Evaluation of A Passive Back-Support Exoskeleton in Bed-to-Chair Patient Handling Tasks

Introductory Information

The objective of this study was to evaluate the effect of a passive back-support exoskeleton on the physical demands of caregivers during bed-to-chair patient handling tasks. Eight participants (5 males and 3 females) performed 4 different patient handling tasks, including 1) lying to sitting, 2) sitting to standing, 3) standing to sitting, and 4) bed to wheelchair transfer with and without the exoskeleton. In certain bed-to-chair patient handling tasks, the exoskeleton (Laevo V2.5) was found to significantly reduce the peak and median values of the hip flexion angles and muscle activities of erector spinae compared to no exoskeleton. The effect of the exoskeleton was task-dependent. The exoskeleton caused a greater reduction of the erector spinae muscle activities of symmetric exertions than the asymmetric exertions. With the exoskeleton, participants adjusted their patient handling strategies by decreasing the hip flexion but increasing the trunk extension. There was a lack of significant changes in the heart rate with the exoskeleton. The results suggest that back-support exoskeletons could play a role in reducing the muscular demand of the low back during certain bed-to-chair patient handling tasks. However, further research would be needed to fully assess its effectiveness and practicality in improving patient-handling techniques.

Methods Collection

Data Collection:

- 8 participants (5 males, 3 females) had 39 reflective markers placed on the head, torso, arms, hands, pelvis, legs, and feet while performing patient handling tasks. The marker positions were recorded by 8 cameras (Flex 13; Optitrack; Natural Point, OR, USA) at a sampling rate of 50Hz).
- Each subject performed two trials of four patient handling tasks: 1) elevating a patient from a supine position to upright sitting position, 2) lifting the patient from sitting on a bed to standing, 3) repositioning the patient from standing to sitting in a wheelchair, and 4) transferring the patient from a bed to a wheelchair.
- All IRB and study protocols were followed including informed consent from participants.

Data Processing

- Motive 2.0 was used to process and analyze three-dimensional (3D) position of markers
- 3D joint angles of the trunk and left/right hips were computed between the local coordinate system of the torso and thighs relative to the pelvis, respectively
- The peak (90^{th} percentiles) and the median angles (50^{th} percentiles) of the trunk flexion/extension and left/right hip flexion/extension were summarized
- Muscle activities (EMG) signals were smoothed using a window size of 0.025 s root mean square in EMGworks 3.0 (Delsys Analysis Software)
- Processed EMG signals of each task were normalized by 95th percentile value of maximum voluntary contraction (MVC) of individual muscle (percentages of MVC); peak (90^{th} percentile) and median (50^{th} percentile) normalized muscle activity values of each task were summarized

Citations – Publications based on the dataset

Zheng, L., Sekhar, C., Alluri, V., Hawke, A. L., & Hwang, J. (2025). Evaluation of a passive back-support exoskeleton in bed-to-chair patient handling tasks. *International Journal of Occupational Safety and Ergonomics*, 1-8.

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