Paramedic physical demands analysis

Prepared by:
Brendan Coffee, Renée MacPhee and Steve Fischer
Queen's University
99 University Ave
Kingston, ON K7L 3N6
PWGSC Contract Number: CSSP-2013-CD-1088
Contract Scientific Authority:
Doug Socha
DRDC Centre for Security Science
613-947-1113

DRDC-RDDC-2014-C158
July 2014

IMPORTANT INFORMATIVE STATEMENTS

CSSP-2013-CD-1088 Paramedic Physical Demands Analysis was supported by the Canadian Safety and Security Program (CSSP) which is led by Defence Research and Development Canada's Centre for Security Science, in partnership with Public Safety Canada. The project was led by Paramedic Association of Canada in collaboration with Paramedic Chiefs of Canada

CSSP is a federally-funded program to strengthen Canada's ability to anticipate, prevent/mitigate, prepare for, respond to, and recover from natural disasters, serious accidents, crime and terrorism through the convergence of science and technology with policy, operations and intelligence

Abstract

Paramedics must complete many physically demanding activities in order to provide essential emergency medical care. While most paramedic and emergency medical services have an indication of the physical demands faced by their own paramedics, a national physical demands profile does not exist. A national profile would help to identify points of commonality and difference between services that might be useful to know when considering process and practice improvements. Using a participatory approach that partnered ergonomic researchers and paramedics, the purpose of this study was to conduct a Physical Demands Analysis (PDA) of paramedic work in different services, sampled from across the country. The result is a national physical demands profile for paramedic work in Canada.

PDAs were conducted at five paramedic services across the country. At each service the PDA was completed using a three-step process: preparation, observation and data collection, and reporting. For the preparation phase, the research team provided two participating paramedics with an intensive 5-hour interactive PDA workshop. The goal of the workshop was to help train paramedics to identify and document specific physical demand elements. Within 1-14 days following the workshop paramedics completed the observation and data collection phase. During this step paramedics rode out third and observed and documented the physical demands during two separate 12-hour shifts (one day and one night shift, where feasible). The PDA-trained paramedics then returned the observational data to the research team for analyses. In the reporting phase, data were transcribed by the research team to determine the types of physical demands and the frequency and duration of each. The five national sites included: British Columbia Ambulance Service (Vancouver, British Columbia - Metro catchment area), Superior North Emergency Medical Services (Thunder Bay, Ontario), Essex-Windsor Emergency Medical Services (Windsor, Ontario), Urgences-Santé (Montréal, Québec), and Ambulance New Brunswick (Saint John, New Brunswick).

While all paramedics must complete similar activities (e.g., moving patients, driving, providing direct patient care, etc.), there were two factors that affected the level of physical demand: equipment, and annual call volume. All paramedics were required to load/unload and raise/lower the stretcher (empty, with equipment, and/or with a patient); however, two services used powered stretchers removing the requirement for the paramedic to physically load/unload/raise/lower in Thunder Bay (Stryker Power-PRO™ XT with Power Load), or raise/lower the stretcher in Montréal (Stryker Power-PRO™ XT). When considering call volume, paramedics working in areas with higher call volumes were exposed to patient care and patient/equipment handling more often (50+ times per shift), with less sedentary time not on a call.

This national study was the first to document the physical demands experienced by paramedics by employing a participatory model. The data helped to identify high demand/frequently occurring tasks, and factors that affect those demands, including call volume and equipment. This information will help inform ergonomists and paramedic services regarding the physical demands performed by paramedics.

Résumé

Les ambulanciers paramédicaux doivent exécuter de nombreuses activités exigeantes sur le plan physique afin de prodiguer des soins médicaux d'urgence essentiels. Bien que la plupart des services paramédicaux et médicaux d'urgence donnent une indication des exigences imposées à leurs propres ambulanciers paramédicaux, il n'existe aucun profil national des exigences physiques. Un tel profil national aiderait à cerner les points communs et les différences entre les services qu'il pourrait être utile de connaître lorsqu'on envisage des améliorations aux processus et aux pratiques. Recourant à une méthode participative établissant un partenariat entre les chercheurs en ergonomie et les ambulanciers paramédicaux, l'étude avait pour but de mener, au sein de différents services, une analyse des exigences physiques (AEP) du travail des ambulanciers paramédicaux, dont l'échantillonnage s'est fait à l'échelle du pays. Le résultat est un profil national des exigences physiques du travail d'ambulancier paramédical au Canada.

Les AEP ont été réalisées à cinq services paramédicaux à l'échelle du pays. À chaque service, l'AEP a été faite à l'aide d'un processus à trois étapes : la préparation, l'observation et la collecte des données, la production du rapport. À l'étape de la préparation, l'équipe de recherche a donné à deux ambulanciers paramédicaux participants un atelier interactif et intensif de 5 heures portant sur l'AEP. Cet atelier avait pour but d'aider à former les ambulanciers paramédicaux afin qu'ils identifient et documentent des éléments d'exigences physiques particuliers. Dans les deux semaines suivant la tenue de l'atelier, les ambulanciers paramédicaux ont achevé l'étape de l'observation et de la collecte des données. Durant cette étape, les ambulanciers paramédicaux ont fonctionné en équipes de trois, et ils sont observé et consigné les exigences physiques durant deux quarts de travail de 12 heures (un de jour et un de nuit, dans la mesure du possible). Les ambulanciers paramédicaux formés en vue de l'AEP ont ensuite transmis les données d'observation à l'équipe de recherche aux fins des analyses. À l'étape de la production du rapport, les données ont été transcrites par l'équipe de recherche afin de déterminer les types d'exigences physiques, ainsi que la fréquence et la durée de chacune. Les cinq sites étaient : le Service d'ambulance de la Colombie-Britannique (Vancouver, Colombie-Britannique – région urbaine desservie), les Services d'urgence médicale Supérieur Nord (Thunder Bay, Ontario), les Services d'urgence médicale d'Essex-Windsor (Windsor, Ontario), Urgences-Santé (Montréal, Québec), et Ambulance Nouveau-Brunswick (Saint John, New Brunswick).

Bien que tous les ambulanciers paramédicaux doivent exécuter des activités semblables (p. ex., déplacer des patients, conduire, prodiguer des soins directs aux patients, etc.), deux facteurs ont eu un effet sur le degré d'exigence physique : l'équipement et le volume annuel d'appels. Tous les ambulanciers paramédicaux ont dû charger/décharger et lever/descendre la civière (vide, chargée d'équipement et/ou d'un patient); cependant, deux services utilisaient des civières motorisées, ce qui annule l'exigence pour l'ambulancier paramédical de charger/décharger/lever/descendre physiquement la civière à Thunder Bay (Stryker Power-PRO™ XT avec Power Load), ou de lever/descendre la civière à Montréal (Stryker Power-PRO™ XT). Lorsqu'on considère le volume d'appels, les ambulanciers paramédicaux qui travaillent dans les régions ayant les plus forts volumes d'appels étaient plus souvent exposés aux soins au patient et à la manipulation du patient et de l'équipement (plus de 50 fois par quart), et ils passaient moins de périodes sédentaires lorsqu'ils ne répondaient pas à un appel. Cette étude nationale est la première à documenter les exigences physiques que subissent les ambulanciers paramédicaux en recourant à un modèle participatif. Les données ont aidé à cerner les tâches très exigeantes/fréquentes, ainsi que des facteurs qui ont un effet sur ces exigences, y compris le volume d'appels et l'équipement. Ces renseignements éclaireront les ergonomes et les services paramédicaux au sujet des exigences physiques imposées aux ambulanciers paramédicaux.

