The Optimization of Lateral Ankle Sprain Management Among Physiotherapists in the Canadian Armed Forces

by

Eric Robitaille

A thesis submitted in conformity with the requirements for the degree of Doctor of Philosophy
Graduate Department of Rehabilitation Science
University of Toronto

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2015

Abstract

Lateral ankle sprains (LAS) are the 3rd most common injury sustained by military members, affecting their physical readiness and thereby the operational readiness of the military. To limit the impact of LAS on the operational readiness of the Canadian Armed Forces (CAF), this thesis used three studies to investigate an approach to optimize the LAS management practices of CAF Physiotherapists. Firstly, a literature review determined the LAS management practices recommended by current best research evidence. Subsequently, 52 CAF Physiotherapists were surveyed to establish their LAS management practices. Comparing these sources revealed that over 84.6% of the respondents reported using evidence based practices across all stages of healing. However, respondents also reported a relative delay in prescribing balance & strengthening exercises until the sub-acute stage of healing, and reported a limited use of balance & functional performance measures across all stages of healing. A focus group of CAF Physiotherapists further explored their LAS management practices and investigated any factors affecting the implementation of a comprehensive rehabilitation program derived from current research evidence. Seven participants confirmed delaying their prescription of strengthening exercises and using a limited number of balance & functional performance measures, but denied barriers to implementing the rehabilitation program in garrison or on deployment. A pilot study investigated the feasibility of conducting a randomized trial to determine the value of adding manual ankle mobilizations to the rehabilitation program to improve ankle dorsiflexion in 20 CAF members with LAS. It was concluded that the study design was feasible in a CAF setting, yet there were no statistically significant differences in ankle dorsiflexion between the mobilization (95.2±47.5mm) and sham groups (94.7±36.9mm) at 2 weeks (p=0.84). However,
while clinically important changes in ankle dorsiflexion and self-reported function were reported by both groups, the magnitude of change was larger in the mobilization group. The recommendations of this thesis may be clinically applied by CAF Physiotherapists to optimize their LAS management practices and limit the impact of LAS on CAF operational readiness.
Acknowledgments

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This project would not have transpired without the approval of my workplace including my direct supervisor Captain Adam Hannaford and our respective chain of command members at the 31 Canadian Forces Health Services Centre at Canadian Forces Base Borden, Detachment Meaford and Canadian Forces Physiotherapy. I am deeply grateful for my colleagues, both military and civilian, who contributed to this project through their study participation and sharing their clinical experiences both on deployment and in garrison. Their contributions have made the results of this project clinically valuable for Canadian Armed Forces Physiotherapists.

I cannot over emphasize the absolute necessity of the support of my friends and family throughout this project. Thanks to my friends for offering an ear for listening, a shoulder to lean on, or a beverage to enjoy together – a problem shared is a problem halved! Thanks to my family for accepting my intermittent absences from events over the last few years. Most of all, words cannot express my gratitude to my wife Nina and our three children; Logan, Emma & Quinn. Your love has kept me grounded and your belief in me inspired me to achieve my academic goals!
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<tr>
<td>AS</td>
<td>Ankle sprain</td>
</tr>
<tr>
<td>CAF</td>
<td>Canadian Armed Forces</td>
</tr>
<tr>
<td>CAI</td>
<td>Chronic Ankle Instability</td>
</tr>
<tr>
<td>CFHLIS</td>
<td>Canadian Forces Health &amp; Lifestyle Information Survey</td>
</tr>
<tr>
<td>CI</td>
<td>Confidence Interval</td>
</tr>
<tr>
<td>DMSS</td>
<td>Defense Medical Surveillance System</td>
</tr>
<tr>
<td>ICD</td>
<td>International Classification of Disease</td>
</tr>
<tr>
<td>ICF</td>
<td>International Classification of Functioning, Disability &amp; Health</td>
</tr>
<tr>
<td>LAS</td>
<td>Lateral Ankle Sprain</td>
</tr>
<tr>
<td>MSKC</td>
<td>Musculoskeletal Conditions</td>
</tr>
<tr>
<td>OR</td>
<td>Odds Ratio</td>
</tr>
<tr>
<td>RR</td>
<td>Risk Ratio</td>
</tr>
<tr>
<td>SD</td>
<td>Standard Deviation</td>
</tr>
<tr>
<td>US</td>
<td>United States of America</td>
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<tr>
<td>WHO</td>
<td>World Health Organization</td>
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## Glossary

<table>
<thead>
<tr>
<th>Term</th>
<th>Definition</th>
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<tr>
<td>Deployment</td>
<td>Deployment encompasses all activities from origin or home station through destination, specifically including intra-continental Canada, inter-theater, and intra-theater movement legs, staging, and holding areas.</td>
</tr>
<tr>
<td>In garrison</td>
<td>A permanent military installation/base.</td>
</tr>
<tr>
<td>Operational readiness</td>
<td>The state of preparedness of a unit/formation, ship, weapon system, or equipment to perform the missions or functions for which it was organized or designed. It may be used in a general sense or to express a level or degree of readiness. It is also referred to as combat readiness.</td>
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Chapter 1

1 Introduction

Non-battle injuries, consisting predominantly of musculoskeletal conditions (MSKC) sustained during physical training or recreation, have become a leading cause of morbidity among military personnel (Cohen et al. 2010; Hauret et al. 2010). MSKC impact the military through several measures of burden including; morbidity, occupational duty limitations, limited duty days, attrition and related costs (Bell et al. 2008; Rowe & Hébert 2011, Jones et al. 2010; Ruscio et al. 2010). For these reasons several authors have reported that MSKC impact the military’s state of ‘readiness’ (Hébert & Rowe 2007, Bell et al. 2008, Jones et al. 2010, Ruscio et al. 2010). The term ‘readiness’ or ‘operational readiness’ has been defined as the state of preparedness of a military unit to perform the mission or function for which it was designed (Hébert 2013).

Military members whom are unable to perform their occupational duties due to MSKC may affect the preparedness of their military units to perform their function and impact a military forces’ capability to perform their mission. Furthermore, the strength of a military force is not only impacted by their number of military members, but the number whom are physically prepared to deploy on operation. Given these findings, determining the most effective evidence based management strategies for the more prevalent MSKC in the military may aid in limiting their potential impact on operational readiness and military force strength.

Lateral Ankle Sprain (LAS) are consistently reported among the 3 most common MSKC sustained by military personnel (Gruhn et al. 1999; Lauder et al. 2000; Strowbridge & Burgess 2002; Canada, Department of National Defense 2005; Davidson et al. 2008). Despite conservative management, the sequelae of LAS in the military include work time loss, persistent symptoms, impairments, recurrences and a substantial rehabilitation workload (Detorri et al. 1994; Gerber et al. 1998; Strowbridge & Burgess 2002), which impact the physical readiness of military members and thereby the operational readiness of the military (Cameron et al. 2010). To limit the potential threat of LAS to operational readiness in the Canadian Armed Forces (CAF), research into the optimization of LAS management practices warrants investigation.
1.1 Purpose of thesis

The overall purpose of this thesis is to develop practical recommendations designed to optimize the LAS management practices of CAF Physiotherapists, in order to promote efficient and effective evidence based practices that are aligned with the CAF Physiotherapy slogan: “Physical and measurable solutions to maintain and enhance operational readiness, anywhere, anytime” (Hébert & Rowe 2013). To this end the following research questions were developed:

1.2 Research questions

1. What LAS management practices are recommended by the current best research evidence?

2. What are the current LAS management practices of CAF Physiotherapists?

3. What factors influence the implementation of current best research evidence in the LAS management by CAF Physiotherapists?

4. Is there value in adding manual mobilizations to a comprehensive rehabilitation program designed from current best research evidence in CAF members with LAS?

1.3 Outline of thesis

This thesis is comprised of 6 chapters organized in the following manner:

- Chapter 1 provides an overview of the topic, and introduces the purpose, research questions and organization of this thesis.

- Chapter 2 outlines the context and relevance for investigating MSKC and LAS management in the military and culminates with the rationale for the research questions of this thesis.

- Chapter 3, 4 & 5 are self-contained papers each prepared for publication in a peer reviewed journal. In the first paper, a literature review was carried out to determine the current best research evidence in LAS management. Subsequently, CAF physiotherapists were surveyed to determine their current LAS management practices. These two data sources were then compared in order to determine any discrepancies between research
and practice. In the second paper, survey respondents were invited to participate in a focus group discussion in order to; 1) explore the discrepancies between the LAS management practices recommended by current best research evidence in the literature review and those reported by CAF Physiotherapists responding to the survey, and 2) determine any factors affecting the implementation of a comprehensive LAS rehabilitation program adapted for CAF members from the current best research evidence. In the third paper, a pragmatic pilot randomized controlled trial investigated the value of adding manual ankle mobilizations to the comprehensive rehabilitation program for CAF members with LAS.

- Chapter 6 is a summary chapter integrating the overall findings of all 3 papers and presenting practical recommendations to optimize the LAS management practices of CAF Physiotherapists, and direct future research to minimize the burden of LAS and other MSKC in the military.
Chapter 2

2 Context and relevance

2.1 Impact of musculoskeletal conditions to society

In a special themed report the “Burden of major musculoskeletal conditions,” the World Health Organization (WHO) reported that musculoskeletal conditions (MSKC) are the leading cause of pain and physical disability worldwide (Woolf & Pfleger 2003). Surveys carried out in Canada, the United States of America (US) and Europe estimate the prevalence of physical disability caused by MSKC at 4–5% of the adult population (Reynolds et al. 1992). The physical disability caused by MSKC result in substantial direct and indirect socioeconomic costs. Direct costs include those associated with the medical diagnosis and treatment of MSKC. Indirect costs include those associated with lost productivity such as lost work time, lost wages and replacement training. In 2005, the USA attributed 72.1 million work days lost to MSKC; with direct costs of approximately $510 billion and indirect costs of approximately $340 billion, which represented 7.7% of their gross domestic product (American Academy of Surgeons 2008). Unquestionably, MSKC result in considerable physical disabilities that limit the work capacity of society and place a drain on the economy.

