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Designing ergonomic interventions for emergency medical services workers—part III: Bed to stairchair transfers

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Abstract

The objective of the current work was to test interventions aimed at reducing the low-back musculoskeletal loads experienced by firefighters/paramedics (FFPs) providing emergency medical services (EMS) that involve transferring a patient between a bed and a stairchair. The interventions, developed or selected using focus groups, were a prototype Drew People Mover™, and a Transfer Sling. These interventions changed the coupling between the EMS worker and the patient. They were compared with an under-axilla lift. Eleven FFP teams transferred a 75 kg dummy between a bed and a stairchair. Both interventions were tested using two-person transfers. In addition, the Transfer Sling was tested using a one-person transfer. Surface electromyographic (EMG) data were collected from 8 trunk muscles from each participant along with spine kinematic data. Additionally, ground reaction force data obtained from two forceplates were acquired for one member of each FFP team that was used to estimate directional spine moments using a 3D linked-segment model. In the two-person transfers, there was 19° less trunk flexion ($p = 0.002$) for the FFP on the patient's left side and a trend towards less motion for the FFP on the patient's *right* side ($p = 0.079$) when using the interventions. Both FFPs showed reductions in the ipsilateral Erector Spinae activity using the Drew People Mover and the Transfer Sling that averaged approximately 9% MVC, which corresponds to a 21% decrease in the muscle activation levels. While the overall EMG was greater when performing a single-FFP transfer, the Transfer Sling reduced the bilateral Erector Spinae activity by approximately 20%. During the two-person transfers, the FFP on the forceplate to the right side of the patient showed a reduction in the forward bending moment using the Drew People Mover relative to the Sling and under-axilla conditions. During the single-person transfers, only the twisting moment was significantly reduced through use of the Transfer Sling. These objective measures, when combined with the subjective ratings of perceived exertion and the verbal feedback lead us to recommend the use of these interventions for bed to stairchair transfers.

Keywords: Low-back disorders; Emergency medical services; Intervention; Firefighter; Back pain

1. Introduction

Musculoskeletal injuries consistently account for about half of all injuries to firefighters/paramedics (FFPs) engaged in emergency medical service (EMS) operations as well as to EMS workers in the private sector (Karter and Molis, 2004; Reichard and Jackson, 2004). These injuries result in lost work time, permanent disability, and high worker compensation costs (Karter and Molis, 2004; Walton et al., 2003). In a recent analysis of 1343 firefighter worker compensation claims, the per-claim average worker's compensation cost for sprain/strain injuries was over 50% greater than for claims overall (Walton et al., 2003). The back was the primary body part affected.

As the prevalence of obesity in the general population increases (CDC, NCHS, 2004), so does the risk for injury to the EMS workers who are responsible for transporting these heavier patients. Many EMS runs begin with a seated patient being transferred from the bed to a stairchair for