Executive summary

Introduction: The prevalence of musculoskeletal injuries is high among paramedics (WorkSafe BC, 1999; Maguire et al., 2005; Sterud et al., 2006; Reichard & Jackson, 2010; Maguire et al., 2014). Whether the goal is to reduce injury rates, lessen the severity of injuries, or improve return to work outcomes, it is essential to understand the demands of job, including all of its diversity, ideally from the perspective of paramedics actually performing the job. Understanding the scope of physical demands required for paramedics work is a foundational step towards improving the health and safety of paramedics in Canada. Therefore, the goal of this study was to gather detailed information about the physical demands experienced while performing the day-to-day work of a paramedic. To meet this goal, researchers and paramedics worked together to complete a physical demands analysis at five paramedic services across the country. This unique approach allowed physical demands data to be accurately captured by paramedics, providing a foundation as we move forward to create a safer work environment for both patients and paramedics.

Results: Paramedics across the country were exposed to high physical demands that may occur nearly 50 times per shift in some regions. The frequency of exposures to highly physically demanding tasks such as loading/unloading the stretcher from the ambulance, or raising/lowering the stretcher was dependent on call volume. However, powered stretchers eliminated/reduced the physical demands associated with loading/unloading and lifting lowering in those services using that equipment. In addition, it was noted that the equipment used by each service (medical bags, cardiac monitor, stretcher, stair chair, etc.) were not standardized across services. As a result the total amount of equipment weight moved per call was dependent on the equipment used by each service.

Significance: This study provided snap shot of the physical demands of paramedic work across five different services across the country. These data demonstrate that paramedics are exposed to intermittent high physically demanding tasks (i.e. lifting/lowering or loading/unloading the stretcher), interspersed with extended sedentary periods (driving, logging paperwork, on standby, etc.). However, equipment and call volume directly affected the magnitude and frequency of these physically demanding tasks. Powered stretchers eliminated/reduced physically demanding components of the job, where higher call volumes increased the frequency of physically demanding activities.

Future plans: This study aimed to provide foundational data documenting the physical demands of paramedic work. Using these data as a launch point, future work can focus on decreasing peak physical demands, improving the capabilities of paramedics to meet those demands, and developing targeted interventions to reduce the number and severity of musculoskeletal injuries in this profession.

Sommaire

Introduction ou contexte : La prévalence des blessures musculo-squelettiques est élevée chez les ambulanciers paramédicaux (WorkSafe BC, 1999; Maguire et coll., 2005; Sterud et coll., 2006; Reichard et Jackson, 2010; Maguire et coll., 2014). Que l'objectif soit de réduire les taux de blessure, de diminuer la gravité des blessures ou d'améliorer les résultats relatifs au retour au travail, il est essentiel de comprendre les exigences du travail, y compris toute sa diversité, idéalement dans la perspective des ambulanciers paramédicaux qui effectuent réellement le travail. Le fait de comprendre l'ampleur des exigences physiques imposées par le travail des ambulanciers paramédicaux est une étape fondamentale de l'amélioration de la santé et de la sécurité des ambulanciers paramédicaux au Canada.
Par conséquent, l'étude avait pour objectif de recueillir des renseignements détaillés sur les exigences physiques subies durant l'exécution du travail quotidien d'un ambulancier paramédical. Pour ce faire, les chercheurs et les ambulanciers paramédicaux ont travaillé ensemble à une analyse des exigences physiques réalisée à cinq services paramédicaux à l'échelle du pays. Cette démarche unique a permis aux ambulanciers paramédicaux de saisir avec exactitude les données relatives aux exigences physiques, ce qui a créé le fondement permettant de créer ultérieurement un milieu de travail plus sécuritaire, pour les patients et les ambulanciers paramédicaux.

Résultats : Les ambulanciers paramédicaux de tout le pays étaient exposés à de fortes exigences physiques qui pourraient se produire près de 50 fois par quart dans certaines régions. La fréquence de l'exposition à des tâches très exigeantes sur le plan physique, comme le chargement dans l'ambulance et le déchargement de la civière, ou la levée/descente de la civière dépendait du volume des appels. Cependant, les civières motorisées éliminent/réduisent les exigences physiques associées au chargement et au déchargement ainsi qu'à la levée et à la descente dans les services qui disposent de cet équipement. En outre, on a remarqué que l'équipement utilisé à chaque endroit (sac médical, moniteur cardiaque, civière, chaise-civière, etc.) n'était pas normalisé entre les services. Par conséquent, le poids total de l'équipement déplacé par appel dépendait de l'équipement utilisé par chaque service.

Importance : L'étude a donné un aperçu des exigences physiques du travail paramédical au sein de cinq services différents à l'échelle du pays. Ces données laissent voir que les ambulanciers paramédicaux sont exposés à des tâches intermittentes très exigeantes sur le plan physique (c.-à-d. lever/descendre ou charger/décharger la civière), entrecoupées de périodes sédentaires (conduite, remplir de la paperasse, être en attente, etc.). Toutefois, l'équipement et le volume des appels ont un effet direct sur l'ampleur et la fréquence de ces tâches exigeantes sur le plan physique. Les civières motorisées éliminaient/réduisaient les aspects physiquement exigeants du travail, tandis que les forts volumes d'appels augmentaient la fréquence des activités exigeantes sur le plan physique.

Perspectives : L'étude visait à fournir des données de base documentant les exigences physiques du travail d'ambulancier paramédical. En utilisant ces données comme point de départ, les travaux futurs pourront être axés sur la diminution des périodes d'exigences physiques intenses, l'amélioration des capacités des ambulanciers paramédicaux pour mieux répondre à ces exigences, l'élaboration d'interventions ciblées afin de réduire le nombre et la gravité des blessures musculo-squelettiques.

Table of contents

List of figures

List of tables

Acknowledgements

This work was supported by the Defence Research and Development Canada, Centre for Security Science, Canadian Safety and Security Program CSSP-2013-CD-1088.

1 Introduction

A physical demands analysis (PDA) is a systematic procedure that can be applied to observe, quantify, and report on all of the physical components of all essential and non-essential tasks within a job. A PDA can be conducted by following three steps: Preparing for the PDA (e.g., training, logistics, etc.); Observation and Data Collection (e.g., documenting and quantifying physical demands); and, Reporting (e.g., synthesizing and reporting on the gathered data). This three-step process allows the evaluator to describe the physical demands of a job in its' entirety. PDA information can be used for many purposes, including: to provide documented information about a job to help medical professions effectively treat injured workers; to provide objective measurements to determine any Bona Fide Occupational Requirements; or, to identify safety concerns, and guide engineering and administrative improvements (OHCOW, n.d). The PDA remains as a cornerstone for any injury prevention program.

Traditionally, a PDA is conducted by a trained ergonomics professional who is hired to interview employees, observe the work processes and associated actions, and lastly to measure the demands of the work (e.g., record reach distances, the weight of lifted/pushed/carried objects, etc.). The work of a paramedic, however, poses some non-traditional challenges. For instance, an ergonomist could unintentionally interfere with the delivery of emergency patient care during a call, or could be exposed to situations that they may not be emotionally or mentally prepared to witness. In contrast, a paramedic would be knowledgeable about each situation such that they would know the best vantage points to observe the work without interrupting patient care. Additionally, a paramedic's occupational experience may allow him/her to more accurately document activities and demands that are often performed quickly during the provision of care; activities that an ergonomist may unintentionally miss during a high intensity situation. In addition, a participative approach encouraged paramedics and ergonomics professionals to unite their expertise to develop a detailed and representative description of the physical demands performed by paramedics. For this reason, this study employed a participatory process wherein the expertise of both ergonomics professionals and paramedics were united in completing the three step process (Figure 1). The research team provided expertise to prepare for the PDA, including providing PDA training to participating paramedics, and synthesized and reported on the data. Paramedics engaged with the research team to learn how to observe and quantify physical demands in the preparation step, and actively observed and gathered the data that were used to develop this report.

