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Exploring implicit preventive strategies in prehospital emergency workers: A novel approach for preventing back problems

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ABSTRACT

Introduction: Back problems are a major occupational health issue for prehospital emergency care professionals. The goals of this article are to: 1) provide descriptive data about the prevalence and the severity of lower back and upper back disorders in EMTs and paramedics; 2) identify some individual and collective strategies used by EMTs and paramedics to protect their health as they perform prehospital emergency missions; 3) assess the possible effectiveness of strategies in preventing back problems by exploring associations between the use of strategies and the presence and severity of symptoms.
Material and methods: The method includes a questionnaire survey (sample $n = 334$; paramedics and emergency medical technicians) and ergonomics work practice analysis involving shadowing ambulance crews in 12 medical emergency services (over 400 h).
Results: A majority of ambulance professionals had experienced back pain in the twelve-month period before the survey. Work practice analysis revealed strategies and tricks of the trade used by ambulance professionals to reduce the chances of back strain while working. Multiple regression analyses showed that self-reported use of such strategies was associated with fewer back symptoms.
Conclusions: Preventive strategies should be integrated into specialised training programs for prehospital medical emergency professionals. This approach could also be used in other work settings.
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1. Introduction

There is evidence suggesting that occupational health problems are a major issue for emergency medical technicians (EMTs) and paramedics. For example, these professions have a high reported rate of retirement on medical grounds (Rodgers, 1998a) which may well be the consequence of deleterious working conditions. Musculoskeletal disorders (MSDs), chiefly chronic back pain, seem to be particularly prevalent in workers providing prehospital emergency care (Maguire et al., 2005). In EMTs and paramedics, they are the cause for 47% of early retirements on medical grounds (Rodgers, 1998b), affect a large proportion of ambulance professionals (Hogya and Ellis, 1990) and are a major reason for seeking medical help (Sterud et al., 2008). Strenuous tasks involving adopting awkward postures, transferring victims from bed to stretcher, or lifting and carrying patients on stretchers, are everyday examples of the work done in these occupations (Doormaal et al., 1995; Lavender et al., 2000a, 2000b). Therefore, the onset of chronic MSDs often entails long absences and high risks of permanent work incapacity for the affected workers. Better understanding the issue of MSDs in EMTs and paramedics is crucial for developing, implementing and assessing the effectiveness of adequate preventive measures. However, recent literature reviews have concluded that little attention has been focused on this topic (Broniecki et al., 2010) and that most studies relied on small or convenient samples (Sterud et al., 2006) implying diverse potential selection biases. Therefore, comparative data about the prevalence and the severity of lower back and upper back disorders in EMTs and paramedics is clearly needed. Providing such data was one of the goals for our article.

Health consequences of deleterious working conditions are affected by diverse individual and organizational factors. The mechanisms which lead to these factors having protective effects are not clear and better understanding them might provide key knowledge for the prevention of MSDs. We believe that these

List of abbreviations: MSD, musculoskeletal disorders; EMT, emergency medical technician.

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mechanisms might be identified through an examination of behavioral strategies developed by workers to best carry out their jobs. These strategies are a common concept in ergonomics and they refer to series of actions or behaviors used by workers to reach a specific goal (Faye and Falzon, 2009). In this article, we investigate the use of such smart practices by EMT and paramedics to protect their health in carrying out prehospital emergency missions, and we explore some quantitative and qualitative evidence supporting the effectiveness of these strategies.

In summary, the goals of this article are to:

1. provide descriptive data about the prevalence and the severity of lower back and upper back disorders in EMTs and paramedics;
2. identify some individual and collective strategies used by EMTs and paramedics to protect their health as they perform prehospital emergency missions;
3. assess the possible effectiveness of strategies in preventing back problems by exploring associations between the use of strategies and the presence and severity of symptoms.

2. Material and methods

We performed an occupational health study on a large sample of ambulance professionals. We invited all the EMTs and paramedics working in the French-speaking part of Switzerland to participate in a questionnaire survey and carried out a work practice analysis in ambulance services. Ambulance professionals in Switzerland are employed by hospitals, private services, or public agencies. Their work consists of the following: performing rescue operations; providing prehospital emergency care to patients requiring their assistance; and transporting patients to the hospital when necessary. They also perform other types of patient transport (e.g., from one hospital to another). Ambulance crews usually consist of two people, but missions occasionally involve medical teams (e.g., emergency physician and emergency nurse).