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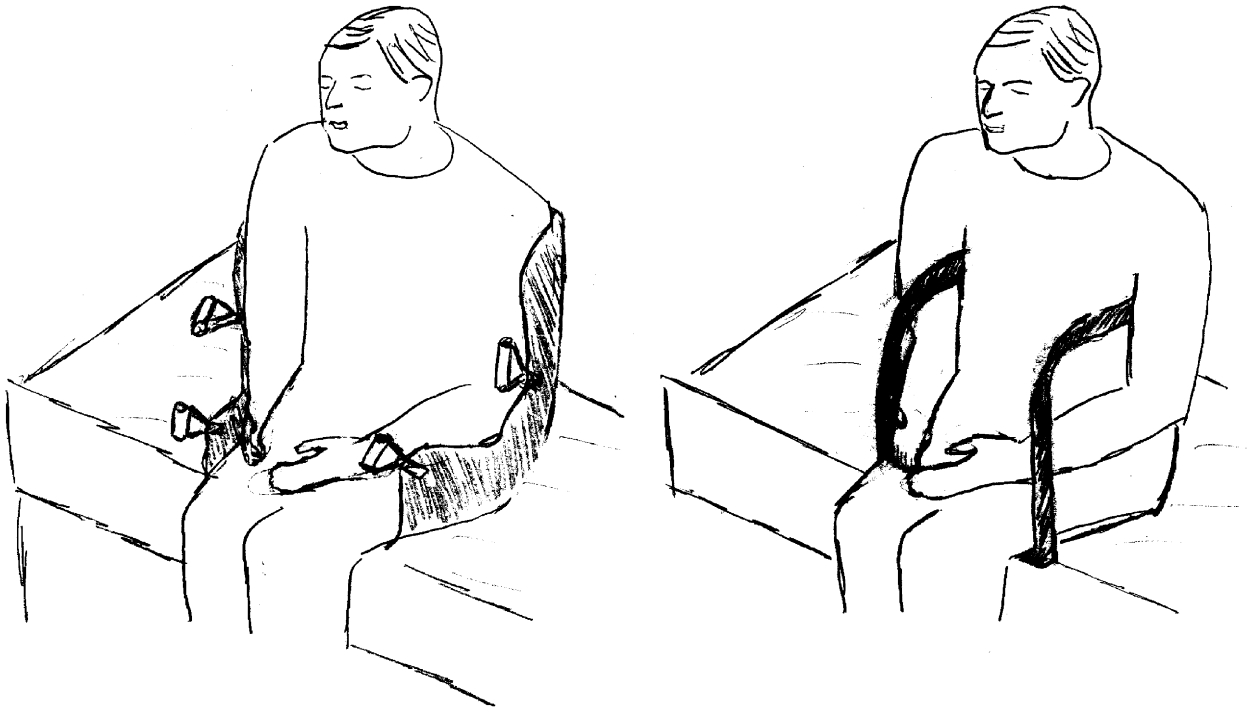
downstairs transport (Conrad et al., 2000). A second transfer is then performed as the patient is moved from the stairchair to the ambulance stretcher. Previous research studying patient handling tasks used in health care settings has indicated that bed to wheelchair transfers result in very large spinal compression and shear loads, with the compression loads in excess of compression force used in the NIOSH action limit (3400 N) (Daynard et al., 2001; Marras et al., 1999) and the shear loads in excess of the 500 N action limit recommended by McGill et al. (1998).

The purpose of this work was to evaluate ergonomic interventions aimed at reducing biomechanical loads on the back as patients are transferred from the bed to a stairchair during simulated EMS operations. Typically, these transfers are performed by lifting the patient using an under-axilla lift and may be performed by one or two EMS workers. The ergonomic interventions described in this paper have been developed to facilitate lifting the patient, by essentially providing handles that facilitate the ability to grasp and handle the patient. In other health care settings, gait belts and slings are often used for this purpose; however, there is conflicting evidence regarding the benefits of that intervention (Hignett, 2003). It should be noted that while a gait belt is not intended for use when it is necessary to lift the patient's entire weight, a sling may be used to do so. Elford et al. (2000) report a reduction in the amount of angular deviation, velocity, and acceleration of the trunk, as measured with a lumbar motion monitor (LMM), when using a sling during chair-to-chair patient transfers, suggesting that the use of one or two slings may reduce the risk of back injury.

The specific ergonomic interventions were developed through a series of focus group discussions with FFPs (Conrad et al., in review). Three groups, each with between 8 and 10 FFPs met twice to brainstorm and refine intervention ideas. An industrial designer sketched drawings of the concepts suggested by the participants. During these discussions, the ergonomic challenges of using the existing approach, the under-axilla lift was discussed and potential interventions were proposed for the ergonomic issues identified.

The first intervention, called the Drew People Mover™ (Drew Systems, LLC), was a piece of fabric 122 cm long that is narrower at the top (41 cm) and wider (76 cm) at the bottom and has multiple attachment points for the four handles (Fig. 1a). The Drew People Mover would be worked under the patient prior to moving, at which point the handles would be attached, and the patient lifted by two or more FFPs and transferred in essentially a fabric seat. The second intervention was termed the Transfer Sling. The Transfer Sling was comprised of a long webbed belt, essentially a very long and continuously adjustable seat belt that could be wrapped around a patient's back and under their thighs before reconnecting with itself to form a continuous loop. When lifting a patient, the FFPs would position themselves in front and to the side of the patient and would grasp the Transfer Sling approximately 1/3rd of the way down from the most superior point on the



(a) (b)

Fig. 1. The two interventions that were evaluated in this study were the Drew People Mover (a) and the transfer sling (b).