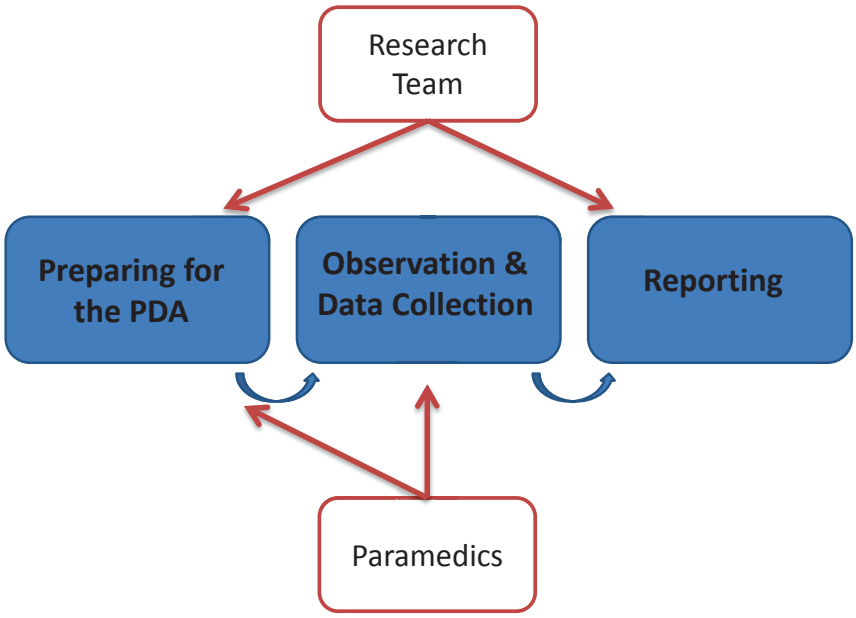

Figure 1 - The participatory processing uniting the expertise of the research team and the paramedic community to observe and document the physical demands of paramedic work.

2 Purpose

The goal of this study was to gather detailed information about the physical demands experienced while performing the day-to-day work of a paramedic. This study is unique in that paramedics and researchers worked together to document the demands of the job.

The outcome of this study was to identify the critical physically demanding tasks encountered by paramedics across Canada. This information is crucial to support the future development of evidence based pre-employment screening tests (Gumieniak et al., 2011), and to improve the ability of health care providers to aid paramedics in safely and efficiently returning to work after injury.

3 Methodology

The research team followed the three step process of the PDA: Preparing for the PDA, Observation and Data Collection, and Reporting, to structure the research methodology (Figure 2).

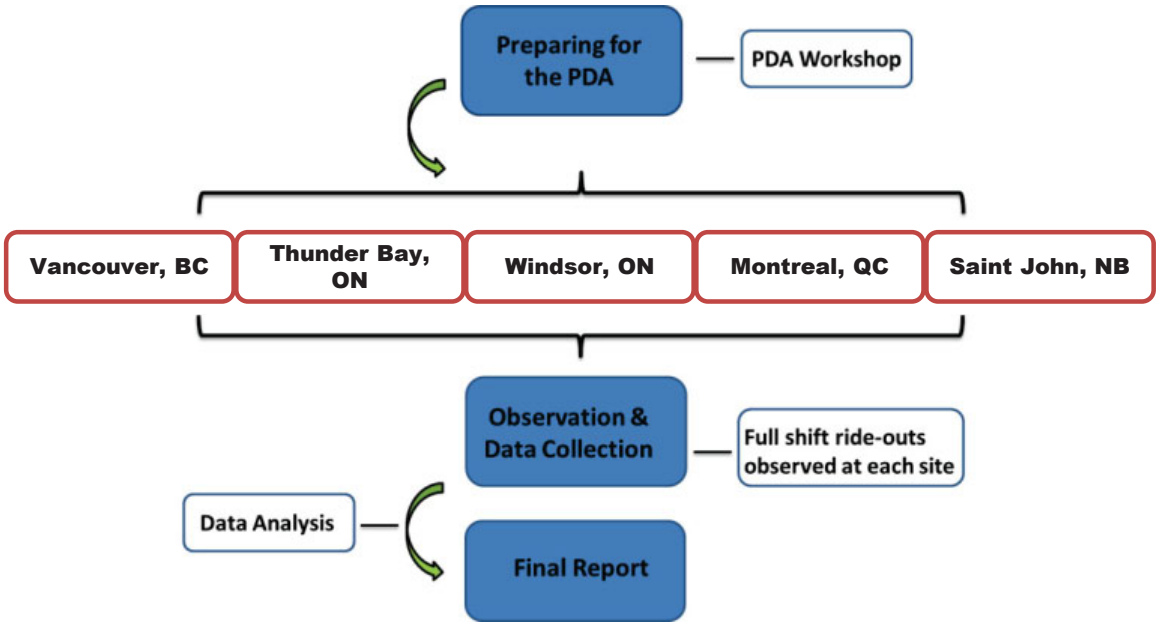

Figure 2 - Outline of the over-arching research methodology.

Preparing for the PDA

Working in consultation with the Paramedic Chiefs of Canada (PCC) and the Paramedic Association of Canada (PAC), as contracted by Public Works and Government Services Canada (PWGSC), the research team identified five national sites to gather PDA information: BC Ambulance Service Metro Operations (Vancouver, British Columbia), Superior North EMS (Thunder Bay, Ontario), Essex-Windsor EMS (Windsor, Ontario), Urgences-Santé (Montréal, Québec), and Ambulance New Brunswick (Saint John, New Brunswick). The research team contacted the respective Chief at each national site and invited them to participate in the *Paramedic Physical Demands Study*. After accepting the invitation to participate, the team worked with each Paramedic Chief to coordinate a PDA training session at his/her respective service, and to recruit two paramedics to participate as research assistants to observe and gather the PDA data. Between November 2013 and February 2014, the research team lead a 5-hour PDA workshop at each national

site, where the two participating paramedics were provided with the background knowledge and skills they would require when riding out with their colleagues to observe and collect physical demands data.

Figure 3 - The research team and paramedics from Thunder Bay ON, working through the PDA workshop.

Observation and Data Collection

The observation and data collection step was completed by the paramedics participating within each service. Following the completion of the 5-hour workshop, the participating paramedics were each required to ride out on two shifts, relying on their PDA training in order to observe, document and quantify the physical demands. Where scheduling permitted, each paramedic was asked to ride-out on one day-shift and one night-shift. Participating paramedics were asked to record all data on the PDA data collection tool supplied by the research team during the training. Completed PDA data collection booklets were then mailed to the research team for data analyses.

Figure 4 - A PDA trained paramedic observing the physical demands of on-duty paramedics at the start of their shift.

Reporting

Nine paramedics from across the country reported on the physical demands. The research team compiled the data based on the physical demands observed during four ride-outs in each of Vancouver BC, Thunder Bay ON, Windsor ON, and Saint John NB, and two ride-outs in Montréal QC. The data reported below represent a grand total of 18 full-shifts worth of physical demands data, or 216 hours of coverage.