2.2 Impact of MSKC to the military

MSKC impact the military through several measures of burden including morbidity, occupational duty limitations, limited duty days, attrition and related costs.

2.2.1 Morbidity on deployment

MSKC are a leading cause of morbidity to deployed military members. Hébert & Rowe (2007) reported on the use of deployed Canadian Armed Forces (CAF) Physiotherapy services during Operation Palladium in Bosnia between February 2000 and March 2004. The mean percentage of the deployed CAF contingent seen by CAF Physiotherapy was 28.3% with a range from 11.4% to 42.8% according to the deployment rotation. MSKC in the lower extremity were the most commonly reported (41.8%), followed by the spine (28.5%) and the upper extremity (21.5%), and the most commonly affected joints were the knee (17.2%) followed by the ankle (16.1%) and the lumbar spine (14.4%). Interestingly, of all MSKC seen in Physiotherapy, only
30.1% of all injuries were acute (symptoms present for <10 days) while 30.1% and 38% were sub-acute (10 days to <7 weeks respectively) and chronic (symptoms present for >7 weeks), respectively. The authors suggested that the higher prevalence of more chronic MSKC may indicate that CAF military members deployed with pre-existing MSKC or that chronic MSKC were exacerbated on deployment.

Hauret et al. (2010) reported on the causes of medical air evacuations from USA Army operations between October 2001 and December 2006 using air evacuation data records. The data collected combines 2 separate operations, Operation Enduring Freedom in Afghanistan between 2001 and 2006 and Operation Iraqi Freedom in Iraq between 2003 and 2006. The leading cause of the 31,197 medical air evacuations was non-battle injuries at 35% (n=11,405) followed by battle injuries at 18% (n=5,401). Over 80% of the non-battle injuries were further categorized into either acute traumatic and overuse MSKC. The most common location of acute traumatic MSKC were lower extremity conditions (39-41%), followed by upper extremity conditions (34-36%). The most common location of overuse MSKC were spinal conditions (49-55%), followed by lower (23-27%) and upper extremity conditions (14-15%). The most common cause of air evacuated non-battle injuries was sports & physical training (19-21%), followed by falls/jumps (18%) and motor vehicle related incidents (11-16%).

Cohen et al. (2010) built on the findings of Hauret et al. (2010) by reporting on the causes of medical air evacuations from the same operations for all USA Department of Defense personnel combined (Air Force, Army, Navy & Marines) between January 2004 and December 2007 using a prospective database maintained by the level IV hospital (a military treatment facility in non-combat area) in Landstuhl, Germany. The most common reason for the 34,006 medical air evacuations out of forward deployed units was musculoskeletal and connective tissue disorders (24%), followed by combat injuries (14%), neurological disorders (10%), psychiatric disorders (9%) and spinal pain (7%). Furthermore, Cohen et al. reported that 87% of soldiers who were medically evacuated secondary to MSKC did not return to deployed active duty (n=7,036).

Military members with MSKC who are unable to return to deployed active duty were repatriated from operation to a US hospital or their home units for further medical care. This study suggests that military members with MSKC are unlikely to return to active duty, leaving their deployed military forces with fewer available soldiers, which logistically may impact a military force’s strength and operational effectiveness.
2.2.2 Morbidity in-garrison

MSKC are a leading cause of morbidity for military members in-garrison (a permanent military installation-base). Rowe & Hébert published an overview of the impact of MSKC on the CAF in 2011, acknowledging that while an integrated electronic health record was in development, the CAF did not yet have a systematic medical encounter tracking system in place to measure injury surveillance. It was estimated that 35-45% of walk-in medical appointments to in-garrison CAF Health Services Centres are MSKC related (Canada, Department of National Defense, Surgeon General’s Report 2010, 2011). In-garrison CAF Physiotherapy services utilization data from 2009 demonstrated that 19,862 CAF members accessed CAF Physiotherapy services, resulting in 101,000 appointments for MSKC (Canada, Department of National Defense, Canadian Forces Health Services, Physiotherapy Workload Statistics 2009, 2010), which indicated that almost 30% of CAF Regular Force members consulted Physiotherapy. An additional 5,711 CAF members were referred off-base during that year to access a further 62,771 Physiotherapy appointments. The CAF Continuous Quality Improvement Database captured injury demographics on a case by case basis across 8 CAF locations between 2002 and 2004 revealed that the most frequent MSKC seen in CAF Physiotherapy affected the lumbar spine (17.6%), knee (17.2%) and the ankle (12.2%). The authors acknowledged that the previous 2 data sources only captured CAF members referred to or accessing CAF Physiotherapy services directly, which may have under-estimated MSKC in the CAF if they were managed by other primary care healthcare professionals such as physicians or nurses.

Utilizing the Defense Medical Surveillance System (DMSS) Jones et al. (2010) documented the MSKC of non-deployed active duty USA Department of Defense personnel (Air Force, Army, Navy & Marines) from their central repository of medical surveillance data, between 01 January 2000 and 31 December 2006. They reported that MSKC were the leading cause of morbidity in 2006 with approximately 1.95 million medical encounters and 1 million individuals affected. To appreciate the magnitude of MSKC compared to other medical conditions, the frequency of medical encounters due to MSKC were more than 2.5 times greater than the next leading medical condition – mental disorders – at 755,000. Furthermore, the number of individuals affected by MSKC was more than 2.5 times greater than the next leading medical condition – sense organ diseases – at 375,000. And despite most military members with MSKC being managed as outpatients, MSKC were the second most common cause of hospitalization days at 68,000 after
mental disorders (n=98,000). The lower extremity at 28% (n=1,945) was the leading body area of acute hospitalization, the most common of which were fractures at 40% (n=1,132). The leading acute outpatient MSKC were sprains and strains at 49% (n=265,000) the most common of which occurred at the lower leg/ankle (n=54,060). Lower extremity overuse injuries were the most common MSKC reported overall at a rate of 900/1,000 person-years. Jones et al. proposed that the most common contributors to MSKC warranted prioritized investigation.

Jones et al. (2010) reported that the overall rate of MSKC related medical encounters remained relatively stable between January 1 2000 and December 31 2006, culminating with 1,600 injury visits per 1,000 service members in 2006. This longitudinal data demonstrates a trend of sustained high rate of medical encounters secondary to MSKC, supporting the authors’ statement that “injuries are the biggest health problem in the military for which medical care is sought. More attention must be focused on these non-fatal injuries to reduce the impact of injuries on the health and readiness [sic operational readiness] of US military personnel” (Jones et al. 2010 ppS48).

2.2.3 Military occupational duty limitations

Military members with MSKC have acknowledged a limited capacity to complete their military occupational duties. To determine the effect of MSKC on US military members, Jennings et al. (2008) carried out a prospective survey of 696 Army soldiers in 2003 injured during active duty. Almost 75% of respondents reported being unable to perform all of their common military tasks such as marching and physical training, and 50% reported being unable to perform their duties in a deployed setting. Similar activity limitations have been reported by CAF members with MSKC in the Canadian Forces Health & Lifestyle Information Survey (CFHLIS). The CFHLIS is a population health survey of Canadian Armed Forces (CAF) members (Royal Canadian Air Force, Canadian Army & Royal Canadian Navy), which inquires as to the health status and lifestyle behaviours of respondents in order to guide health resource allocation, health promotion programs and health care utilization. In the 2008/09 version of the CFHLIS there were 3,844 respondents, 20.7% of which acknowledged sustaining an acute injury and 22.7% acknowledged a repetitive strain injury that limited their ability to perform their normal duties during year prior to the survey (Canada, Department of National Defense, Canadian Forces Health & Lifestyle Information Survey 2008/09, 2011). Furthermore, 32% of CAF respondents acknowledged that
a MSKC were the most common reason for being unable to deploy on operation in the previous 2 years. The self-reported limitations of military members secondary to MSKC not only impact their readiness to perform their occupational duties both in garrison and on deployment, they also affect their ability to prepare for deployment.

2.2.4 Limited duty days

As a result of occupational limitations, MSKC account for a substantial number of limited duty days. If military members with MSKC are unable to safely complete their occupational duties, they may be issued limited duty days that medically excuse them from full duty participation. Ruscio et al. (2010) estimated the burden of limited duty days secondary to MSKC in non-deployed active duty USA Department of Defense personnel in 2004. The leading cause of acute hospitalized MSKC were for fractures of the lower extremity at 20% (n=23,911) resulting in over 2.8 million limited duty days. The most common cause of limited duty days from acute outpatient MSKC were sprains and strains of the lower extremity at 14% (n=134,137) resulting in over 1.8 million limited duty days. The leading cause of limited duty days from repetitive strain injuries were lower extremity overuse injuries at 34.5% (n=240,796) with over 3.8 million limited duty days. When the body areas affected by those military members with MSKC seen as outpatients were ranked by their total number of limited duty days, the lower extremity demonstrated the highest burden at 43.2%, followed by the upper extremity 14.7% and the spine/torso at 13.2%. Ruscio et al. estimated that when data from the 10 most frequent MSKC were combined, approximately 25 million limited duty days were attributable to MSKC in 2004.

While Jones et al. (2010) stated that the morbidity secondary to MSKC impacted the readiness of military personnel, Ruscio et al. proposed that limited duty days secondary to MSKC were “an indicator of and surrogate for costs to military readiness” (Ruscio et al. ppS26). At the individual level, a military member unable to complete their occupational duties due to limited duty days may compromise the readiness of their respective unit to complete their designated function. At an organizational level, should the volume of limited duty days limit the capabilities of multiple military units, the capacity of the military to function as an organization may become affected, including their readiness to deploy on operation.
2.2.5 Attrition

MSKC contributes to soldier attrition as a leading cause of medical discharge from the military due to permanent disability. Rowe & Hébert (2011) reported that the leading cause of medical release from the CAF in 2009/2010 was MSKC (53%), followed by mental health conditions (34%) and miscellaneous medical conditions (8%). Of those CAF members medically released secondary to MSKC, 27% were for lower extremity, 21% spinal and 5% upper extremity conditions. Bell, Schwartz, Harford, Hollander & Amoroso (2008) documented the disability rates of 108,119 active-duty US Army soldiers medically discharged due to permanent disability between 1981 and 2005. MSKC were reported to be the leading cause of permanent disability at 72% (n=77,418), followed by neurological conditions at 6% (n=6,896) and mental health disorders at 5% (n=5,705). Furthermore, MSKC were the only category of disability that increased progressively over the study period at a rate of 2.5% per year. Bell et al. (2008) proposed that the increasing levels of disability in the US Army impacted productivity and combat readiness. Similarly, 70% of the medical discharges from the British Army were due to MSKC (Bergman & Miller 2000). As the leading cause of permanent disability, Bergman & Miller proposed that MSKC reduces the strength of a military force by eroding the volume of its’ members with premature medical discharges.