2.1. Questionnaire study

The target population and study sample have been presented previously (Arial et al., 2011). In summary, we contacted all 32 emergency medical care services in the French-speaking part of Switzerland. Twenty-seven services (84%) accepted the invitation to participate and provided the researchers with lists of the names and email addresses of their employees. Among the services which accepted to participate to the study, 44% were independent private services, 30% belonged to hospitals, and 26% were linked to diverse organizations (e.g., fire department, police, and airport emergency services). The questionnaire took approximately 45 min to complete. Questionnaires were sent to all ($n = 669$) employees of those services. Participants who were not EMTs or paramedics were excluded from our analysis. Arrangements were made with the employers to allow their employees to answer the questionnaire during working hours (i.e., waiting time between missions). We offered the option of answering the questionnaire on paper or on-line. After completion paper questionnaires were returned by means of a prepaid envelope. When using the on-line version, participants had the opportunity to leave the session and log in again later without losing data entered during the previous session.

We used a French version of the Nordic Questionnaire (Dickinson et al., 1992; Kuorinka et al., 1987) to acquire the information on musculoskeletal symptoms. This questionnaire has been used in several professions such as nurses (Smith et al., 2004), computer users (Brisson et al., 1999; Bergqvist et al., 1995; Cook et al., 2000), forestry workers (Hagen et al., 1998) or coopers (Macdonald and Waclawski, 2006). This questionnaire is repeatable, sensitive and appears to be appropriate as a screening tool (Crawford, 2007). It is also reported as a valid tool for monitoring diverse work-related MSDs in epidemiologic studies (Descatha et al., 2007; Perreault et al., 2008). We considered symptoms (pain or discomfort) affecting 2 anatomical regions: 1) lower-back, and 2) neck-shoulder-upper-back. Symptoms were assessed for duration and severity separately for each anatomical region considered. The rating procedure for the duration of discomfort/pain to both the anatomical regions considered is as follows: (0) no pain or discomfort in previous 12 months, (1) pain or discomfort experienced 1–7 days in previous 12 months, (2) pain or discomfort experienced 8–30 days in previous 12 months, (3) pain or discomfort experienced more than 30 days in previous 12 months. Severity: We choose not to use the standardized procedure included in the Nordic Questionnaire to measure the severity of symptoms. Instead, respondents reporting symptoms (pain or discomfort) to the lower-back region or the neck-shoulder-upper-back region within the twelve months before answering the questionnaire were asked to rate its peak episode on a scale ranging from 0 - “no pain at all” to 10 “unbearable pain”). This scale is well-known and widely used by EMTs and paramedics in Switzerland. It is particularly used as an aid to estimating the pain patients are suffering and whether to inject a quick-acting narcotic analgesic (i.e. Fentanyl). We choose this formulation because ambulance professionals who pretested our questionnaire spontaneously transcribed our formulation into their more usual one (0–10).

Strategies: respondents were asked whether they agreed with the following sentence: “With my work experience, I developed and learned some tricks of the trade helping me to spare my health”. The coding is as follows: (1) totally disagree, (2) rather disagree, (3) rather agree, and (4) totally agree. Answers (1) and (2) were grouped for the purposes of our analyses.

The survey also included a variety of other categories of questions (on mental health, effort-reward imbalance, types of mission, average weekly number of missions, etc.) covered in another article on the association of different stressors with mental health indicators in EMTs and paramedics (Arial et al., 2011).