4 Results

Overview of Participating Services

BC Ambulance Service Metro Operations

BC Ambulance Service (BCAS) is an emergency medical service operated by BC Emergency Health Services. BC Ambulance services a population of 4.4 million, covering a geographic area of almost one million square kilometers. At the time of the study, the service employed 2,691 Primary Care Paramedics (PCP), 217 Advanced Care Paramedics (ACP), and 51 Critical Care Paramedics (CCP). BC Ambulance Service is comprised of two operations divisions: Metro Operations and Rural Operations. Metro Operations are responsible for ground operations in the metropolitan areas of the province including Metro Vancouver and the Capital Regional District on South Vancouver Island, whereas Rural Operations are responsible for ground operations in all areas of province outside of the Metro Operations. Overseen by Metro Operations are 36 metropolitan stations and 35 urban stations staffed 24/7 by a combination of full-time paramedic crews and paramedics working standby shifts. In 2011-2012, BC Ambulance responded by ground to a total of 486,138 calls; 394,069 were pre-hospital, and 92,069 were inter-facility patient transfers. In Metro Vancouver, there were 262,873 calls; 214,720 of which were pre-hospital, and 48,153 were patient transfer or standby calls.

Superior-North EMS

Superior North Emergency Medical Services (SNEMS) is operated by the City of Thunder Bay, with headquarters located in Thunder Bay and an additional 16 satellite stations throughout the District of Thunder Bay. During the time of the study in 2014, SNEMS employed approximately 170 full and part-time PCPs, and 20 full and part-time ACPs who delivered provincially mandated emergency care to approximately 169,000 residents within the City and District of Thunder Bay. The service responded to approximately 27,000 total calls. SNEMS was unique from other services in that each ambulance was equipped with a Stryker Power-PRO™ XT and the Power-LOAD™ fastener system. This powered stretcher and powered stretcher loading mechanism removed the need for paramedics to manually load/unload or lift/lower the stretcher.

Essex-Windsor EMS

Essex-Windsor Emergency Medical Services provides emergency medical services for Essex County, including the County of Essex, the City of Windsor and the Township of Pelee. Essex County is Canada's southernmost county, spanning over 4,797 square

kilometres, and with a population of over 392,000, it is the second most populated county in Ontario. At the time of the study, Essex-Windsor EMS employed 227 PCPs and 39 ACPs whom responded to 93,536 calls per year, where 51,213 were for patient care, and 42,323 were for coverage standbys. There are a total of 12 stations and 38 ambulances operated by Essex-Windsor EMS.

Urgences-Santé

Urgences-Santé is the only public organization that provides pre-hospital emergency services in Québec. Responsible for serving only the cities of Montréal and Laval, Urgences-Santé services between 40 and 50% of all emergency calls within Québec. In all other regions of Québec private ambulance providers deliver pre-hospital and ambulatory care. With 132 ambulances responding to approximately 220,000 calls annually, Urgences-Santé has the highest call volume in Canada and sixth highest in North America. Similar to SNEMS, Urgences-Santé has also equipped each ambulance with a Stryker Power-PRO™ XT. This powered stretcher removed the need for paramedics to manually lift/lower the stretcher.

Ambulance New Brunswick

Ambulance New Brunswick (ANB) in contract with New Brunswick EMS, is a subsidiary of Medavie EMS, and provides ambulance services throughout the province of New Brunswick. ANB is committed to providing excellent and progressive pre-hospital care through a, "made in New Brunswick" solution. Headquartered in Moncton, ANB operates 134 ambulances spread across approximately 70 stations and posts throughout the province. ANB employs nearly 1,000 professionals as paramedics, emergency medical dispatchers and flight nurses who deliver emergency medical services to approximately 750,000 residents in New Brunswick. The service provides medical response to emergency 911 calls where paramedics assess, treat, and transport patients to hospitals for further medical care. According to the ANB 2nd quarter 2013 report, ANB responded to 12,190 emergency calls, 4,269 non-emergency calls and performed 7,957 transfers in the period from July through September 2013.

National Site Summary

Sites were selected to ensure that physical demands were observed in different geographical regions (rural vs. urban), in addition to services supporting different population demographics. The research team was effective in obtaining data from a range of services as indicated in Table 1. Of particular note, the services in Montreal and Vancouver function in densely populated metro areas and experience higher call volumes

as a result. By contrast, Thunder Bay and Saint John function in lower density areas (mixing urban and rural geographies) where they experience fewer calls than the services in high density metro centres.

Table 1 - A summary of service statistics for participating sites. Data were provided directly by each service at the time of the study.

	Montreal QC	Vancouver BC	Windsor ON	Thunder Bay ON	Saint John NB
Total Call Volume	373,119	262,873	93,536	27,000	15,351
Emergency Calls	291, 780	214,720	51,213	21,600	15,351
Non-Emergent and/or Standby Calls	81,339	48,153	42,323	5,400	N/A
Number of Ambulances	154	480*	38	42	8
Number of paramedics	930 PCP, 8 ACP	2,237 part time & 1,532 full time *	227 PCP, 39 ACP	170 PCP, 20 ACP	78 PCP, 0 ACP

*Data from the entire province

Call Volume Statistics

A total of 92 calls were observed during the course of this study. Mapping closely with the statistics in Table 1, services in more densely populated areas attended a greater number of calls per shift than those in less densely populated areas (Table 2). In addition, average call duration was also estimated as the total time between "crew mobile" to the "transfer of care". Two of the services with the greatest call volume per shift were also noted to have longer average call durations. When parsing out the data further, paramedics in Montreal and Windsor spent more time on scene (19.8 and 19.3 minutes)

and in off-load delay (12.5 and 18.3 minutes) per call on average than any other observed service. Paramedics in Vancouver averaged the least amount of time on scene per call (9.6 minutes), and Saint John and Thunder Bay averaged the least amount of time in off-load delay per call (3.4 and 4.3 minutes).

Table 2 - A summary of the average number and length of calls observed in each site. Data represents the mean and standard deviation based on the samples obtained from each site.

	Montreal QC	Vancouver BC	Windsor ON	Thunder Bay ON	Saint John NB
Average number of calls per shift	6.0 ± 0	8.5 ± 2.5	5.0 ± 2.3	3.5 ± 1.3	3.0 ± 1.4
Average duration* of call per shift (minutes)	53.3 ± 35.8	34.7 ± 23.5	51.52 ± 22.3	37.6 ± 17.2	36.9± 13.5

* Call duration was measured as the length of time between the crew going mobile (after receiving the call details from dispatch) to the transfer of care (i.e. transit times, on-scene time and any off-load delay time).

Patient Statistics

Over the course of the 92 calls observed, paramedics provided services to a range of patients based on their demographics (Table 3). These data represent an average across all patients from ages 1-100 years. Considering the call statistics above, services attending fewer average calls per shift were required to provide care for patients that were heavier, on average, relative to those providing care in higher call volume services. Moreover, when considering patient weights (plus equipment weights) when lifting, lowering, loading, unloading, or transferring activities, these maximum weights help to provide an indication of the peak physical demands that paramedics may be exposed to during the course of their work.

Table 3 - A summary of patient demographic information based on the calls observed. Data represents the mean and range (maximum and minimum) based on the samples obtained from each site.