2.2.6 Costs

The total annual cost of MSKC in the US military was estimated to be $1.5 trillion in 2005, with over $700 million from direct medical costs (excluding physical therapy follow ups) and the remaining balance associated with limited or lost duty days and contract extensions for reservists due to medical reasons (Altarum Institute 2006). This estimate did not include costs associated with pension claims or medical discharge due to MSKC related permanent disability, which may be significant. Furthermore, Bell et al. (2008) reported that 77% (n=83,330) of soldiers medically discharged with a permanent disability due to MSKC received separation with severance pay, while 15% (n=16,107) received a permanent disability retirement and 8% (n=8,692) received separation without benefits. With MSKC as the most common cause of medical discharge with severance pay, they are justifiably expected to represent a considerable portion of the $1.25 billion paid out to disability retired US military members in 2005.
2.2.7 Summary of burden of MSKC

In summary, MSKC are the leading cause of morbidity in the military, resulting in occupational limitations and limited duty days that affect the ability of military members to perform their duties and prepare for deployment. The number of occurrences and low return to duty rates of deployed military members due to MSKC may further challenge operational effectiveness. The attrition of military members with MSKC secondary to permanent disability impacts the strength of military forces. For these reasons several authors have reported that MSKC threaten the military’s state of readiness (Hébert & Rowe 2007, Bell et al. 2008, Jones et al. 2010, Ruscio et al. 2010). It is evident given these findings that research is warranted to determine the most effective management strategies for the more prevalent MSKC in the military so as to limit their impact on readiness and force strength. Due to their considerable burden as measured by frequency of medical encounters, individuals affected, numbers of limited duty days, and permanent disability (Hébert & Rowe 2007, Jones et al. 2010, Ruscio et al. 2010), lower extremity conditions such as ankle sprains should be prioritized over other MSKC.

2.3 Ankle sprain

2.3.1 Definition of ankle sprain

A sprain is an injury occurring to a ligament when a tensile force causes it to stretch, tear or rupture (Mosby’s Medical Dictionary 2005). A ligament is a viscoelastic band of dense, fibrous regular connective tissue that binds various bones together at a joint (Mosby’s Medical Dictionary 2005). There are several types of ankle sprains (AS), due to the fact that there are a number of ligaments located in the area of the ankle joint. The most common type of AS is a Lateral AS (LAS) which is a sprain of the lateral ankle ligaments (anterior talofibular ligament, calcaneofibular ligament and/or the posterior talofibular ligament) (Brostrom 1965; Garrick 1977; Holmer et al. 1994; Gerber et al. 1998; Safran et al. 1999; Ferran & Maffullli 2006; Waterman et al. 2010). Traditionally, a patho-anatomical classification scheme has been applied to grade individually sprained ligaments (Kannus & Renstrom1991, Lynch 2002). I.e., Grade I sprains are defined as microscopic ligament injuries without macroscopic stretching, grade II sprains as macroscopic stretching with incomplete ligament damage, and grade III sprains as complete ligament ruptures. Furthermore, several functional classification schemes have been proposed for clinical use to establish the severity of LAS (Kannus & Renstrom 1991, Gerber et
Although each classification scheme varies, they typically report 3 clinical grades: grade I (mild), grade II (moderate) and grade III (severe). Grade I injuries involve minimal pain, swelling and tenderness and result in minimal/no functional limitations nor mechanical instability. Grade II injuries involve moderate pain, swelling and tenderness and moderate functional limitations and mechanical instability. Grade III injuries involve severe pain, swelling and tenderness, with severe functional limitations and signs of mechanical instability. Although these schemes are intended to simplify clinical use, we are unaware of any studies investigating the validity of any of these classifications. In this thesis, the term incomplete LAS will refer to a grade I or II sprain to the lateral ankle ligaments.

2.3.2 Incidence of ankle sprain

LAS are consistently reported among the 3 most common MSKC sustained by military personnel in Canada (Canada, Department of National Defense 2005), the US (Lauder et al. 2000), Britain (Strowbridge & Burgess 2002), Australia (Gruhn et al. 1999) and New Zealand (Davidson et al. 2008). In fact, the incidence rates of LAS in military members have been reported to be between 35 to 58 per 1,000 person years (Cameron et al. 2010; Waterman et al. 2010), which are significantly more frequent than those reported by civilian populations of 2 to 7 per 1,000 person years (Holmer et al. 1994; Bridgman et al. 2003; Waterman et al. 2010). The clear discrepancy in LAS incidence rates between civilian and military populations may be explained by the differences in data collection procedures between epidemiological studies. The above studies of civilian populations solely reported individuals whom were admitted to emergency departments, while the studies of military populations have reported individuals whom were admitted as emergent or ambulatory visits. However, the incidence of LAS may be underestimated in active populations such as the military, as approximately 55% of athletic subjects sustaining a LAS have reported not seeking medical attention (Smith & Reischl 1986; McKay et al. 2001). The substantial incidence of reported LAS in military populations suggests that this MSKC should be prioritized for further investigation.

2.3.3 Socioeconomic burden

LAS contribute to the socioeconomic burden associated with MSKC. The aggregate direct and indirect costs of LAS have been estimated to cost $2 billion annually in the US (Soboroff et al. 1983) and €187 million annually in the Netherlands (Hupperets et al. 2010). In Canada, the total
costs associated with managing LAS have been estimated to be between $490 and $4,662 per person (Bielska et al. 2012). Adding to the economic impact of LAS on society, the above studies report that individuals may require between 5 and 73 days away from work due to LAS.

Regrettably, despite LAS being reported as a leading cause of hospitalization between 1989 and 1994 in the US Army (Lauder et al. 2000), and causing a rehabilitation workload 2nd only to lower back pain in the British Army (Strowbridge & Burgess 2002), the costs attributed solely to LAS in military populations have not been reported (Cameron et al. 2010). With a reported incidence rate between 5 to 10 times that of the civilian population (Cameron et al. 2010, Waterman et al. 2010), the direct costs of LAS on the military would justifiably be substantial. Several authors have reported that LAS account for a considerable amount of work time loss in military personnel. Waterman et al. (2010) reported that 4,252 total work days were missed by cadets who sustained AS at the US Military Academy between 2005 and 2007, with an average time lost to injury for syndesmosis sprains of 9.82 days, followed by LAS at 7.94 days. Detorri, et al. (1994) reported a median of 30 days before return to work in their randomized controlled trial of early mobilization versus cast immobilization in 64 military personnel with LAS. Gerber et al. (1998) reported that at 6 weeks 95% of military personnel with a LAS had returned to sports and physical training. The indirect costs associated with these reports of time loss, which would include lost wages and replacement training, have been reported to compromise 80% of the total costs of LAS (Verhagen et al. 2005), exacerbating the projected socioeconomic impact of LAS in the military.

2.3.4 Symptoms and impairments

Individuals sustaining LAS often acknowledge pain, swelling, episodes of “giving away,” body function impairments in mobility, strength, and balance and activity limitations in self-reported function (Detorri et al. 1994; Gerber et al. 1998; van Rijn et al. 2008; Aiken et al. 2008; Perron et al. 2008). The potential consequences of these impairments for individuals in society may be explored using the WHO’s International Classification of Functioning, Disability and Health (ICF) (2001). In the ICF, issues related to body structure or function are defined as impairments, while reports of difficulty in the completion of activities is referred to as activity limitations, and the influence on changes in life situations is referred to as participation restrictions. In the context of an individual sustaining a LAS, impairments in balance or strength may lead to
difficulty completing the activities of daily living, occupations and/or recreation. Such activity limitations may restrict individuals with LAS from actively participating as members of their families, workplaces, and recreation teams, which may negatively influence their perceived role as family members, employees or team members. In the military, a CAF member with LAS having difficulty completing their military occupational tasks may restrict their participation in unit military duties, influencing their perceived role as a soldier.

2.3.5 Persistent symptoms, impairments & recurrences

A substantial number of individuals sustaining LAS acknowledge persistent symptoms, impairments and recurrences. In 2008 van Rijn et al. conducted a systematic review on the natural course of recovery of adults with acute LAS whom were treated conservatively with early mobilization, defined as early mobilization instructions with or without external support. A summary of the high quality studies (≥5/7 criteria for methodological quality) revealed that 5-33% of subjects continued reporting pain and 0-33% acknowledged subjective feelings of instability at 1 year, 3-34% subjects acknowledged recurrent sprains between 2 weeks to 96 months and between 36-85% reported full recovery at 3 years.

Interestingly, van Rijn et al. (2008) reported that persistent symptoms were independent of the severity of LAS. In fact, they reported only one study with substantial evidence to claim a prognostic variable that influenced persistent symptoms. In that study, Linde et al. (1986) prospectively treated 150 subjects with LAS with early mobilization. They reported at 8 days 67% were walking without pain and 81% had resumed work, while at 1 month 70% had resumed sports, 90% were pain free and 97% had resumed work. Athletes participating in sporting activities ≥ 3 times per week had an increased risk of residual symptoms compared to < 3 times per week (p<0.01), with residual symptoms (pain, functional instability) reported by 32% at 1 year. These prognostic results suggest that individuals participating in regular physical training may be at greater risk of persistent symptoms and impairments following LAS. These findings are of particular interest to physically active individuals such as military personnel, whom must participate in regular physical training as part of their occupational requirements.