2.1.1. Statistical analysis

Descriptive statistics were used to describe participants’ answers on demographics, self-reported symptoms and self-reported use of preventive strategies. The self-reported health outcomes (severity and duration of symptoms to lower-back and neck-shoulder-upper-back regions) were analysed using an ordered logistic regression, also called proportional odds model (ologit command in STATA) owing to the ordinal nature of these two variables. Ordered logistic regression generalizes logistic regression, in that the dependant variable is not binary but ordinal. The coefficients of this regression can also be interpreted as a summary of J logistic regressions if the dependant variable has $J + 1$ possible outcomes (see for example Long and Freese, 2006). The parameters of ordered logistic regressions can therefore be interpreted as mean odds-ratios or log-odds-ratios, when dividing the dependant variable using the J different possible cutoffs. The main independent variable considered is variable coding the self-reported use of strategies for the prevention of back problems in three categories (rather disagree, agree, totally agree). These regression model were further adjusted on known determinants of back pain (gender, age and on professional category which were considered as a potential confounders). No post-hoc selection of covariables was applied. The analyses were performed with STATA software for Windows, release 12.0 (Stata corporation, College Station, TX, USA). For all statistical tests, an overall significance level was set at $P \leq 0.05$.

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Table 1
Prevalence, severity, duration and associated medical care seeking of musculoskeletal problems among all Emergency Medical Technicians (EMTs) and paramedics from the French-speaking part of Switzerland ($n = 334$).

	Total	Gender		Professional category		Strategy[a]		
	$n = 334$	Male $n = 258$	Female $n = 76$	EMTs $n = 96$	Param. $n = 238$	Totally agree $n = 87$	Rather agree $n = 218$	Rather & totally disagree $n = 28$
Neck-shoulder-upper-back								
Symptoms at least one day during the previous 12 months[b]	184 (55%)	131 (51%)	53 (70%)	52 (54%)	132 (55%)	**41 (47%)**	**119 (55%)**	**23 (82%)**
Limitations in household or work activities[b]	26 (8%)	20 (8%)	6 (8%)	3 (3%)	23 (10%)	**1 (1%)**	**23 (11%)**	**2 (7%)**
Limitations in leisure activities[b]	56 (17%)	45 (17%)	11 (14%)	**5 (5%)**	**51 (21%)**	10 (11%)	40 (18%)	6 (21%)
Worst pain intensity greater than 5 (scale 0–10)	49 (15%)	38 (15%)	11 (14%)	**6 (6%)**	**43 (18%)**	8 (9%)	35 (16%)	5 (18%)
Symptoms for at least 8 days during previous 12 months	74 (22%)	49 (19%)	25 (33%)	15 (16%)	59 (25%)	18 (21%)	46 (21%)	9 (32%)
Symptoms more than 30 days during previous 12 months	39 (12%)	23 (9%)	16 (21%)	9 (9%)	30 (13%)	8 (9%)	26 (12%)	5 (18%)
Seeking medical care[b]	123 (37%)	**79 (31%)**	**44 (58%)**	**28 (29%)**	**95 (40%)**	27 (31%)	79 (36%)	16 (57%)
Lower-back								
Symptoms at least one day during the previous 12 months[b]	224 (67%)	174 (67%)	50 (66%)	56 (58%)	167 (70%)	49 (56%)	152 (70%)	22 (79%)
Limitations in household activities[b]	58 (17%)	46 (18%)	12 (16%)	10 (10%)	47 (20%)	11 (13%)	41 (19%)	6 (21%)
Limitations in leisure activities[b]	94 (28%)	74 (29%)	20 (26%)	21 (22%)	72 (30%)	23 (26%)	61 (28%)	10 (36%)
Worst pain intensity greater than 5 (scale 0–10)	77 (23%)	54 (21%)	23 (30%)	17 (18%)	59 (25%)	19 (22%)	50 (23%)	7 (25%)
Symptoms for at least 8 days during previous 12 months	97 (29%)	68 (26%)	29 (38%)	23 (24%)	73 (31%)	19 (22%)	65 (30%)	12 (43%)
Symptoms more than 30 days during previous 12 months	33 (10%)	23 (9%)	10 (13%)	7 (7%)	26 (11%)	9 (10%)	23 (11%)	1 (4%)
Seeking medical care[b]	141 (42%)	**96 (37%)**	**45 (59%)**	31 (32%)	109 (46%)	35 (40%)	89 (41%)	16 (57%)

Note: percentages are calculated based on the number of valid answers provided.
Note: results for which a Khi-2 test was significant at $p < 0.05$ are presented in **bold**.
[a] Respondents were asked whether they agree with the following sentence: "with my work experience, I developed and learned some tricks of the trade that are helping me to spare my health". The coding is as follows: (1) Totally disagree, (2) Rather disagree, (3) Rather agree, and (4) Totally agree. Answers 1 and 2 were grouped for presentation purposes.
[b] Positive answer (yes) to the item considered.