	Montreal QC	Vancouver BC	Windsor ON	Thunder Bay ON	Saint John NB

Age (years)	57.5 (20-93)	53.4 (7-91)	52.1 (1-89)	61.2 (24-100)	53.5 (1-92)
Weight (kg)	65.3 (51-90)	67.8 (21-114)	67.6 (12-86)	81.9 (40-140)	70.7 (21-110)
Height (cm)	163.6 (120-172)	162.5 (83-182)	163.2 (60-183)	168.7 (155-188)	167.1 (65-185)

Equipment

Paramedics require an extensive collection of equipment to provide timely and effective emergency patient care. While all services used equipment designed to achieve the same objectives (e.g., stretcher's, stair chairs, medical bags, etc.), the make, model and manufacturers of the equipment varied. Equipment weights were also varied as a result of the different manufactures. Currently, across Canada there are no national standards on the style and type of equipment paramedics must carry. For example both SNEMS and Urgences-Santé used a power stretcher (Stryker Power-PRO™ XT) that automatically raises and lowers the stretcher. SNEMS has also equipped each Ambulance with the Stryker Power-LOAD™ fastener system to automatically load and unload the stretcher from the ambulance. While paramedics in each of these regions still need to move the stretcher, the powered stretchers remove the physical demand elements associated with these tasks. Similarly, services also differed in the types of stair chairs that were used. While all stair chair use required physical demand to move the chair, those with a track system (EZ Glide® and Stair Pro model 6252) allow paramedics to push/pull the chair down the stairs, rather than requiring paramedics to physically lift and carry the chair. Variation in the weight of medical and airway bags was due to the inclusion of different supplies (types and amounts) and the use of different types of bags to contain those supplies. The weight of all equipment commonly used within each site, is provided in Table 4. Note: the recorded weights were measured by the research team onsite and may differ from factory specifications. For example, the factory specifications for weight do not often include the mattress or restraints, which are both included in these reported measures.

Table 4 - Equipment weights in kilograms (kg).

	Montreal QC	Vancouver BC	Windsor-Essex ON	Thunder Bay ON	Saint John NB
Patient Transfer Equipment					
Stretcher	Stryker Power-	Ferno 35X PROFlexX®	Stryker MX-Pro®	Stryker Power-	Ferno 35X PROFlexX®

	PRO™ XT		R3	PRO™ XT	
	72.9	48.9	50.1	72.9	48.9
Stair Chair	Stryker Stair Pro 6252	Ferno EZ-Glide®	Stryker Stair Pro 6252	Stryker Stair Pro 6251	Ferno EZ-Glide®
	15.9	18.5	15.9	10.0	18.5
Spinal Board	5.3	9.8	8.1	6.1	6.3
Patient Care Equipment					
Cardiac Monitor	11.2	12.5	12.0	11.0	11.0
Medication Bag	1.4	9.5	11.4	6.9	7.7
Airway Bag	6.9	7.0	6.2	6.1	11.4

Physical Demands

During each call, paramedics must complete a variety of physically demanding activities. While call volume, patient statistics and equipment all affect the frequency and magnitude of those physical demands, the following section reports on the specific physical demands elements that were identified.

Strength Demands

Paramedics were responsible for transferring patients' on-scene to the ambulance, and from the ambulance to the destination (e.g., emergency room, hospital, nursing home, etc.). Meeting these responsibilities, paramedics must perform several strength related physically demanding actions including loading and unloading the stretcher from the ambulance, raising and lowering the stretcher, lifting and transferring patients. These actions were commonly performed using the patient transfer equipment listed in Table 4. As shown in Figure 5, these activities required paramedics to load and/or unload an empty stretcher (blue bars), or stretcher loaded with the patient (red bars) into or out of the ambulance. Additionally, paramedics were required to raise or lower the stretcher (green bars) to specific target heights when transferring or moving patients. Further, paramedics completed a variety of patient transferring and repositioning tasks where they may manually lifted a patient (Pt) vertically (purple bars), horizontally (light blue bars) or

rotationally (orange bars). To aid in interpreting these data, recall that paramedics responded to an average of 3 – 8.5 calls per shift (Table 2). Considering that the stretcher was manipulated an average of 17 (Saint John) – 48 (Montreal) times per shift depending on the service (summing the blue, red and green bars), paramedics were manipulating the stretcher up to 5 times per call; however, in Thunder Bay and Montreal, some of these actions were automated through the use of the powered stretcher.

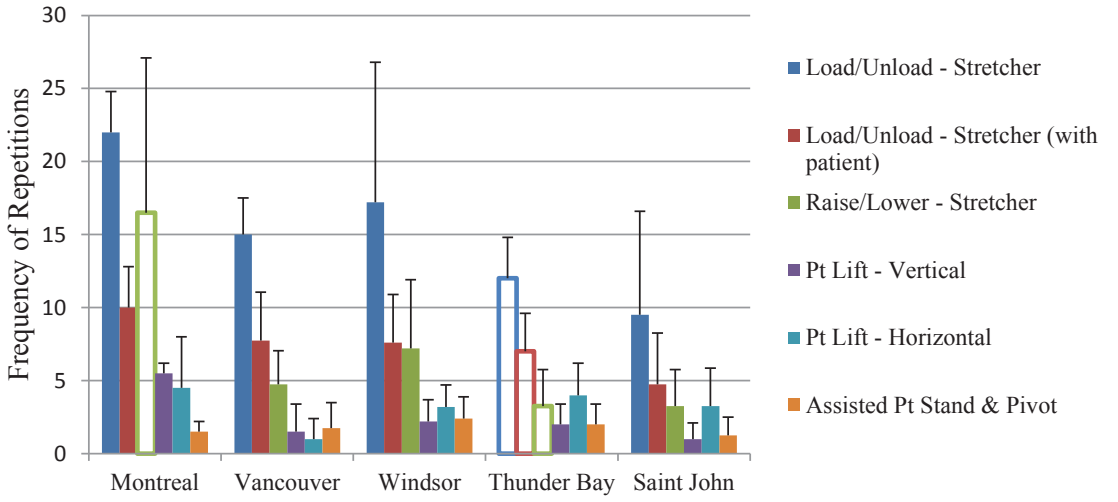

Figure 5 - The frequency of strength demanding activities observed per shift stratified by location. Error bars indicate the standard deviation about the mean.
**Note: Bars that are only outlined indicate the number of times that these activities were completed; however, due to the use of powered stretchers, paramedics were not required to physically perform those actions.*

Providing timely and effective patient care required paramedics to lift, carry and place a series of supporting equipment. The specific type and weights of patient care equipment varied by service (Table 4); however, all services typically reported bringing a cardiac monitor, airway bag, and medication bag to the scene. Figure 6 indicates the average frequency of patient care equipment handling per shift. This high-level overview demonstrates again that paramedics are moving equipment several times per call (3 – 8.5 calls per shift). It is also important to note that different services moved and transported this equipment in different ways. In some services, the stretcher was set-up with specific locations for equipment (i.e., bottom carriage). This allowed paramedics to simply load their equipment onto the stretcher for transport to and from the scene (still requiring a lift, but reducing the total carry time). In other services, however, these provisions were not available and paramedics were required to manually carry all of the equipment to and from the scene. Anecdotally, the frequency of this work was often the most surprising to

participating paramedics as they had never actually considered the number of times they lifted, lowered, and carried these pieces of equipment.