Studies investigating military personnel report persistent symptoms, impairments and recurrences following LAS. Gerber et al. (1998) reported persistent symptoms in a prospective investigation of 104 cadets at the US Military Academy at West Point who sustained an ankle
sprain over a 2 month period in 1995. At initial examination, 63% (n=60) of the 96 subjects acknowledged previous sprains. After following a supervised rehabilitation program 95% of subjects returned to sports and physical training activities within 6 weeks, however 40% continued to report pain & demonstrated functional impairments in hop testing and 14% sustained a recurrence at 6 months. Similarly, Detorri et al. (1994) investigated the effects of early ankle mobilization versus cast immobilization followed by supervised rehabilitation in a randomized trial of 64 military personnel with LAS. At initial examination, 47% (n=30) of their 64 subjects acknowledged previous sprains. Although the majority of participants returned to duty after approximately 30 days, 44% of subjects reported pain, feelings of giving away or abnormal feelings in their ankle and 30% sustained a recurrence at 1 year. In a prospective observational study, Perron et al. (2008) documented the evolution of signs and symptoms of 36 CAF members with LAS over 6 months. At initial examination, 47% (n=17) of the 36 subjects acknowledged previous sprains. Despite non-standardized physiotherapy, pain at the end range of dorsiflexion and inversion, as well as strength deficits in the ankle plantar flexors and evertors, remained significantly different in the injured limb compared to the uninjured limb, and 40% of subjects self-reported activity limitations at work or sporting activities at 6 months.

In the above studies a substantial number of military members sustaining a LAS acknowledged a history of ankle sprain (47-63%). Several authors investigating military members with LAS have suggested that a history of ankle sprain may be prognostic for recurrences. Milgrom et al. (1991) prospectively investigated risk factors for LAS among 390 male infantry recruits participating in basic training in Israel. They reported an 18% LAS incidence rate during basic training. While there was no significant difference in the incidence of LAS between recruits training in modified basketball shoes or standard infantry boots, there was a significant difference among those who were taller and heavier (p=0.004) and those with a previous LAS (p=0.01). Knapik et al. (1999) retrospectively reviewed the medical records of officers attending the US Army War College to determine injury rates and causes of injuries. They reported that students with a previous AS in the 5 years prior to attending the College were 6 times more likely to sustain another AS compared to students who did not have a history of a previous AS (p=0.02).

Furthermore, a history of LAS may increase the likelihood of other lower extremity injuries. Jones et al. (1993) investigated the incidence, types and risk factors of training-related injuries
among men undergoing 12 weeks of US Army infantry basic training. They reported that LAS were the most prevalent injury related to physical training accounting for 35% of all lower extremity injuries and the 3rd most commonly diagnosed condition amongst all injuries at 6.3%, following muscle strains at 8.6% and painful overuse injuries at 23.8%. Soldiers with a previous LAS were at a significantly higher risk of lower extremity injuries than those without a history of a LAS (45.1% vs 32.1%, Risk Ratio [RR] = 1.37, 95% Confidence Interval [CI]:1.03-1.84, p=0.05).

If unresolved, individuals with persistent symptoms, impairments or recurrences following LAS may be identified with Chronic Ankle Instability (CAI). CAI has been characterized by “repetitive bouts of lateral ankle instability, resulting in numerous AS” (Hertel 2002 pp364.). CAI has been attributed to one or more causes; functional instability – secondary to impairments in proprioception, neuromuscular control or strength, and/or mechanical instability – secondary to any factor affecting the movement of the ankle joint complex, which may include impairments in passive joint movement, pathologic ligament laxity and/or degenerative changes (Hertel 2002). While the understanding of CAI remains under investigation (Hiller et al. 2011), individuals with the persistent symptoms of CAI have self-reported participating in less physical activity (Verhagen et al. 1995) and have demonstrated evidence of articular degeneration of the talus and an increased risk of ankle osteoarthritis (Hintermann et al. 2002).

Should the chronic sequelae of LAS lead to occupational limitations in CAF members the consequences may have considerable career repercussions. The principle of Universality of Service – recognized by the Canadian Human Rights Act – states that CAF members are “liable to perform general military duties and common defense and security duties, not just the duties of their military occupation or occupational specification. This may include, but is not limited to, the requirement to be physically fit, employable and deployable for general operational duties” (Canada, Department of National Defense, Defense Administrative Orders & Directives, Policy Direction Section). The consequences of this principle outline that should the chronic symptoms of LAS result in a CAF members’ persistent inability to perform their duties, they may be prematurely released from military service, which may ultimately impact force strength.
2.3.6 Summary of burden of LAS

Military populations are burdened with an incidence rate of LAS that has been reported to be 5-10 times greater than in civilian populations. The management of the symptoms and impairments secondary to LAS has led to reports of substantial rehabilitation workloads and time loss in military members. Despite receiving early mobilization and supervised rehabilitation, a substantial number of military personnel with LAS report persistent symptoms, impairments and recurrences. These persistent symptoms, impairments and recurrences in military members with LAS impact their physical readiness and consequently the operational readiness of the military. If the resulting symptoms and impairments from LAS are not resolved through efficient and effective management strategies, they may lead to premature release and thereby impact force strength. This suggests that these interventions alone may be insufficient to rehabilitate an individual with LAS. To limit the potential threats of LAS to operational readiness and force strength in the CAF, research into the optimization of LAS management warrant investigation.

2.4 Rationale for research questions

2.4.1 Establish current best research evidence in LAS management

While a number of LAS management practices exist, in order to optimize their effectiveness military Physiotherapy Officers and civilian Physiotherapists (CAF Physiotherapists) are advised to use evidence based practices (Hébert 2013). Evidence based practices have been defined as the integration of the best evidence with clinical expertise and patient values (Sackett et al. 2000). The two most current clinical guidelines in acute LAS management were both published in 2006 (van der Wees et al. 2006a; McKay & Cook 2006), thus a literature review including more recent papers with high quality evidence in the management of LAS is warranted to ensure that any recommended practices reflect the current state of the research. In order to align with the definition of evidence based practice, the results of the literature review should then be evaluated by CAF Physiotherapists and adapted in order to meet the specific occupational requirements of CAF members.
2.4.2 Characterize current LAS management practices of CAF Physiotherapists

While CAF Physiotherapists have reported using the following interventions to manage general MSKC; 35.9% exercises, 31.9% electrotherapy, 17.7% manual techniques & 13.1% advice (Hébert 2005), the specific interventions they use to manage LAS has not been reported. Determining the baseline LAS management practices of CAF Physiotherapists is essential in order to analyze if they are in line with current best research evidence.

2.4.3 Determine factors affecting implementation of current best research evidence

Several review articles report that despite acknowledging the awareness of pertinent research evidence, health care providers do not reliably apply them in clinical practice (Graham et al. 2007; Cochrane et al. 2007; Francke et al. 2008). The same trend has been reported in LAS management by Leemrijse et al. (2006), who surveyed 240 physiotherapists in the Netherlands to determine their compliance with the Dutch acute LAS guidelines, reporting that although 96% reported an awareness of the guidelines only 66% applied them to more than half of their patients. The concept that research evidence is not consistently integrated into clinical practice has been referred to as the “knowledge to practice gap” (Graham et al. 2007). Systematic reviews have reported that several factors influence the implementation of research evidence into clinical practice including the characteristics of the research evidence, practice setting, health care provider and patient (Davis & Taylor-Vaisey 1997; Cabana et al. 1999; Graham et al. 2007; Francke et al. 2008). Therefore, interventions designed to minimize the knowledge to practice gap must be predicated by an assessment of the particular factors which may act as barriers or facilitators to the uptake & utilization of research evidence.

The factors influencing the implementation of research evidence into practice by CAF Physiotherapists have not been reported. CAF Physiotherapists work with a specialized patient population in unique settings whether in garrison or on deployment (Hébert 2013), which may present distinct factors that influence the implementation of research evidence. Developing an awareness of these factors is essential to facilitate the uptake and utilization of current best research evidence in LAS management by CAF Physiotherapists.
2.4.4 Determine the value of adding manual mobilizations to a comprehensive rehabilitation program

Existing clinical practice guidelines on the conservative management of acute LAS have recommended the following interventions; i) functional treatment defined as weight bearing as tolerated with bandaging, bracing or taping to facilitate return to work, ii) cryotherapy to reduce pain and improve function, iii) therapeutic exercises to improve function and reduce recurrence risk and iv) manual mobilizations to improve ankle mobility (McKay & Cook 2006, van der Wees et al. 2006a). While combinations of the first 3 interventions have been investigated in military personnel with LAS, many continue to report persistent symptoms and impairments (Detorri et al. 1994; Gerber et al. 1998). It is possible that the combination of the first 3 interventions may not be addressing all LAS impairments crucial to asymptomatic ankle function.

Limited ankle dorsiflexion is a common impairment found in individuals post-acute LAS (Green et al. 2001, Cross et al. 2002, Aiken et al. 2008, Perron et al. 2008). The consequences of ankle dorsiflexion hypomobility may include difficulty with; walking, kneeling (Harris 1994) and running activities (Pink et al. 1994) which are common tasks in military training. Furthermore, limited ankle dorsiflexion has been reported as a risk factor for LAS in a sample of military subjects (Pope et al. 1998) as well as being associated with CAI (Hertel 2002). Dorsiflexion hypomobility may increase the risk of LAS by preventing the talocrural joint from achieving a stable, closed pack position during gait, which would expose it to the common mechanisms of LAS - plantar flexion and/or inversion (Hertel 2002). In this way, limited ankle dorsiflexion may be a crucial impairment sustained following LAS that prevents asymptomatic function and may increase the risk of LAS recurrence.