The resulting four models are displayed at Table 2.

2.2. Interviews and work practice analysis

We asked all 32 emergency medical care services located in the French-speaking part of Switzerland to let us carry out a work practice analysis on them. Five of these services refused due to organizational changes they were undergoing at that time (i.e. service mergers). We subsequently selected a convenience sample of 12 services (among the remaining 27 services) in order to analyse work practices in a variety of contexts: different sized emergency medical care services; urban and non-urban environments; those

Table 2
Multiple ordered logistic regression measuring associations of our independent variable (reporting to have developed and learned strategies) with self-reported health outcomes (Severity[a] and Duration[b] of symptoms to lower-back and neck-shoulder-upper-back regions), controlled for age, gender, and professional category. $N = 334$.

	Severity			Duration		
	Coeff. (β)[e]	β 95% CI	P	Coeff. (β)	β 95% CI	P
Neck-shoulder-upper-back						
Age (in years)	0.003	−0.023; 0.029	0.823	0.001	−0.027; 0.029	0.939
Professional category[c]	−0.156	−0.585; 0.273	0.477	−0.209	−0.655; 0.238	0.360
Gender (men as reference)	0.445	−0.019; 0.909	0.060	0.752	0.258; 1.246	**0.003**
Strategy[d]						
"Totally agree"	−0.434	−0.898; 0.031	0.067	−0.272	−0.750; 0.206	0.265
"Rather disagree"	0.505	−0.155; 1.166	0.133	0.762	0.048; 1.477	**0.036**
Lower-back						
Age (in years)	0.0321	0.005; 0.059	**0.020**	0.206	−0.007; 0.048	0.150
Professional category[c]	−0.370	−0.792; 0.060	0.093	−0.395	−0.842; 0.052	0.083
Gender	0.378	−0.103; 0.859	0.123	0.308	−0.199; 0.816	0.233
Strategy[d]						
"Totally agree"	−0.490	−0.954; −0.025	**0.039**	−0.593	−1.073; −0.114	**0.015**
"Rather disagree"	0.027	−0.647; 0.701	0.937	0.370	−0.330; 1.069	0.300

Note: Results for which association was significant at $p < 0.05$ are presented in **bold**.
[a] Intensity of symptoms: peak episode on a scale in the twelve months before answering the questionnaire (0 – "no pain at all" to 10 – "unbearable pain").
[b] Duration of symptoms: coded 0 days = "1"; 1–7 days = "2"; 8–30 days = "3"; >30 days, but not every day = "4"; every day = "5".
[c] Professional category: emergency medical technicians vs. paramedics; paramedics used as reference.
[d] Strategy Self reported use of preventive strategies and tricks of the trade. Category "agree" used as reference.
[e] Coeff. (β): Regression coefficients (summary log odds-ratios).

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only performing emergency missions and those also performing patient transfers; and services belonging to hospitals or other private and public entities.

We asked the emergency medical care service managers to suggest weeks when observations would be most feasible. We contacted potential participants by telephone or emails and asked ambulance professionals who were scheduled to work whether they would accept our presence with them. Nobody refused. By shadowing EMTs and paramedics in the selected services throughout whole work shifts (usually 12 h), we collected examples of preventive strategies using interviews and work practice analysis. A total of 416 h of observation took place (one week per group, including day and night shifts).

Observations and interviews were shared between three researchers (1 female, 2 males): a psychologist, an ergonomist, and a health and safety specialist. A pen and paper technique was used to record tasks performed by participants. When note-taking during a mission proved impossible, researchers wrote notes retrospectively at the end of the workday. We also used the "subsequent verbalization" technique (Leplat and Hoc, 1981): after missions, participants were asked to explain the tasks they had just performed. For example, researchers asked them to explain what kind of problems they had encountered, how the actual mission had differed from what they had expected initially, their satisfaction regarding how the mission had gone, etc.).

