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Overall risk index for patient transfers in total assistance mode executed by emergency medical technician-paramedics in real work situations

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ABSTRACT

Few studies have quantified the risk of musculoskeletal disorders during patient transfers in total assistance mode in real-life prehospital emergency care situations. An index to assess the overall risk of patient transfers was created; it makes it possible to quantify risk based on the patient's position and the height of the patient's location. An analysis of 71 transfers executed by paramedics in actual work situations showed that moving a patient from the ground was characterized by acute sagittal flexions and axial rotations, respectively, 42% and 12% of the time. When the patient was lying on a raised surface, the lifting index and perceived exertion were the lowest (2.55; easy). According to the overall risk index, patient transfers from the ground are the riskiest. Paramedics execute many risky lifts even in favorable patient handling contexts.

1. Introduction

Ambulance services provide prehospital emergency care with the aim of reducing the mortality and morbidity of patients in distress (Corbeil et al., 2017). Regardless of the work context, emergency medical technician-paramedics (EMT-Ps) must move the patient safely to the ambulance, load the patient and then transport him/her to a hospital to receive the necessary care.

Epidemiological studies conducted on large populations classify professions according to their arduousness (Jolivet, 2011; Yilmaz, 2006). The main factors identified by these studies are high work tempo, handling of heavy loads, high physical exertion and awkward postures (Jolivet, 2011; Yilmaz, 2006). The consequences of high arduousness include premature aging of workers and disability at retirement (Yilmaz, 2006). These consequences have in fact been reported for EMT-Ps (Hogya and Ellis, 1990; Rodgers, 1998; Sterud et al., 2006).

To lower the prevalence of musculoskeletal disorders (MSDs) among workers, some prehospital urgent care companies have opted to purchase mechanized stretchers and loading systems, which considerably reduce the number of lifts EMT-Ps have to make (Armstrong et al., 2017; Fischer et al., 2017). Nevertheless, patient transfers continue to be regular, demanding, variable activities at risk for MSDs, particularly when EMT-Ps must carry the patient's entire weight (transfers in total assistance mode) (Conrad et al., 2008; Dropkin et al., 2015; Fischer et al., 2017; Lavender et al., 2000a).

Laboratory simulations have made it possible to quantify awkward postures, primarily related to sagittal flexion. When the patient was lying on the ground, maximum sagittal flexions of almost 70° were observed (Lavender et al., 2000b). Very high lumbar loads were assessed, ranging from 3700 to 7600 N depending on the type of transfer (patient lying on the ground versus on a surface raised above the ground) (Doormaal et al., 1995; Lavender et al., 2000a). Laboratory simulations minimize the impact of certain work characteristics, since they expose participants to controlled, minimally variable situations. Although these scenarios are practical, they may limit EMT-Ps' repertoire of motor actions and working strategies, and thus provide only a partial view of their exposure to risks of MSDs.

Outside the hospital environment, few studies have examined patient transfers, such as those carried out by EMT-Ps in real-world situations, since they are unpredictable (Corbeil et al., 2017; Hignett,

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2003). Field studies have reported that EMT-Ps often adopted awkward back postures (bending or twisting) to perform their tasks, particularly during lifting activities (Doormaal et al., 1995; Prairie and Corbeil, 2014), and that more time is spent in trunk bending and twisting positions when the task becomes more demanding (Prairie and Corbeil, 2014). Arial et al. (2014) observed general work strategies used by EMT-Ps to protect their back during lifting activities: moving the furniture to free up more space around the patient so they can adopt more comfortable postures; protecting the patient's bed with a cover, so they can put their boots on the bed, allowing better adapted postures and easier access to the patient; and requesting support from colleagues or other professionals with appropriate lifting equipment (e.g., hydraulic lifting) when available. Other related tasks that may have negative impacts on workers' health are carried out immediately before and after the loading task; these include positioning and repositioning the patient with or without equipment (Hignett, 2003; Prairie et al., 2016). Given the variability of work situations, a classification based on the patient's position and the height of the patient's location was retained: (1) patient lying on a surface that is above ground level, (2) patient sitting on a surface that is above ground level, or (3) patient sitting or lying on the ground (Larouche, 2013). On the basis of real-life patient transfers carried out by EMT-Ps, the MSD-related risk assessment for each family of patient transfers remains to be done to get a more accurate picture of the situation and thus help formulate recommendations for preventive measures.