Two recent systematic reviews report moderate level evidence supporting manual ankle mobilizations performed by physiotherapists to improve ankle dorsiflexion following acute LAS (van Der Wees et al. 2006b & Bleakley et al. 2008). Despite reporting common methodological flaws, these systematic reviews concluded that while manual ankle mobilizations can rapidly improve ankle dorsiflexion in the short term, it was unknown if these gains led to long term functional improvements due to inadequate outcome measures in unrealistic settings, or follow ups of only 1 week. Determining the value of manual ankle mobilizations as an adjunct to a comprehensive rehabilitation program may be especially relevant to CAF Physiotherapists as
restoring ankle dorsiflexion following LAS may limit the undesirable functional consequences of dorsiflexion hypomobility.

2.4.5 Summary of rationale for research questions

Stakeholders are scrutinizing CAF health care service expenditures and demanding accountability from health care providers such as CAF Physiotherapists to provide evidence based practices that maintain force strength and expedite operational readiness. In this fiscal context, the CAF Physiotherapy vision is “to provide professional excellence in physiotherapy services, demonstrated in the ability to contribute to the rehabilitation and maintenance of operationally deployable forces and by providing physical and measurable solutions to operational readiness anywhere, anytime” (Hébert & Rowe 2013).

Due to the high incidence of LAS in the CAF and their potential impact on operational readiness and military force strength in the face of shrinking health care resources, it is crucial to optimize the LAS management practices of CAF Physiotherapists. The chronic sequelae in military members with LAS despite receiving early mobilization and supervised rehabilitation suggest that these interventions alone may be insufficient for asymptomatic ankle function.

The gaps in the literature surrounding LAS management by CAF Physiotherapists provide several opportunities for research that will contribute to limiting the consequences of LAS to the military. Firstly, the current LAS management practices of CAF Physiotherapy have not been reported. Establishing the current LAS management practices of CAF Physiotherapists and comparing them to the current best research evidence in LAS management will determine any discrepancies between research and practice. Once determined, any discrepancies may be evaluated for their appropriateness, and adapted to meet the occupational requirements of CAF members with LAS. Secondly, the factors affecting the implementation of research evidence by CAF Physiotherapists on LAS management into practice have not been studied. Engaging CAF Physiotherapists to identify and overcome any factors affecting the implementation of LAS management research evidence in CAF members may increase the likelihood of research evidence uptake and utilization. Lastly, the value of adding manual ankle mobilizations to the management strategy of CAF members with LAS has not been determined. As military members with LAS report persistent symptoms, impairments and recurrences despite early mobilization and supervised rehabilitation, adding manual ankle mobilizations may expedite the
restoration of ankle mobility and reduce the risk of LAS recurrence. Therefore, in order to promote optimal LAS management practices by CAF Physiotherapists this thesis will explore; the current LAS management practices of CAF Physiotherapists, the factors affecting the implementation of evidence based LAS management practices by CAF Physiotherapists, and the value of adding manual ankle mobilizations to a comprehensive rehabilitation program in CAF members with LAS.
Chapter 3
A Survey of LAS Management Practices Among CAF Physiotherapists

This paper characterizes the LAS management practices of Physiotherapists working with Canadian Armed Forces members through an electronic survey and compares their actual management practices to current best research evidence.

3 Introduction

LAS are among the 3 most common MSKC sustained by members of the CAF (Canada, Department of National Defense 2005), the USA Armed Services (Lauder et al. 2000) and the British Army (Strowbridge & Burgess 2002). In fact, members of the USA Armed Services sustain LAS at a rate between 5 to 10 times greater than the general population (Cameron et al. 2010; Waterman et al. 2010). The effect of sustaining a LAS may be incidental for civilians, yet the resulting impairments may result in significant consequences for military members.

Military members with LAS have reported complaints of pain, swelling, and episodes of giving away, impairments in joint mobility, strength, balance/proprioception & limitations in self-reported function (Detorri et al. 1994; Gerber et al. 1998; Perron et al. 2008). Considering the World Health Organizations’ International Classification of Functioning, Disability and Health model as a framework (WHO 2001), a CAF member having difficulty completing occupational tasks may restrict their participation in unit military duties, influencing their perceived role as a soldier and the productivity of their military unit. In this way, the consequences of LAS affect not only the individual lives of military members, but also burden military organizations.

Personnel time loss has been reported as a result of LAS in a sample of military personnel (Gerber et al. 1998). Such time loss delays the completion of military duties and thereby may hinder operational success. In Britain, LAS result in a substantial workload for rehabilitation professionals, second only to low back pain (Strowbridge & Burgess 2002). In this way, the personnel time loss and rehabilitation workload secondary to LAS place significant demands on the material, human and fiscal resources of military organizations (Cameron et al. 2010).
Several authors have reported that military members with LAS are more likely to sustain recurrent injuries, which may multiply the impact of these issues. In an observational study of musculoskeletal injuries among 303 male infantry trainees, those who sprained their ankles were significantly more likely to sustain recurrent injuries than those who did not (Jones 1993). Similarly, in an investigation of injuries sustained at the United States Army War College, officers were more than 6 times more likely to sustain an ankle sprain if they had sustained one within the previous 5 years (Knapik 1999). Furthermore, recurrent LAS may lead to chronic ankle instability, a commonly reported cause of persistent pain and ankle disability (Hertel 2002).

Even following conservative management, LAS have demonstrated persistent symptoms in military members. Gerber et al. (1998) reported persistent symptoms in a prospective investigation of 104 West Point cadets sustaining LAS. Following supervised rehabilitation, 95% of subjects returned to sports and physical training activities within 6 weeks, however 40% continued reporting pain & demonstrated functional impairments at 6 months. Similarly, Detorri et al. (1994) investigated the effects of early ankle mobilization versus cast immobilization in a randomized trial of 64 military personnel, and found 44% remained symptomatic at 1 year. The implications of persistent symptoms in military members would include employment limitations that restrict their ability to deploy, or result in repatriation from deployment, and if unresolved may result in premature military release. Ultimately, LAS have a negative and measurable impact on the CAF’s operational readiness.

In order to minimize the detrimental consequences of LAS to CAF members and expedite their return to operational readiness, the LAS management practices of CAF Physiotherapists should be in line with current best research evidence. Determining the baseline management practices of CAF Physiotherapists will allow for an analysis of how physiotherapy services in the CAF compare with those supported by current best research evidence. It was hypothesized that the LAS management practices of CAF physiotherapists would consist primarily of evidence based practices and therefore would be comparable to best research evidence; however their practices have not yet been systematically reported. Therefore, the objectives of this study were; 1) To characterize the LAS management practices of CAF physiotherapists, and 2) to compare these management practices to those supported by current best research evidence.
3.1 Methods

3.1.1 Survey participants

Potential survey participants were Physiotherapists employed in Canadian Forces Health Service Centres across Canada (CAF Physiotherapists) including military physiotherapy officers, civilian federal public servants and civilian physiotherapists hired by external contractors.

3.1.2 Survey questionnaire development

A questionnaire was developed based on factors reported to influence clinical decision making among health care professionals, including; the characteristics of the clinician, work setting and the patient (Francke et al. 2008). The final section asked respondents to select the interventions and the outcome measures used most of the time when managing incomplete LAS (grade I or II) across the stages of healing (Kisner & Colby 2007), defined as acute (< 7 days), sub-acute (7-21 days) and rehabilitative (>21 days). The questionnaire was pilot tested for content validity, clarity and ease of completion in a convenience sample of 5 physiotherapists. Minor changes were made to enhance clarity of some questions.

3.1.3 Current best research evidence

While a number of LAS management practices exist, CAF Physiotherapists are strongly advised to use evidence based practices (Hébert 2013). Evidence based practices have been defined as the integration of best research evidence with clinical expertise and patient values (Sackett et al. 2000). To identify current best research evidence in the management of LAS in the CAF, a literature review was completed to seek interventions demonstrating statistical significance in high quality randomized controlled trials, systematic reviews, meta-analyses or clinical practice guidelines.

A literature review using the keywords ‘ankle’ and ‘sprain’ in the Physiotherapy Evidence Database (PEDro) revealed one clinical guideline (van der Wees et al. 2006a) and one clinical statement (McKay & Cook 2006) both published in 2006. As these reported reviewing articles up to 2006, an additional search was conducted for current articles published between January 2006 and December 2011. The electronic databases searched included those reported to have the most comprehensive content of articles evaluating physiotherapy interventions (Michaleff et al. 2011). Additional keywords included; injury or injuries or trauma, and management or treatment
or intervention or rehabilitation or therapy or physiotherapy or physical therapy or exercise, and randomized trial or clinical trial or literature review or systematic review or meta-analysis or practice guideline. The reference lists of retrieved articles were reviewed for potential eligibility. This strategy returned 79 articles. From these, articles were selected if the following criteria were met; published in English, full text available electronically, in a peer reviewed journal, subjects were adults with acute incomplete LAS. Articles were excluded if they investigated solely subjects with chronic ankle complaints, pharmacologic or surgical interventions, or if they reported a methodological quality of <6/10 using the Physiotherapy Evidence Database criteria (PEDro).

This search strategy returned 6 systematic reviews and 5 randomized controlled trials. Overall, these articles were in support of most recommendations made by the clinical guideline and clinical statement for the management of acute incomplete LAS, supporting; functional treatment defined as early mobilization as tolerated with external support in the form of bandage, brace or tape (Seah & Mani-Babu 2011; Kemler et al. 2011; O’Connor & Martin 2010), intermittent ice with compression (Hing et al. 2011; Bleakley et al. 2010; Bleakley et al. 2011), manual mobilizations (Bleakley et al. 2008) and exercise (Bleakley et al. 2008; van Rijn et al. 2010, Seah & Mani-Babu 2011), while not supporting electrophysical modalities such as ultrasound (Bleakley et al. 2008, van den Bekerom et al. 2011), laser (Bleakley et al. 2008) or electric currents (Mendel et al. 2010; Ow Man et al. 2007). These interventions were used as a reference to determine if CAF Physiotherapists were using evidence based practices (Appendix 1).