We recorded certain prehospital emergency missions on video, following a strict procedure. Both the professionals and the patients involved had to agree to the use of video and retained the option to ask the researcher to cease recording at any moment during the mission. We also identified diverse exclusion criteria: for example, we did not use the camera when patients were alcohol/drug impaired or unconscious (and therefore unable to give their informed consent). Video recordings were used in auto-confrontation interviews (during which participants are confronted with the video recording of their own work activity). This technique is useful for revealing the cognitive processes underlying the work activity (Mollo and Falzon, 2004). Descriptions of relevant video sequences and interview excerpts were written up by researchers. Analysis began with several readings of all the data. Preventive strategies were identified and discussed by a multidisciplinary team (consisting of the ergonomist, the psychologist, and the health and safety specialist). Strategies were grouped together a first time and then all the data (video, interviews, written notes) were reviewed again in order to identify strategies that did not come to light during the first analytical sessions carried out by the team. At the end of the project, the strategies were presented to a large audience ($N = 50$) of EMTs and paramedics for validation purposes.

No incentives were provided for participation. The study protocol was submitted and approved by an independent ethical commission, and was in compliance with the Declaration of Helsinki.

3. Results

A total of 374 questionnaires were returned (56% response rate). Forty participants were excluded from our analysis because they were neither EMTs nor paramedics (most of excluded cases were emergency nurses or professional firefighters). Most participants were male (77%) and a majority were married or cohabitating (62%) and 40% had at least one child. Nearly half (49%) of participants were between 30 and 40 years old. Only 25% of participants were 40 or older. Respondents with 0–5 years of work experience in prehospital emergency care represented 28% of our sample. About 50% had more than five and less than fifteen years of such work experience. A large majority of participants are working full time (86%). More detailed demographics of the participants are available in (Arial et al., 2011). The median number of missions per week was 12 ($p25 = 7$; $p75 = 16$). Prehospital emergency missions represents most of missions performed by participants. For example, more than 40% of respondents mentioned that those missions represent at least 80% of the missions they usually perform.

The Table 1 shows the prevalence, the duration, and severity of symptoms for both the anatomical regions considered, by known potential confounders and variables of interest.

A majority (56%) of participants reported pain or discomfort (at least one day in the 12 months before answering the questionnaire) in at least one of the anatomic regions considered (lower-back region; neck-shoulder-upper-back region). A total of 143 (43%) reported symptoms in both regions (data not shown in tables).

Age and the number of years worked as an EMT or paramedic were highly correlated ($r = 0.74$; $p < 0.001$). We decided to only include age in our multiple ordered logistic regression models in order to avoid interdependency between these two variables. Table 2 shows the association between our independent variable (self-reported use of preventive strategies) and self-reported health outcomes, controlled for age, gender and professional category.

The dependent variables of symptom severity and symptom duration (in both anatomic regions) were negatively associated to health outcomes in three out of four models. In the fourth model, the level of association was close to significant. Gender was significant in only one model.

Our analysis of EMTs and paramedics' work practices revealed several strategies that had good potential for preventing musculoskeletal problems to the lower-back region and neck-shoulder-upper-back region. The list of strategies we examine below is not exhaustive. Our goal is to give examples of some observed strategies and briefly explain their relevance for preventing MSDs.

We observed several strategies, many of them aimed at protecting the back (mostly for the lumbar region). Table 3 displays some examples of such strategies. Several of the techniques taught in vocational training for EMTs and paramedics were applied in a variety of environments. EMTs and paramedics had also developed genuinely new strategies by adapting known principles for lifting and moving patients to the specific environments they met in prehospital settings. Examples included leaning and sliding the shoulder against the wall while carrying a stretcher in stairways. This allowed transferral of part of the weight to the wall, thus using it as a lateral support. The belt buckles were often used for supporting stretchers, allowing the distribution of weight between the lumbar region and the hips. Many strategies aimed at adapting and using the environment on site. Moving furniture and optimizing the environment around the patient were frequently done to avoid awkward postures. Medical intervention bags were often installed on a small table or directly on the patient's bed in order to facilitate access to the material needed while providing care to the patient. Some participants also mentioned that they had added an extra step to their standard arrival procedure on a mission site: in addition to the usual assessment of the surroundings (e.g. potential dangers), and anticipating evacuation possibilities, they also assessed the postures they might have to adopt (and started thinking about how they could improve them). Awkward and constraining postures are therefore now among the potential hazards they consider at the very beginning of missions, allowing them to initiate preventive measures to bypass those postures.

