assess the body during transfers. Load, coupling, movement, and body posture were the primary focuses when analyzing the transfer.

Figure 2. Transfer with Prototype Device

C. *Design of Experiment*

Two experiments were set up and conducted for this project. The first was the procedure to collect the average push/pull force required to lift the patient for the prototype. Jackson Evaluation Strength System (J.E.S.S) was utilized to measure the average force. A second experiment was set up to understand the usability of manual transfer against transfers done using the prototype. Test subjects were Northern Illinois University students, and the transfers were performed by a qualified nurse.

V. RESULTS

Static images and video recordings demonstrating transfers done using sliding board, pivot disc and prototype allowed the team to implement two work measurements. The team utilized 3D Static Strength Prediction Program (3DSSPP) and the Rapid Entire Body Assessment (REBA) tool.

A. *3DSSPP RESULTS*

The humanoid in 3DSSPP software was modified to mimic the posture of the nurse using the prototype. The hand loads were at 25.6 pounds for each hand, and this was determined from the Jackson Evaluation Strength System (J.E.S.S). As shown in Figure 3, the predicted lower back compression forces for both male and female using prototype was significantly lower than the predicted lower back compression for the two other device.

B. *REBA*

REBA score portrays the level of risk the body would be under during the associated task. Inputting the proper postures and angles into the program, a REBA score of five is outputted. This score indicates a level of medium risk with the associated patient transfer. When in comparison with the sliding board and the pivot disc, both received a higher score of 10. This score represents a high level of risk and in need of implemented change. Results predict our device reduced the level of Musculoskeletal disorder risk by 50%.

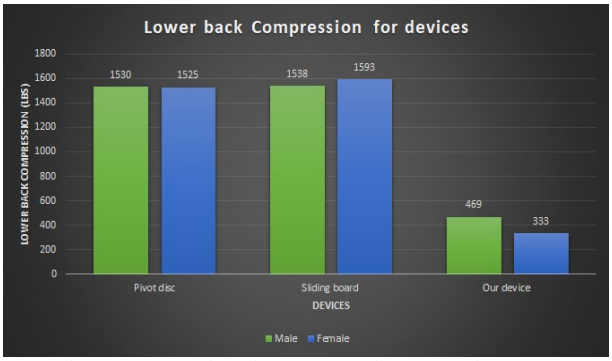

Figure 3. Comparison for Lower Back Compression Force

VI. COST ANALYSIS

Washington State Ergonomics Cost Benefit Calculator was used to estimate the predicted saving if the prototype was implemented. The model took inputs such as engineering costs, posture data and effectiveness of the solution. Predicted results indicate $4500 saved annually, 40% reduction in injury claims and 4 months payback period for one device.

VII. CONCLUSION

The team accomplished designing, prototyping, and evaluating our device within the budget constraints of $200. The team successfully utilized two work measurements to analyze the associated tasks involved in patient transfers. Predications involving correct implementation and adoption of this prototype reduced spinal compression forces and work-injury related costs for the healthcare industry.

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