3.1.4 Data collection and analysis

Following Health Sciences Research Ethics Board approval from the University of Toronto and coordination through the Social Science Research Review Board of the Director General Military Personnel Research & Analysis office, all eligible CAF Physiotherapists were sent a recruitment electronic mail written in both English and French. Two reminder emails were sent to non-responders 2 weeks apart for an approximate 5 week recruitment period beginning 02 August 2011.

Data collected from the questionnaire was imported into a Microsoft Excel spreadsheet. The statistical analysis was performed using SPSS version 20 (IBM SPSS Inc. Chicago, Illinois). Due to the nominal data collected, descriptive statistics (frequency distributions and percentages)
were used to present most results, and Fishers Exact Test (FET) with two tailed p values (p<0.05) were used to determine relationships between respondent characteristics and practice patterns.

3.2 Results

3.2.1 Respondent characteristics

Ninety-five (95) Physiotherapists were retrieved from the most current CAF Physiotherapy Personnel List (September 2010) (Figure 1). Ninety-two physiotherapists were deemed eligible to participate in the survey and 52 physiotherapists responded to the survey, resulting in a response rate of 56.5% (52/92). When the numbers of civilian and military respondents were compared to their relative totals across Canada, the differences are negligible (Table 1). This minimizes potential biases and increases the generalizability of findings to all CAF physiotherapists.

Figure 1. Survey response rate flow diagram
Table 1. Demographic characteristics of respondents

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Percentage</th>
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<tbody>
<tr>
<td><strong>Age</strong></td>
<td></td>
</tr>
<tr>
<td>25-34.9</td>
<td>42.3% (22/52)</td>
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<tr>
<td>35-44.9</td>
<td>40.3% (21/52)</td>
</tr>
<tr>
<td>≥ 45</td>
<td>17.3% (9/52)</td>
</tr>
<tr>
<td><strong>Employment type</strong></td>
<td></td>
</tr>
<tr>
<td>Civilian physiotherapist</td>
<td>55.7% (34/61)</td>
</tr>
<tr>
<td>Military physiotherapy officer</td>
<td>58.0% (18/31)</td>
</tr>
<tr>
<td><strong>Entry level physiotherapy degree</strong></td>
<td></td>
</tr>
<tr>
<td>Diploma</td>
<td>5.7% (3/52)</td>
</tr>
<tr>
<td>Bachelors’ degree</td>
<td>69.2% (36/52)</td>
</tr>
<tr>
<td>Masters’ degree</td>
<td>23.0% (12/52)</td>
</tr>
<tr>
<td><strong>Year of entry level degree completion</strong></td>
<td></td>
</tr>
<tr>
<td>≤ 1989</td>
<td>15.3% (8/52)</td>
</tr>
<tr>
<td>1990-1999</td>
<td>15.3% (8/52)</td>
</tr>
<tr>
<td>≥ 2000</td>
<td>69.2% (36/52)</td>
</tr>
<tr>
<td><strong>Years of experience in musculoskeletal physiotherapy</strong></td>
<td></td>
</tr>
<tr>
<td>≤ 9 years</td>
<td>51.9% (27/52)</td>
</tr>
<tr>
<td>10-19 years</td>
<td>30.7% (16/52)</td>
</tr>
<tr>
<td>≥ 20 years</td>
<td>13.4% (7/52)</td>
</tr>
</tbody>
</table>

3.2.2 Work Setting Characteristics

Twenty-nine respondents (55.7%) reported their Physiotherapy Section was the most common work environment used to assess LAS, followed by 23 (44.2%) reporting a walk-in clinic. The most frequently reported initial assessment time allotment was 40-59 minutes (61.5%), while follow ups were provided 20-39 minutes (71.1%). Forty-one respondents (78.8%) reported having regular opportunities to interact with their peers to discuss patient care. Thirty-two (61.5%) reported employing physiotherapy support personnel in their management of LAS, with the most frequent tasks being electrophysical modality application followed by exercise monitoring.
3.2.3 Patient characteristics

The most frequently reported age group served was 25-29.9 years (36.5%). Thirty-seven respondents (71.1%) reported serving CAF members of the Land element most frequently and thirty-one (59.6%) reported serving members from high intensity training units. Thirty-four (65.3%) reported assessing LAS in the acute stage of healing (<7 days), followed by 17 (32.6%) in the sub-acute stage (7-21 days). Twenty-five respondents (50.0%) estimated that 25-50% of members report their LAS as a recurrence. Respondents ranked the activities that members reported participating in when sustaining their LAS as sports/physical training or adventure training, followed by military training/military exercise, and finally paid military duties. Twenty-two respondents (42.3%) ranked specific interventions requested by CAF members in their LAS treatment plan as external support (i.e., bracing) followed by non-steroidal anti-inflammatory drugs.

3.2.4 Lateral ankle sprain management practices

When asked which interventions they use most of the time when managing incomplete LAS across all stages of healing, 84.6% of respondents reported using interventions consistent with the results of our current best research evidence literature review, including; functional treatment, advice to use ice with compression, exercise, manual mobilizations and advice to wear a functional brace for intense sporting activities (Figure 2). When respondents were sorted into civilian or military CAF Physiotherapists, or those graduating before 2000 and after 2000, no significant differences were found with their use of these interventions with a p = 0.77 and 0.84 (FET), respectively.

When asked which interventions they use most of the time when managing incomplete LAS during the individual stages of healing, during the acute stage of healing 98% of respondents reported prescribing range of motion exercises, while 15.3% prescribed balance and 30.7% prescribed strengthening exercises (Table 2).

When asked which outcome measures they use most of the time when managing incomplete LAS, during the rehabilitative stage of healing 39.2% respondents reported using the Star Excursion Balance Test while 47% reported using an agility/hop test to measure balance, and
21.5% respondents reporting using the CAF EXPRES test, the mandatory annual test of physical fitness in the CAF, to measure functional performance (Table 3).

Fifty-one (98.0%) of respondents reported they would be willing to modify their practice based on the results of research into LAS management, and fifty (96%) reported a willingness to participate in such research. Respondents ranked their preferred methods to receive research on LAS management as; practical workshop, internet, videoconference, teleconference and publication. Twenty-three (44.2%) reported following clinical guidelines/pathways in their management of LAS, while 12 (50.0%) of those not using them reported that “members were too different for standard guidelines to be used.”

**Figure 2. Percentages of respondents reporting interventions used most of the time when managing lateral ankle sprains across all stages of healing.**
Table 2. Frequency of respondents reporting interventions used most of the time when managing incomplete lateral ankle sprains during the individual stages of healing.

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Stages of healing</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acute  (&lt;7 days)</td>
</tr>
<tr>
<td>Exercise</td>
<td></td>
</tr>
<tr>
<td>Range of motion</td>
<td>98.0% (51/52)</td>
</tr>
<tr>
<td>Aerobic exercise</td>
<td>25.0% (13/52)</td>
</tr>
<tr>
<td>Strengthening</td>
<td>15.3% (8/52)</td>
</tr>
<tr>
<td>Balance training</td>
<td>30.7% (16/52)</td>
</tr>
<tr>
<td>Physiotherapist applied modalities</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>86.5% (45/52)</td>
</tr>
<tr>
<td>Mobilization</td>
<td>44.2% (23/52)</td>
</tr>
<tr>
<td>Manipulation</td>
<td>5.7% (3/52)</td>
</tr>
<tr>
<td>Soft tissue techniques</td>
<td>30.7% (16/52)</td>
</tr>
<tr>
<td>Taping</td>
<td>78.8% (41/52)</td>
</tr>
<tr>
<td>Electotherapy modalities</td>
<td></td>
</tr>
<tr>
<td>Heat modalities</td>
<td>0.0% (0/52)</td>
</tr>
<tr>
<td>Cold modalities</td>
<td>96.1% (50/52)</td>
</tr>
<tr>
<td>Whirlpool</td>
<td>30.7% (16/52)</td>
</tr>
<tr>
<td>Contrast baths</td>
<td>69.2% (36/52)</td>
</tr>
<tr>
<td>Electro-stimulation</td>
<td>38.6% (20/52)</td>
</tr>
<tr>
<td>Acupuncture</td>
<td>15.3% (8/52)</td>
</tr>
<tr>
<td>Ultrasound</td>
<td>59.6% (31/52)</td>
</tr>
</tbody>
</table>
Table 3. Frequency of respondents reporting outcome measures used most of the time when managing incomplete lateral ankle sprains during the individual stages of healing.