A significant part of emergency response work is performed inside the ambulance itself. In Switzerland this corresponds to a relatively standardized and thus stable working environment. It is of note that many ambulances still have a bench seat in the medical

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Table 3
Examples of strategies observed while shadowing paramedics and emergency medical technicians.

Hypothesized protective mechanism	Examples
Easing and stabilizing posture	• During transfer to the hospital, pushing leg against the stretcher • Inserting the foot in the stretcher's frame during transfer to the hospital • Using leg as counterweight when bending trunk (pendulum) • From kneeling, push up with hand on one knee • Protecting the patient's bed with a cover or a plastic layer, permitting to put boots on bed, allowing better adapted postures and an easy access to the patient • Asking the driver to stop the ambulance (a few seconds) to perform tasks (e.g. performing an intravenous injection) that would otherwise require important effort for stabilization while driving
Using material that contributes to decrease strenuous effort	• Using stairway evacuation chair instead of stretcher to carry the patient in stairway • Requiring support from firefighters with appropriate lifting equipment when needed • Using hydraulic lifting devices when available (e.g. devices lifting and lowering the cot into and out of the ambulance) • Adapting working procedures in order to optimize using such devices • Use a backpack type of emergency bag to carry heavy material (e.g. oxygen bottle)
Adapting physical environment on intervention site	• Moving the furniture to have more space around the patient (and adopt more comfortable postures) • Put emergency bags on a table beside of the patient's bed (access to it with little bending and twisting of the trunk) • Leaning and sliding the shoulder against the wall while carrying a stretcher in stairways • Remove frames from wall and use nail to hang intravenous saline bag
Sharing physical demand among colleagues	• Asking the colleague to help with moving the patient on bed • Create a counterweight by pushing on stretcher handles as the colleague pulls on the other side to lift it (stretcher with extendable handles) • Exchange role from one intervention to the other (facilitating recovery)
Patient participation	• Asking the patient to walk to the emergency vehicle (or supporting the patient to do so) • Add a moveable step or a running board to the emergency vehicle to ease the access of the patient with minimal support
Avoid unnecessary transfer to the hospital	• Using tricks of the trade to make sure the patient is not simulating unconsciousness

compartment. Most EMTs and paramedics used this seat instead of the one positioned at the head of the patient while providing care on the drive to the hospital (although the latter would be preferable for safety reasons). This choice was justified by practical reasons: easier access to most of the equipment and material stored in the medical compartment; the patient has a better view of the ambulance professionals face (making interactions more natural); communication with the driver is easier; access to any part of the patient's body is easier should that be necessary, etc. For ambulance personnel however, this choice has important ramifications in terms of safety (especially in the case of a crash) and in terms of strenuous exertion for the back (there is no lateral support sitting perpendicularly to the road; limited space for the legs implies difficulties in adopting usual postural stabilization techniques; etc.). This seating arrangement increased the relevance of EMTs and paramedics using diverse, efficient, posture stabilization strategies during the patient's transfer to the hospital. Such strategies were needed in order to compensate for accelerations, decelerations and lateral vehicle movement. Examples included pushing one leg up against the stretcher or jamming a foot in the stretcher frame in order to provide more stability. These strategies are particularly crucial for performing delicate procedures (e.g., inserting an intravenous line) while the emergency vehicle is moving.