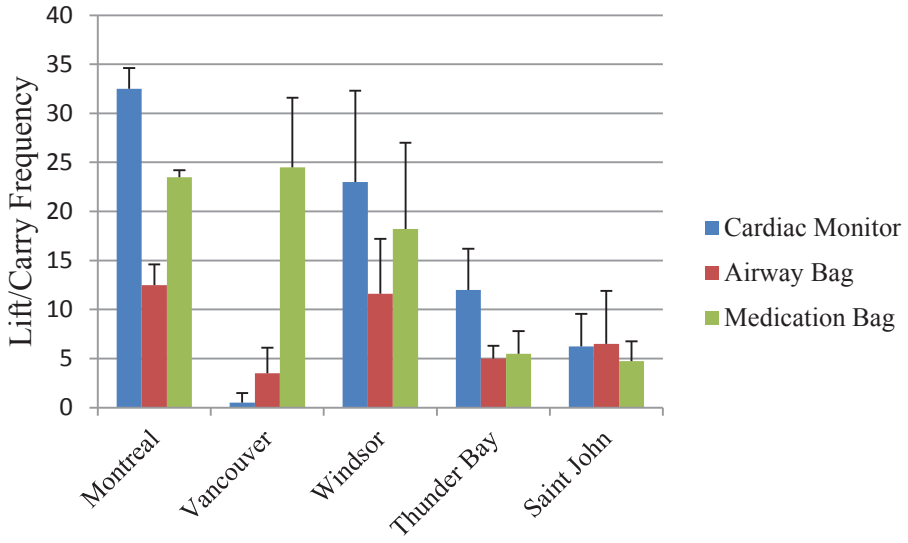

Figure 6 - The frequency of lifting and carrying associated with patient care equipment handling per shift stratified by location. Error bars indicate the standard deviation about the mean.

Paramedics were observed to routinely lift, lower and carry a range of patient transfer and care equipment. Considering the nature of the job, and the uniqueness of each and every call it was difficult to determine "average" lift, lower or carry heights. Paramedics were observed to lift, lower and carry at a range of heights as low as ground level (when transferring a patient from the ground to the stretcher), to a height high enough to load the stretcher into the rear of the ambulance (where this height depends on the make and model of the ambulance). Additionally, when carrying, paramedic services in the study carried equipment and medical bags using single over-the-shoulder style straps, while others used hand-held handles.

Paramedics also used the stair chair to transfer patients; this information is described in the mobility demands section below along with a description of demands related to pushing and pulling demands required by paramedics.

Peak Physical Demands

Paramedics were exposed to lifting, lowering, carrying, pushing, and pulling along with other physical demands. As illustrated the frequency depends on the equipment, and the call volume. Considering worst case scenarios, the peak weight (stretcher + heaviest patient + patient care equipment also place on the stretcher) handled ranged from 153.7

kg to 236.9 kg depending on the service (Figure 7). As a percentage, patient weight accounted for 49-59% (depending on the service) of the total weight lifted when considering the worst case scenario, where the stretcher represented 25-40% and the weight of patient care equipment represented the remaining 10-16%; however, when considering the average patient, patient weight accounted for 41-50% (depending on the service), where the stretcher represented 33-46% and the weight of patient care equipment represented the remaining 12-20%.

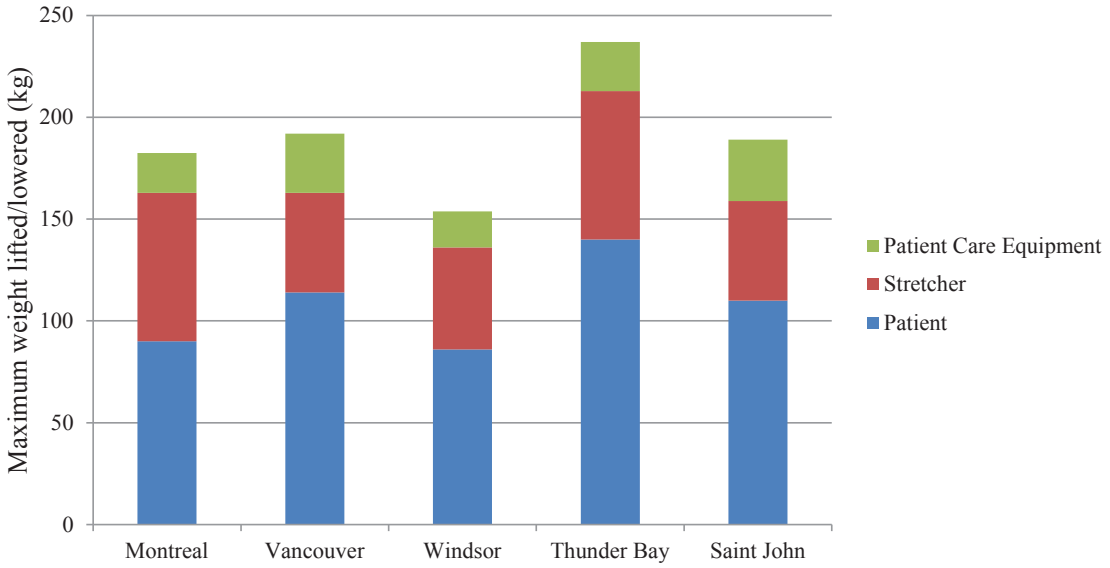

Figure 7 - The maximum weight (heaviest patient + stretcher + patient care equipment) lifted/lowered within the observation period in each service.
** While Montreal and Thunder Bay both use powered stretchers it is very important to note that paramedics may still be required to manipulate the stretcher up and over obstacles such as curbs, door jams, uneven surfaces, or on terrain that may be covered in snow and ice.*

Mobility Demands

The work of paramedics was dynamic and required them to move between the ambulance and the scene, often several times throughout a call; the environment and terrain were always varied. This section of the report describes the pushing/pulling, walking, and stair climbing demands as observed during the observation periods.

Walking demands varied between the participating services (Figure 8). Depending on the location of the call and the regional geography/city layout during the observational ride-outs, it was observed that it was not always possible to park the ambulance close to the

scene in some situations. This required paramedics to walk for several hundred meters to traverse between the ambulance and the scene. Moreover, paramedics were required to push, pull and carry their equipment across these distances as well.

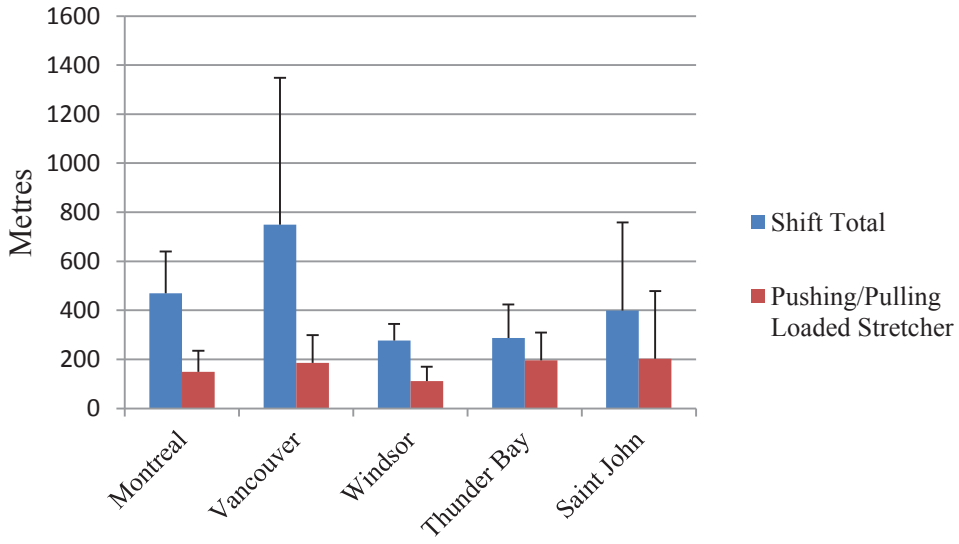

Figure 8 - The average distance (meters) walked by paramedics per call.
The blue bars indicate the total distance walked. The red bars indicate the distance that the stretcher was pushed/pulled per shift (with and without the patient). Error bars indicate the standard deviation about the mean.