<table>
<thead>
<tr>
<th>Outcome measure</th>
<th>Stages of healing</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Acute (≤7 days)</td>
<td>Sub-acute (7-14 days)</td>
<td>Rehabilitative (≥ 21 days)</td>
<td></td>
</tr>
<tr>
<td><strong>Pain</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual analogue scale</td>
<td>61.5% (32/52)</td>
<td>60.7% (31/51)</td>
<td>56.8% (29/51)</td>
<td></td>
</tr>
<tr>
<td>Quad visual analogue scale</td>
<td>3.8% (2/52)</td>
<td>5.8% (3/51)</td>
<td>5.8% (3/51)</td>
<td></td>
</tr>
<tr>
<td>Present pain intensity</td>
<td>11.5% (6/52)</td>
<td>13.7% (7/51)</td>
<td>15.6% (8/51)</td>
<td></td>
</tr>
<tr>
<td>Numeric pain rating scale</td>
<td>44.2% (23/52)</td>
<td>39.2% (20/51)</td>
<td>35.2% (18/51)</td>
<td></td>
</tr>
<tr>
<td><strong>Swelling</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual estimation</td>
<td>30.7% (16/52)</td>
<td>35.2% (18/51)</td>
<td>25.4% (13/51)</td>
<td></td>
</tr>
<tr>
<td>Figure of 8</td>
<td>53.8% (28/52)</td>
<td>41.1% (21/51)</td>
<td>21.5% (11/51)</td>
<td></td>
</tr>
<tr>
<td>Circumference measurement</td>
<td>42.3% (22/52)</td>
<td>37.2% (19/51)</td>
<td>17.6% (9/51)</td>
<td></td>
</tr>
<tr>
<td>Volumetry</td>
<td>0.0% (0/52)</td>
<td>0.0% (0/51)</td>
<td>1.9% (1/51)</td>
<td></td>
</tr>
<tr>
<td><strong>Range of motion</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visual estimation</td>
<td>28.8% (15/52)</td>
<td>29.4% (15/51)</td>
<td>19.6% (10/51)</td>
<td></td>
</tr>
<tr>
<td>Goniometry (°)</td>
<td>73.0% (38/52)</td>
<td>60.7% (31/51)</td>
<td>56.8% (29/51)</td>
<td></td>
</tr>
<tr>
<td>Bent knee dorsi flexion (cm)</td>
<td>57.6% (30/52)</td>
<td>68.6% (35/51)</td>
<td>64.7% (33/51)</td>
<td></td>
</tr>
<tr>
<td>Passive accessory motions</td>
<td>32.6% (17/52)</td>
<td>50.9% (26/51)</td>
<td>31.3% (16/51)</td>
<td></td>
</tr>
<tr>
<td>Strength</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>----------------------------------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
<td></td>
</tr>
<tr>
<td>Manual muscle testing</td>
<td>61.5% (32/52)</td>
<td>64.7% (33/51)</td>
<td>64.7% (33/51)</td>
<td></td>
</tr>
<tr>
<td>Hand held dynamometry</td>
<td>7.6% (4/52)</td>
<td>15.6% (8/51)</td>
<td>19.6% (10/51)</td>
<td></td>
</tr>
<tr>
<td>Isokinetic-isotonic testing</td>
<td>3.8% (2/52)</td>
<td>3.9% (2/51)</td>
<td>1.9% (1/51)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Balance</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Single leg balance</td>
<td>5.8% (3/52)</td>
<td>1.9% (1/51)</td>
<td>0.0% (0/51)</td>
</tr>
<tr>
<td>Modified foam dome test</td>
<td>1.9% (1/52)</td>
<td>3.9% (2/51)</td>
<td>3.9% (2/51)</td>
</tr>
<tr>
<td>Star excursion balance test</td>
<td>1.9% (1/52)</td>
<td>31.3% (16/51)</td>
<td>39.2% (20/51)</td>
</tr>
<tr>
<td>Agility/Hop test</td>
<td>0.0% (0/52)</td>
<td>13.7% (7/51)</td>
<td>47.0% (24/51)</td>
</tr>
<tr>
<td>Biodex stability testing</td>
<td>0.0% (0/52)</td>
<td>5.8% (3/51)</td>
<td>11.6% (6/51)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Functional</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Canadian Forces EXPRES test</td>
<td>1.9% (1/52)</td>
<td>3.9% (2/51)</td>
<td>21.5% (11/51)</td>
</tr>
<tr>
<td>Battle fitness test</td>
<td>0.0% (0/52)</td>
<td>0.0% (0/51)</td>
<td>11.7% (6/51)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Standardized self-reported questionnaire</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Lower Extremity Functional Scale</td>
<td>90.3% (47/52)</td>
<td>78.4% (40/51)</td>
<td>88.2% (45/51)</td>
</tr>
<tr>
<td>Foot Function Index</td>
<td>9.6% (5/52)</td>
<td>11.7% (6/51)</td>
<td>9.8% (5/51)</td>
</tr>
<tr>
<td>Foot &amp; Ankle Disability Index</td>
<td>19.2% (10/52)</td>
<td>17.6% (9/51)</td>
<td>15.6% (8/51)</td>
</tr>
<tr>
<td>Foot &amp; Ankle Abilities Measure</td>
<td>13.4% (7/52)</td>
<td>11.7% (6/51)</td>
<td>9.8% (5/51)</td>
</tr>
</tbody>
</table>

### 3.3 Discussion

This is the first published survey of LAS management practices among CAF Physiotherapists. We are unaware of any other LAS practice surveys in the military for comparison. Our response rate may be compared to Leemrijse et al., whom reported a 60% response rate in a LAS practice survey of Physiotherapists in the Netherlands (2006). Despite not prospectively disseminating
LAS practice guidelines as Leemrijse et al. (2006), several management practices of this sample of CAF Physiotherapists are in line with current best research evidence. As seen in Figure 1, when asked which interventions they use most of the time when managing incomplete LAS across all stages of healing, at least 84.6% of respondents reported interventions consistent with the results of our current best research evidence literature review including; functional treatment, ice with compression, manual mobilizations and exercise. The interventions selected during the individual stages of healing were comparable to those reported to facilitate connective tissue repair, such as early mobilization to avoid the detrimental effects of prolonged immobilization and progressive functional exercise to facilitate a gradual return to usual activities (Roebroeck et al. 1998).

However, when taking into consideration that they are treating a military population, respondents may be unnecessarily delaying interventions and are not always employing the most evidence based outcome measures. For example, the relative delay in prescribing strengthening and balance interventions into the sub-acute stage of healing is inconsistent with recent literature. To investigate the effect of early exercise, Bleakley et al. (2010) randomized 101 subjects with acute incomplete LAS to receive therapeutic exercise including isometric strengthening in addition to a standard intermittent ice with compression protocol. The experimental group reported significantly higher weight bearing activities during the first week of follow up without any adverse events. This evidence proposes that initiating early strengthening exercises may safely facilitate early weight bearing in CAF members with LAS, which has the added value of promoting a faster return to the physically demanding work of military subjects (Detorri et al. 1994). Similarly, a recent systematic review with meta-analysis recommends bilateral balance training following their conclusion that balance is bilaterally impaired following acute LAS (Wikstrom et al. 2010). Bilateral balance impairments are suggestive of centrally mediated deficits, which may be an underlying cause of recurrent LAS and chronic ankle instability. As bilateral impairments have been confirmed in CAF members with LAS (Perron & Hébert 2006), balance training should be initiated immediately on the uninvolved limb until the injured limb tolerates weight bearing enough to engage in balance training. This practical strategy is intended to maximize adaptations throughout the central nervous system, to efficiently resolve bilateral balance impairments following LAS and thereby limit recurrences and chronic ankle instability. These recommendations are not only consistent with current best evidence but are also in
alignment with the early, active exercise based rehabilitation promoted by CAF Physiotherapy Standards & Guidelines (Hébert & Rowe 2013).

The limited report of balance and functional performance measures in this survey were surprising, given that such measures are recommended as discharge criteria (Creighton et al. 2010). The value of measuring balance impairments should not be overlooked, as balance deficits are significant among individuals with recurrent LAS (Hiller et al. 2011). There are existing balance tests including military and/or athletic subjects with LAS and otherwise healthy controls, which may be used for comparison including the Timed Foam Test (Perron & Hébert 2006), the Star Excursion Balance Test (Hertel et al. 2010) and other hop tests (Gerber et al. 1998; Ross et al. 2002; Perron et al. 2008). Wikstrom et al. (2010) reported that secondary to strong evidence that balance deficits are bilateral after acute LAS the uninjured limb should not be used as a criterion for a normal score. If balance is impaired on both limbs and one is used as a reference, individuals may be discharged from rehabilitation prematurely and potentially at risk for a recurrence. In lieu of the uninjured limb, a healthy reference group or preferably baseline testing results within the same subjects should be used when evaluating balance deficits post-acute LAS.

Functional performance measures are intended to reproduce the demands of a sport in order to assess the integration of physical impairments and activity limitations concurrently with the stress of competition (Creighton et al. 2010). Failing to assess functional performance may result in premature discharge and may have contributed to the increased recurrences reported in this survey and previous military literature (Jones et al. 1993; Detorri et al. 1994; Gerber et al. 1998; Knapik et al. 1999). There are limited studies investigating appropriate guidance for return to play in sport following musculoskeletal injuries (Creighton et al. 2010) and none to our knowledge for LAS. Without appropriate guidelines, it is recommended that the rehabilitation of CAF members with LAS include normalizing all impairments, followed by a progressive integration of their military duties, which at a minimum should reflect the CAF’s annual operational requirements evaluation (Reilly et al. 2012).

Some of our findings differ with the results of existing LAS management practice surveys. Leemrijse et al. (2006) reported that when managing LAS, 73% of their respondents applied taping/bracing and 55% avoided the use of electrophysical modalities such as electric currents or
ultrasound. In contrast, our respondents reported more frequent bracing (85%) and electrophysical modality use (73%). Frequent bracing was requested by CAF members following LAS and is not surprising considering their heavy workload demands and the evidence for external support in facilitating early return to work in military personnel (Detorri et al. 1994). Frequent electrophysical modality use was surprising due to the limited or conflicting evidence for their effectiveness in the management of LAS. However, authors of systematic reviews highlight that only a few studies have compared the effects of varying dosages of electrophysical modalities (Bleakley et al. 2008; van den Bekerom 2011), so it may be that optimal dosage schedules have yet to be investigated.

Due to differences in methodology, it is challenging to further compare our findings with existing LAS practice surveys. We elected not to compare our findings further with surveys (Leemrijse et al. 2006) or prospective cohort studies (van der Wees et al. 2007), which compare LAS management practices to the Dutch LAS practice guidelines. Interventions in the Dutch guidelines are largely determined by the results of the Ankle Function Score, an instrument purported to determine LAS severity (deBie et al. 1997). Although the Ankle Function Score appears to be a promising clinical tool, at the time of paper preparation we were unaware of any research establishing its’ psychometric properties with military subjects, and any more than partial support for its’ clinical use (van Rijn et al. 2009). Furthermore, practice guidelines may be said to provide advice to clinicians regarding the selection of interventions for a general population, however we have observed that injured CAF members have specific rehabilitation requirements that such practice guidelines do not address.