4. Discussion and conclusion

Major findings: our study confirmed that MSDs are prevalent and represent a major occupational health issue for EMTs and paramedics. However, associations we observed between our independent variable (self-reported use of preventive strategies) and dependent variables (self-reported health outcomes) suggest that prehospital emergency care professionals do develop strategies and tricks of the trade that appear to have a beneficial effect on the number and severity of back problems. Our work practice analysis identified several strategies and tricks of the trade, most of which were aimed at avoiding awkward postures and easing the lifting/carrying of patients (e.g., from the bed to the stretcher, from the stairway evacuation chair to the stretcher, or on the stretcher itself in stairways). Very few strategies dealt with recuperating after heavy or strenuous physical effort. Strategies we identified seem to be relevant for preventing back problems. However, studies involving experimental validation of their effect in decreasing risk factors, as well as epidemiologic studies aiming at measuring their effect on long term occurrence and severity of symptoms are needed. They should also be assessed for other relevant aspects (i.e. patient's safety, patient's comfort, time needed to implement, etc). It is also important to mention that strategies we identified do not replace other preventive measures. For example, track-type stair descent devices or stretchers equipped with hydraulic lifting devices can have much more of an impact on biomechanical spine loads than can leaning against the wall when descending the stairs with a stretcher. However, we believe that behavioral strategies we identified could be combined with other ergonomic changes and might for example contribute to optimize the investment in new devices and technological improvements.

Prevalence & severity: our results confirmed that back problems are a major issue for EMTs and paramedics. More than half of our participants reported symptoms in the neck-shoulder-upper-back region in the 12 months prior to answering the questionnaire. This proportion was even higher (about two-thirds) for the lower-back region. This is in line with results from an American study reporting a back pain incidence rate of more than 25% (Studnek and Crawford, 2007) and with a Swedish study reporting an overall prevalence of 47% for the upper-back and shoulder region, and 57% for lower-back region (Aasa et al., 2005). Our results on activity limitations were also comparable with the results of this Swedish study.

A study of the main causes of early retirement on medical grounds (Rodgers, 1998a) suggested that there was a higher incidence of MSDs in female prehospital emergency care professionals than in males. Trends we observed in our study were in line with those findings for the neck-shoulder-upper-back region, however this trend was not observed for the lower-back region. Reasons for such a discrepancy remain unknown and studies aimed at better understanding gender differences on this topic are needed. Our results showed that the prevalence of symptoms in the upper-back

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and lower-back regions was comparable for EMTs and paramedics. This contrasts with results from an American study (Hogya and Ellis, 1990) where differences very close to a significant level (0.06) were observed. One possible explanation for this discrepancy between studies is that technicians and paramedics in Switzerland work in very close collaboration and often switch roles from one mission to the next. They therefore face the same exposure to back disorders and develop similar strategies to prevent them. This could explain the fact that the professional category was not a significant variable in any of our four models.

Strategies: we believe that the strategies we observed resulted from implicit preventive skills derived from a combination of vocational education and training, personal work experience, and shared working practices among emergency professionals. Basic notions about lifting and carrying patients, as well as anatomic and biomechanical principles are taught in initial and continuous education for EMTs and paramedics. Those notions are definitely important for developing the preventive skills that lay behind the strategies we observed. We believe that increasing and improving teaching of those principles might enable EMTs and paramedics to develop and implement more and better adapted strategies. Nevertheless, transfer of training and generalization of such knowledge also require EMTs and paramedics to develop the necessary skills for analysing their own work practices (Faye and Falzon, 2009). To the best of our knowledge, the education and training which EMTs and paramedics receive does not involve learning activities aimed at developing those meta-skills. We believe that prevention of occupational back problems in prehospital medical care professionals would benefit from combining teaching of anatomic and biomechanical principles, with learning activities aimed at the development of meta-skills for analysing work.

Considering the number and variety of strategies we observed aimed specifically at preventing back problems it was striking to find so few centred on the optimization of recovery opportunities. The downtime between missions could be used as an opportunity for proactive recovery after strenuous effort. However, we observed no such strategies. In fact, we actually observed many aspects which might contribute to reducing the benefits from potential recovery periods. For example, office furniture used for administrative work was usually shared by the employees on duty and seldom adapted to their specific morphology. Breaks were often taken in non-optimal environments (e.g., sofas fostering pelvic retroversion and general spinal kyphosis, uncomfortable seats in the hospital waiting room, sleeping on “camping” mattresses unrolled on the floor of the office during night shifts, etc.). We believe that identifying means to improve the possibilities for recovery between missions is a relevant concern for most of the services where we performed observations.

