

# Electromyography as a measure of peak and cumulative workload in intermediate care and its relationship to musculoskeletal injury: An exploratory ergonomic study

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## Abstract

Injury rates in Intermediate Care (IC) facilities are high and the factors related to these injuries are unclear. The objectives of this exploratory sub-study, which is part of a large multi-faceted study in 8 IC facilities are to: (1) evaluate EMG measured over a full-shift in the back and shoulders of 32 care aides (CAs) as an indicator of peak and cumulative workload ( $n = 4 \times 8$  facilities); investigate the relationship between EMG measures and injury indicators; and explore the relationship between EMG measures and other workload measurements. Lumbar EMG was converted to predicted cumulative spinal compression and ranged in CAs from 11.7 to 22.8 MNs with a mean of 16.4 MNs. Average compression was significantly different during different periods of the day ( $p < 0.001$ ) with highest compression during pre-breakfast when CAs assist most with activities of daily living. Significant differences were found in average compression between low and high injury facilities for 3 of 5 periods of the day ( $p < 0.010$ ). Peak compressions exceeding 3400 N occurred for very little of the workday (e.g. 11.25 s during the 75 min period pre-breakfast). Peak neck/shoulder muscle activity is low (99% APDF ranged from 8.33% to 28% MVC). Peak and cumulative spinal compression were significantly correlated with lost-time and musculoskeletal injury rates as well as with total tasks observed in the CAs ( $p < 0.01$ ). Perceived exertion was only correlated with peak compressions ( $p < 0.01$ ). Facilities with low injury rates provided significantly more CAs ( $p < 0.01$ ) to meet resident needs, and subsequently CAs performed fewer tasks, resulting in less peak and cumulative spinal loading over the day.

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## 1. Introduction and review of literature

According to the British Columbia Workers' Compensation Board, injury rates for workers in health care are higher than those in any other industry in BC

(Workers' Compensation Board of British Columbia, 2000). Average injury rates among staff in Intermediate Care (IC) facilities in British Columbia are among the highest, ranging from 9.6 to 10.5 claims per 100 person years for the period of 1995–1999. This injury rate is approximately 50% higher than in BC's acute care sector and slightly higher than in long-term care as a whole (Workers' Compensation Board of British Columbia, 2000). The majority of the injuries are

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musculoskeletal in nature, occurring especially to the back, shoulder and neck.

IC facilities provide 24-h nursing care for individuals who can no longer live safely in their homes. Residents in IC are generally mobile, however they have varying degrees of intermittent dementia, resulting in high and changeable needs related to activities of daily living such as toileting, dressing, and eating (Cohen et al., 2003). Unlike Extended Care where Care Aide (CA) injuries are associated with frequent manual lifting, transferring and repositioning of residents, it is unclear in IC the factors contributing to such high injury rates.

A large multi-method, multi-disciplinary study was conducted over 2.5 years in eight IC facilities to investigate the factors associated with injuries in order to determine strategies for prevention of such injuries. Four areas were investigated, including: organizational culture and climate; safety environment; physical environment; and workload. The main study design and effects of the organizational culture and climate on injury rates are presented elsewhere (Yassi et al., 2004). Results of various workload measures compared with injury rates are also presented elsewhere (Cohen et al., 2004). This study will present results of an exploratory ergonomic sub-study investigating the use of full shift electromyography (EMG) measures as an indicator of peak and cumulative workload. It will then compare the EMG measures with other measures of workload, as well as with rates of loss-time and musculoskeletal injury in IC.

Workload may be thought of by CAs in several ways. The staffing level or number of residents per CA is an important workload construct and there is evidence that high staffing ratios are linked to improved resident outcomes, increased job satisfaction and higher retention rates (Feuerberg, 2000), as well as fewer injuries (Cohen et al., 2004). Yet, staffing levels do not describe fully the workload construct because workload also depends upon the acuity or demands of the residents. Those with higher levels of dementia require more time and assistance with activities of daily living, and thus more workload. To this end, Directors of Care will assign staff to units based not only on the number of residents, but also their acuity such that some designated dementia units have twice the staffing ratio, but not necessarily less workload.

Workload can also be thought of in production terms, such as the number of tasks performed by CAs in the day. This is a function of how the facility organizes its workload among staff, for example whether CAs are required to also make beds, fold laundry, serve meals and bathe residents (some facilities have designated Bath Aides). Environmental factors can contribute to workload for CAs including the age and design of the facility, especially the size of resident rooms and bath rooms, and lengths of hallways. In some facilities, bathrooms

are too small for mechanical lift equipment or 2-person lifting and all assistance is provided by single person manual lifts and transfers. It is expected that CAs who work in facilities with low staffing ratios and with residents of higher acuity, and who perform other tasks, often in tight spaces will have more awkward bending and lifting postures and therefore more peak and cumulative loading of the spine and shoulders.

Few ergonomic studies in health care have investigated peak and cumulative spinal or shoulder loading, especially over an entire shift. Most studies measure very specific aspects of workload, such as the postures, loads and forces on the spine when performing patient lifts and transfers (Daynard et al., 2001; Engels et al., 1994; Winkelmoen et al., 1994). Often such studies report considerable peak loads on the lumbar spine of CAs while performing these tasks (Daynard et al., 2001). While there is ample evidence that peak loads contribute to low back pain and injury (Norman et al., 1998; Punnett et al., 1991; Marras et al., 1993), there is growing evidence that cumulative compressive load is also associated with back pain and disorders (Kumar, 1990; Norman et al., 1998; Seidler et al., 2001).

Choosing methods for the measurement of workload in IC facilities is challenging. Observational techniques, supported by the use of videotaped recordings for further computer modeling analysis have been used extensively for peak and cumulative loading (Norman et al., 1998; Punnett et al., 1991; Daynard et al., 2001). However, in most of these studies the tasks were repetitive, or certain tasks were selected, and all occurred at a single workstation allowing for proper videotaping technique. In IC, the tasks are non-repetitive and varied and CAs move quickly from room to room making the set-up of videotape prohibitive. In addition, there are issues of privacy when residents are dressing and toileting that hinder observation, and difficulties obtaining informed consent with residents suffering dementia.

Self-report measures of workload where workers respond to questions in self-administered questionnaires, diaries or interviews are also a popular technique (Burdolf and van der Beek, 1999; Wells et al., 1997; van der Beek and Frings-Fresen, 1998). While they have the advantage of being inexpensive to administer and allow for a wide variety of risk factors to be investigated, they often do not give reliable information on either the nature of the exposure, or the magnitude (Wiktorin et al., 1993). Direct measurement of tissue loads is generally preferred as it is thought to be objective, although it is more costly and time-consuming (Burdolf and van der Beek, 1999; Wells et al., 1997). Wells et al. (1997) advocate using lumbar compression as a common metric across measurement methods. They argue that it

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