The average number of stairs ascended/descended per shift (both with and without patient transfer equipment) was greater in areas with higher population density (Figure 9). This was likely a result of the increased number of high density residences in these areas such as high- and low-rise apartment buildings. For reference, there are typically 15-17 steps per floor; paramedics in Montreal were ascending / descending the equivalent of nearly 7 ½ floors per shift.

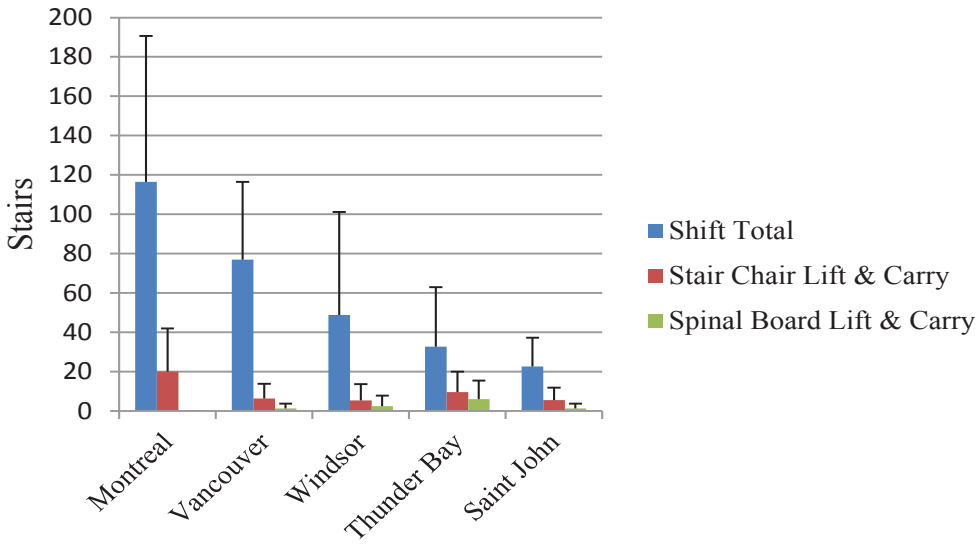

Figure 9 - The average number of stairs ascended/descended by paramedics per shift.

Driving and Time Demands

Driving was an essential requirement of paramedics' work. Paramedics routinely drove within their assigned catchment area between calls, in addition to their driving duties on route to and from a call. Figure 10 summarizes how paramedics spent their "on-call" time estimated as the total time between "crew mobile" to the "transfer of care", where the blue and green bars represented the total time spent driving to and from the scene respectively. The red and purple bars indicated the total amount of time spent on scene at the call defined as time the ambulance arrived on scene to the time the ambulance departed the scene, or at the hospital in an off-load delay situation. While Table 2 indicated the average call duration, Figure 10 indicated the total time per shift. Paramedics had between 35 minutes (Vancouver) and 120 minutes (Thunder Bay) between calls, on average.

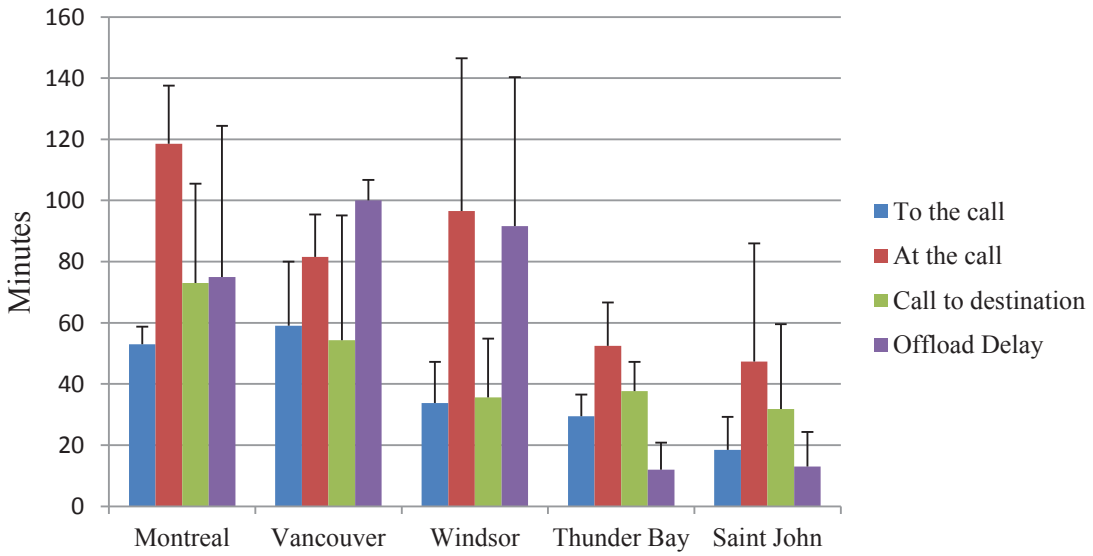

Figure 10 - The total amount of time spent driving; providing on-scene care and waiting in off-load delay per shift for each service observed.

Despite being exposed to instances of high physical demands (i.e. loading / unloading the stretcher), by contrast, paramedics were also sedentary for more than half of their average 12-hour shift. Figure 11 illustrates the total amount of time that was spent on activities that were not captured in Figure 10. As indicated by the participating paramedics this time could have been spent driving the ambulance roaming through their catchment area, seated in the ambulance or in a satellite station awaiting a call, or cleaning and restocking the rear compartment of the vehicle. While paramedics completed some low demand activities during this "off-call" time between calls, most of this time was reported as primarily sedentary.

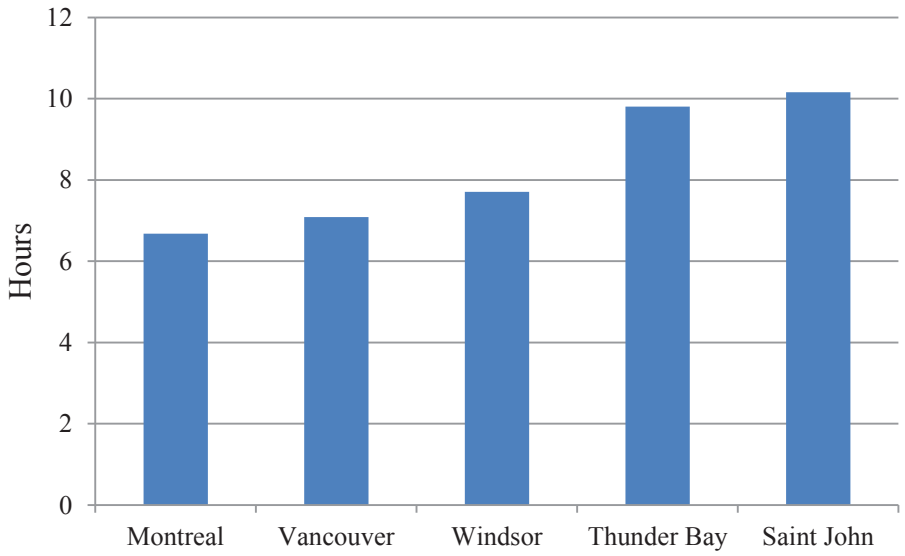

Figure 11 - The total amount of sedentary time / time spent on non-patient care activities per shift.