Several validated tools can be used to measure the risks of MSDs during real-life patient transfers. Each of them targets one specific aspect of risk: perceived exertion, static and awkward postures, or handling of heavy loads (Borg, 1990; Marras et al., 1995; Snook and Ciriello, 1991; Waters et al., 2006). Recently, the development of a high-tech measurement instrument has made it possible to measure three-dimensional back movements in real work situations and quantify the ranges of motion and holding times of awkward postures (Marras et al., 1995; Plamondon et al., 2007).

The primary objective of this study is to create an overall risk index that takes account of several aspects of risk, such as awkward postures recorded by a dosimeter, a lifting index, perceived exertion and duration of the task. The second objective is to compare the risk associated with patient transfers in total assistance mode observed in real work situations and assigned to three families of transfers. Considering that work methods are influenced by the patient's position and the height thereof, the following hypothesis was formulated: the overall risk index will be higher for the family of patient transfers from the ground (sitting or lying) and lower for patient transfers from a raised surface.

2. Material and methods

2.1. Participants

This field study was carried out between summer 2011 and summer 2013 and necessitated almost 2000 h of observation and measurement. The EMT-Ps in the study could not have been off work in the 30 days preceding data collection. Ethical approval was obtained from the institutional ethics committee. Participants were recruited on a voluntary basis, and written informed consent was obtained from all of them.

An observer accompanied 175 two-person teams of EMT-Ps during an entire work shift (Corbeil et al., 2017). During these shifts, the EMT-Ps responded to 639 call-outs that required a prehospital intervention ending in the transportation of a patient to a hospital. This study concerns only patient transfers directly to stretchers that were executed in total assistance mode. A total of 71 such transfers were observed, involving 45 pairs of EMT-Ps. A single member of each pair was the subject of the study (Table 1). Considering that each team member has a specific role (one is responsible for providing care to the patient, EMT-P 1; the other is responsible for evacuating the patient, EMT-P 2) and that their roles may alternate within a given shift, the participants' roles were therefore variable (Corbeil et al., 2017).

Table 1
Characteristics of EMT-Ps observed.

	Total
Number of EMT-Ps	45
Age (years)	35 ± 10 (22–59)
Experience (years)	11 ± 11 (1–35)
Height (m)	1.77 ± 0.08 (1.57–1.91)
Weight (kg)	80.8 ± 12.2 (52.2–110.0)
Men/Women	40/5
EMT-P 1/EMT-P 2	44/27

Age, Experience, Height and Weight = mean ± standard deviation (minimum and maximum); EMT-P 1 = assigned to care; EMT-P 2 = assigned to preparing for the patient's evacuation and driving the ambulance.

2.2. Data collection

All the EMT-Ps observed wore a piece of equipment that continuously measured the three-dimensional angular movements of their back (Fig. 1; Plamondon et al., 2007). The acquisition frequency of these signals was set at 120 Hz. Validation and repeatability tests indicated that root mean square errors were below 5° for forward flexion and lateral flexion angles and below 7° for torsion (Plamondon et al., 2007).

A digital camcorder (GZ-HD500BU, JVC Canada) was used to

Fig. 1. Posture dosimeter. This equipment is composed of three parts: two inertial sensors (Xsens Technologies B.V., NL) on the pelvis (lower sensor) and on the thorax (upper sensor) and a flexible structure equipped with a potentiometer that connects the two orientation sensors (Plamondon et al., 2007). Data from the two sensors and the potentiometer are integrated with a complementary filter that optimizes the sensors' response (Plamondon et al., 2007).