The present article focused on strategies and tricks of the trade that might contribute to the prevention of back problems in prehospital emergency workers. However, the strategies we observed also combined different goals: strategies and tricks of the trade used by EMTs and paramedics are also relevant for improving psychosocial aspects of work, increasing patient safety and enhancing the general quality and efficiency of the care provided (Arial and Benoît, 2011). Those are key issues in emergency medical care and their corresponding strategies should be investigated in further studies.

Associations: negative associations of our independent variable (self-reported use of preventive strategies) with the severity and duration of symptoms to lower-back and upper-back regions were significant for most of the models we developed. This supports the idea that strategies used by workers might contribute to the prevention of work related back problems. To our knowledge, this is the first time that quantitative evidence has been provided supporting the preventive role of such strategies. Obviously, this conclusion has to be taken with caution because alternative explanations could result in the associations we identified. However, work practice analysis confirmed the presence of several strategies or tricks of the trade that appeared to reduce physical effort and awkward postures during prehospital emergency missions. Strategies used by EMTs and paramedics seems to influence positively the prevention of occupational back problems. Development of learning activities targeting those strategies and tricks of the trade are clearly needed. The cross-sectional design we used for identifying associations between self-reported use of preventive strategies and health outcomes precluded any causal inference. In fact, reverse causation might have been an issue in our study because respondents without symptoms might have the impression that they have more or better strategies than the others. Reciprocal causation might also have been an issue as respondents with symptoms might have been more prone to implementing different strategies in order to cope with them, which in turn might have affected the severity or duration of symptoms. In this case however, the associations observed would have been less discernible. We therefore believe this issue was not really important in the present study. Measurement of the strategies we used relied on a single item based on self-reporting. This is a rather simplistic way to assess strategies; a different, more rigorous approach may be necessary. For example, a prospective study involving measurements based on scales assessing workers', co-workers' or supervisors' opinions about the use of strategies might be relevant. The self-reported use of strategies could also be confirmed by ergonomic work practice analysis at an individual level.

The prevalence of back problems we observed in EMTs and paramedics calls for effective preventive measures. The strategies and tricks of the trade we identified seems to be relevant for the prevention of back disorders. Teaching and training appear to be promising ways for EMTs and paramedics to learn the necessary skills to develop genuine preventive strategies and tricks of the trade of their own. Providing ergonomics training and education to workers is not a new approach in occupational health and ergonomics (Montreuil and Bellemare, 2001; Montreuil and Teiger, 1996). However, the content of ergonomics training is often based on a top down approach, providing the participants with evidence-based guidelines and recommendations. Another approach based on the type of strategies we described in this paper goes far beyond the approach described above. Providing the necessary skills to enable workers to diagnose their own work practices (and identify the strategies they implement), and using the results of their analyses for educational purposes, is rather uncommon. However, our findings in terms of strategies advocate strongly in favor of developing preventive programs based on this approach. We recommend helping ambulance professionals to become specialists in the analysis of their own work practices in order to individually or collectively develop, confront, criticize and improve their strategies. We believe it would improve and help generalize knowledge of ergonomics in EMTs and paramedics, and therefore create a more durable effect on the prevention of back problems in those occupations. For EMTs and paramedics, prevention based on the type of strategies we observed, appears particularly relevant due to some of the important characteristics of these professions (unpredictable work environments, situations that are difficult to anticipate, non redundancy of missions, waiting time that can be used for recovery purposes, etc.). Most of these characteristics are not limited to medical emergency work, and in fact recent developments in the socio-economic environment (subcontracting, rapid pace of change, frequent interruptions, etc.) have increased the pressure for workforce flexibility and adaptability. Workers must adapt

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instantly to unpredictable events. For example, the environment in which the work will take place, the time available to do the job, and even the tasks to be performed, are often unknown until the very last minute. This dramatically decreases the possibilities of anticipating the constraints that employees will face at work, as well as the resources they will need to meet them. Approaches based on the preventive strategies that we have explored in this article, therefore appear to be promising solutions to these recent challenges: they are suited to the emergency context. We also believe that their added value goes far beyond the prevention of back problems because they are relevant to crucial issues, such as accident prevention at work, quality, system resilience, etc. Enabling and fostering the development of preventive strategies appears to be a novel, integrative approach for dealing with crucial issues in many professions.

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