Limitations of the results

These data were gathered by nine paramedics observing a total of 92 calls over 18-twelve hour shifts. The magnitude of the observation period far exceeded the typical window of observation that an ergonomics professional would use when documenting physical demands. The breadth of the observations likely improves the resolution of the frequency counts over those obtained by trained ergonomics observing for fewer shifts; however, the paramedics trained to observe had much less experience observing work from the lens of an ergonomist and were more likely to miss physically demanding aspects of their work. For example, some paramedics provided detailed step-by-step data for each call, indicating each and every time the stretcher (for example) was moved, while others provided less detailed data, noting when the stretcher was unloaded, but omitting the re-loading step, or omitting the raising/lower requirements when transferring a patient. From this perspective, it is likely that these data may still be an under representation of the actual demands experienced by paramedics.

5 Transition and Exploitation

Transition to End Users

These data are intended to provide a point of reference for the paramedic community when considering the physical demands of their work. It is recommended that this report be circulated to Paramedics and Chiefs via the Paramedic Chiefs of Canada, the Paramedic Association of Canada and the Paramedic Community of Practice. Additionally these data should be made available to ergonomic and health care professionals and other key stakeholders by the aforementioned associations to provide these professionals with a clearer understanding of paramedics' work as observed by paramedics.

Follow-On Commercial Development or R&D Recommended

Research and development is required to help reduce peak physical demands and ultimately injury claims among paramedics. Considering the physical demands profiled, it is clear that paramedics must be able to demonstrate peak physical capabilities on-demand, following periods of prolonged inactivity (seated and/or driving). Thus future research is likely required along two pathways. First, research is needed to help identify effective strategies and interventions to help reduce the magnitude and frequency of peak exposures. Second, research should also focus on improving/refining/maintaining the physical abilities of paramedics to ensure they can continue to meet these high demands.

During the cross-country data collection process the research team learned that there were already many local interventions and strategies being employed to help reduce peak exposures. As a case example, Thunder Bay and Montreal use powered stretchers throughout their fleet. Although this increased the net weight, it eliminated the need to physically lift and lower the stretcher (and load / unload the stretcher in Thunder Bay) thereby reducing the number of times their paramedics had to perform peak lifts. While these may prove to be effective counter measures to reduce injury occurrence and severity, it is important to monitor health outcomes to ensure that these interventions provide the intended effects. As such, the profession may see an immediate benefit by helping services to systematically measure the effectiveness of local interventions, then providing a mechanism to share these local "bright spot" successes with other services.

Considering the physical demands of paramedic work as indicated in this report, there is a need to ensure the incoming paramedics are able to indeed meet those demands. While this study noted differences in the frequency of physical demand exposures and the magnitude of those demands due to differences in equipment; regardless of the service,

all paramedics were required to complete the same general physical activities (lifting, lowering, carrying, etc.). As such, there is an opportunity to develop a standardized method to evaluate paramedic physical readiness. A national standard for physical ability, based on well documented physical demands (Gumieniak et al., 2011), would accomplish two key objectives: providing a clear guideline for entry to practice (regarding physical abilities) that could be used to enhance paramedic curriculum/education; and, ensuring that all paramedics, regardless of service, municipality, or province are all able to meet the same requirements, enhancing potential portability for paramedics, but also ensuring public safety in the event that paramedics must temporarily relocate to another service, municipality or province in the event of an emergency.

Intellectual Property Disposition

This report provides descriptive data about the physical demands of paramedic. There is no specific intellectual property contained within this report.

6 Conclusion

This study is the first of its kind in the paramedic community. Representing the largest and most diverse repository of paramedic physical demands data in Canada, this study was also the first to employing a participatory approach, teaming ergonomics experts and paramedics together to observe and document physical demands across the country. The data demonstrated two key high level outcomes: call volume and equipment play essential roles in dictating the frequency and magnitude of physical demand, and, regardless of the service, the provision of emergency patient care requires paramedics to perform the same activities from coast to coast. These data, gathered by paramedics, for paramedics demonstrate that paramedic work is physically demanding. Moving forward there are clear opportunities to reduce high demand physical elements, while also ensuring that paramedics are able to maintain their capabilities to meet these demands.

References

Gumieniak R, Jamnik VK, Gledhill N. 2011. Physical Fitness Bona Fide Occupational Requirements for Safety-- Related Physically Demanding Occupations; Test Development Considerations. Health and Fitness Journal of Canada, 4(2): 47-52.

Maguire BJ, Hunting KL, Guidotti TL, Smith GS. 2005. Occupational injuries among Emergency medical services personnel. Prehospital Emergency Care, 9: 405-411.

Maguire BJ, O'Meara PF, Brightwell RF, O'Neill BJ, Fitzgerald GJ. 2014. Occupational injury risk among Australian paramedics: an analysis of national data. Medical Journal of Australia, 200: 477-480.

Occupational Health Clinics for Ontario Workers (OHCOW). n.d. OHCOW Physical Demands Description Handbook. Retrieved from http://www.ohcow.on.ca/uploads/Resource/OHCOW%20PDD%20Handbook%20-%20High%20Resolution.pdf

Reichard AA, Jackson LL. 2010. Occupational injuries among emergency responders. American Journal of Industrial Medicine, 53: 1–11.

Sterud T, Ekeberg O, Hem E. 2006. Health Status in the ambulance service: a systematic Review. BMC Health Services Research, 6: 82.

Annex A Study Team

The study team is comprised of the following people.

Role	Name	Organization
Project Leader	Mark Williamson	DRDC CSS
Project Director	Doug Socha	DRDC CSS Paramedic Portfolio Manager
Project Manager	Gale Chevalier	Paramedic Chiefs of Canada
Project Champion	Pierre Poirier	Paramedic Association of Canada
Project Champion	Kelly Nash	Paramedic Chiefs of Canada
Principle Investigator	Steven Fischer	Queen's University
Principle Investigator	Renée MacPhee	Wilfrid Laurier University

Annex B PROJECT PERFORMANCE SUMMARY

PROJECT PERFORMANCE SUMMARY

Technical Performance Summary: The focus of this project was to gather descriptive data about the physical demands of paramedic work. As such, this report did not include specific technology objectives. Regarding the specific purpose outlined above, this report does provide a detailed description of the physical demands of paramedic work based on data obtained from a sample of services representative of Canada.

Annex C Publications, Presentations, Patents

- Coffey B, MacPhee R, Socha D, Fischer SL (2014). A day in the life of a paramedic: A participatory approach to documenting the physical demands of paramedic work. Proceedings of the 45th Association of Canadian Ergonomists National Conference. Montreal Quebec, [Accepted for presentation – October 2014].

List of symbols/abbreviations/acronyms/initialisms

ACP	Advanced Care Paramedics
ANB	Ambulance New Brunswick
CCP	Critical Care Paramedics
CSS	Centre for Security Science
DND	Department of National Defence
DRDC	Defence Research Development Canada
EMS	Emergency Medical Service
MSD	Musculoskeletal Disorder
NIOSH	National Institute for Occupational Safety and Health
OPI	Office of Primary Interest
PAC	Paramedic Association of Canada
PCC	Paramedic Chiefs of Canada
PCP	Primary Care Paramedics
PDA	Physical Demands Analysis
PWGSC	Public Works and Government Services Canada
R&D	Research & Development