CAF members with LAS require intensive rehabilitation that reflects the physical demands of the military. Due to the frequent requirements for strenuous performance under constraints of time, equipment and environments, the physical demands of military members are distinctly different than those of the general population (Berkowitz et al. 1999; Bergman & Miller 2000. For example, a series of standardized simulations of CAF common military tasks are measured annually during the Fitness for Operational Requirements for CAF Employment (FORCE) test including time limited performance of; 30 consecutive lifts of a 20kg sandbag to a height above 91.5cm, a 400m shuttle with a 20kg sandbag load, 80m rushes, and an untimed 100kg sandbag drag. CAF members in the Army must also perform a time limited 13km march carrying 24.5kg
of equipment (CAF fighting order). These tasks place significant loads on military personnel, which are not required by civilian occupations. In fact, the physical demand of the weight loaded march alone requires some CAF members to work near their maximum strength capabilities (Hébert 2012). It is not surprising then that the heavy occupational demands of military members are associated with an increased risk of injury and disability (Hollander & Bell 2010), making them comparable to competitive high calibre athletes rather than the general population (Jones & Knapik 1999). In contrast even to professional athletes, military members must perform their unique job tasks while encumbered by tactical equipment, navigating unpredictable environments with limited visual input and potentially while under assault. Due to their occupational requirements, following practice guidelines designed for typical patients with LAS or even athletes would not be tailored to CAF members for the habitual arduous demands of soldiering. Therefore, in order to adequately rehabilitate CAF members with LAS and avoid recurrence risk, physiotherapy interventions must target the specific impairments and limitations of military tasks while considering the operational environment of military occupations.

Furthermore, physiotherapy discharge criteria following LAS must be selected in accordance with the high physical demands of military occupations, with the value for each outcome measure reflecting the demands of military task requirements.

Rather than transferring research from general practice guidelines to military personnel, a consideration of the persistent impairments and functional limitations reported by CAF members with LAS may assist in determining appropriate management strategies. Given their value in hastening return to work, the persistent impairments reported in military personnel following LAS despite early mobilization or supervised neuromuscular exercise (Detorri et al. 1994; Gerber et al. 1998) suggest that these interventions alone are insufficient for asymptomatic ankle function. In a recent observational study of 36 CAF members with incomplete LAS, Perron et al. (2008) reported several statistically significant differences remain at 6 month follow up. Almost 40% of subjects self-reported difficulty on the Lower Extremity Functional Scale with dynamic balance activities including; running on uneven ground or while changing directions and jumping. In addition, a subgroup analysis revealed decreased ankle plantar flexion and evertor strength in subjects with second degree LAS. If the weight loaded march requires working at near maximum strength capacity, and a CAF member has strength deficits, there is an evident increased risk of activity limitations and recurrences. The persistent deficits in dynamic
balance and ankle strength reinforce the importance of a sufficiently diverse and intensive neuromuscular rehabilitation program for CAF members with LAS in order to adequately prepare them for the rigors of military duties.

A significant complaint amongst CAF members with LAS was pain at the end of weight bearing bent knee ankle dorsiflexion (Perron et al. 2008). Interestingly, ankle dorsiflexion hypomobility has been reported to be a strong predictor of LAS in military personnel (Pope et al. 1998). As the functional relevance of this impairment remains unknown, it may be that painful or restricted ankle dorsiflexion deficits are an impairment following LAS that prevents asymptomatic function & increases recurrence risk. Manual ankle mobilizations have demonstrated statistically significant improvements in pain free ankle dorsiflexion following LAS in all stages of rehabilitation (van der Wees et al. 2006; Bleakley et al. 2008). The addition of manual ankle mobilizations to a comprehensive program of early mobilization and intensive neuromuscular exercise may synergistically hasten the rehabilitation of the persistent impairments and activity limitations among CAF members with LAS and reduce recurrence risk. As all 3 of these interventions were reported by over 96% of our respondents, and 96% reported a willingness to participate in clinical research, a pragmatic trial may be feasible amongst CAF Physiotherapists.

3.3.1 Limitations

The timing of the data collection period may have influenced the response rate, as this time period is a common leave period and is also posting season in the CAF. However, the fact that there was no significant difference between the numbers of civilian or military respondents eliminates a potential bias. Limited definitions of terms used in the questionnaire may have resulted in differing interpretations by respondents. As the questionnaire consisted of self-reported behaviours, it is unknown if socially-desirable answers were provided. Similarly, as the questionnaire involved past behaviours, there is a risk of potential recall bias. We attempted to minimize the potential for recall issues by asking about usual practice patterns used “most of the time.”

3.3.2 Conclusions

This is the first survey of LAS management practices among CAF Physiotherapists. Several of the LAS management practices reported by this sample of CAF Physiotherapists are in line with
current best evidence including functional treatment and exercise, while others such as the use of
electrophysical modalities were not. The reported use of strength and balance exercises
following LAS was delayed into the later stages of rehabilitation while the literature, and the
military context, supports their earlier prescription. Respondents reported limited balance and
functional performance outcome measures, which are ideal discharge criteria following LAS in a
military population. The reasons behind the relatively delayed interventions and limited
outcome measurements could not be determined from our close ended questionnaire, proposing
an opportunity for further qualitative research with CAF Physiotherapists.

The results of this study provide the opportunity to make several best practice recommendations
which may be implemented immediately by CAF Physiotherapists to minimize the risk of
detrimental consequences of LAS to the CAF. Firstly, it is recommended that Physiotherapists
analyze their use of electrotherapy modalities in LAS management to ensure evidence based
clinical decision making. Secondly, strength and balance exercises should be initiated as soon as
they can be tolerated, with the type and dosage of their exercise prescription reflective of the
individual physical demands of each CAF member. Thirdly, it is recommended that objective
measures of strength, balance and functional performance that reflect military occupational
demands be used to avoid premature discharge that may increase the risk of recurrence. The
preferred research dissemination methods reported by this sample propose several practical
knowledge translation strategies for these recommendations.
Chapter 4
LAS Management Practices Among CAF Physiotherapists: A Focus Group Discussion

This paper engaged a cohort of CAF Physiotherapists to explore; the factors influencing the use of interventions and outcome measures in their management of LAS, the factors influencing the implementation of current best research evidence in the management of LAS, and the preferred methods to receive current best research evidence in the management of LAS.

4 Introduction

LAS are the 3rd most frequent musculoskeletal injury in the CAF. The implications of LAS in the military include; disrupted duties, persistent impairments (Detorri et al. 1994; Gerber et al. 1998) and high recurrence rates (Jones 1993; Knapik 1999). Persistent impairments in military personnel lead to employment limitations that may restrict their ability to deploy on operation and if unresolved may lead to premature release. In 2010, CAF Health Services Group Headquarters reported that approximately 53% of medical releases were due to musculoskeletal injuries (Canada, Department of National Defense, 2010). Twenty-seven percent of these were lower extremity conditions, of which LAS were a major contributor. Therefore, when considering both the prevalence and consequences of this injury, LAS may impact the operational readiness of the CAF.

In a recent survey, Robitaille et al. (2013) characterized the LAS management practices of CAF Physiotherapists by reporting the frequency of interventions and outcome measures used throughout the stages of healing. This survey provided quantitative data related to management practices, however due to the limitations inherent in survey methodology, participant responses could not be further explored. For example, the survey reported that the prescription of strengthening exercises was relatively delayed, and only a limited number of outcome measures were reported to evaluate balance/proprioception and function. The reasons for these findings could not be determined from the close ended nature of the survey questionnaire. Moreover, factors potentially acting as barriers or facilitators to implementing current research evidence in LAS management could not be fully explored.
Optimal healthcare may be exemplified when current research evidence is integrated into patient care (Sackett, Rosenberg, Gray, Haynes, Richardson 1996; Graham, Logan, Harrison, Straus, Tetroe, Caswell & Robinson 2006). Systematic reviews have highlighted the role of health care professionals and the identification of any barriers to the implementation of research evidence. In 1999 Cabana et al. searched electronic databases (MEDLINE, Educational Resources Information Centre, and Health STAR between January 1966 to 1998), bibliographies and relevant textbooks to systematically review the factors affecting physician adherence to clinical practice guidelines. They concluded that a lack of awareness of research evidence, and a lack of barriers to the implementation of research evidence, were the factors most frequently reported. Furthermore, they proposed that barriers affecting implementation were not necessarily generalizable between settings, and therefore they recommended that interventions to develop adherence were only planned once specific barriers were identified. Barriers to providing optimal health care were also investigated in 2007 by Cochrane et al. They replicated the search strategy used by Cabana et al. (1999) and Pagliari & Kahan (1999) systematically reviewing studies published between January 1998 and March 2007 that explored how barriers to the implementation of research evidence were assessed and what types of barriers were commonly identified. Support/resources, followed by the behaviours/characteristics of health care professionals, were among the most frequently reported barriers to the implementation of research evidence.

CAF Physiotherapists work in unique settings whether in garrison or on deployment, which may influence those factors associated with the implementation of research evidence, and thereby present barriers to providing optimal healthcare. Despite the importance of identifying such factors, they have not been previously studied in CAF Physiotherapists. If the factors influencing research evidence implementation are not identified in CAF Physiotherapists, appropriate interventions cannot be planned to promote evidence based practices and thereby optimal health care provision.

Qualitative research methods, such as face-to-face interviews and/or focus groups, can augment the data gained in survey methods. While both of these qualitative methods can provide rich and detailed data, focus groups can synergistically produce a broader data set than individual interviews alone due to the nature of interactive discussions (McLafferty 2004). The inherent explanatory transactions that occur during group communication compel participants to both
rationalize their responses and seek clarification for their questions (Morgan 1996). In this manner, the product of focus groups can provide insight into behaviours, which would not be evident from close-ended survey responses. Group interaction also offers the unique opportunity to confirm levels of agreement and/or disagreement with survey results (Morgan & Kruger 1993). Furthermore, interaction with colleagues has been reported to improve the likelihood of research evidence into clinical practice (Graham, Logan, Harrison, Straus, Tetroe, Caswell & Robinson 2006; Sudsawad 2007; Francke et al. 2008). Thus, engaging CAF Physiotherapists in a focus group discussion may provide valuable supplementary data to corroborate and expand the findings of our recent survey, as well as promote the implementation of research evidence on LAS management into their clinical practice.

Therefore, our research objectives were to use a focus group methodology to explore the following in CAF Physiotherapists: 1) The factors influencing the use of interventions and outcome measures in the management of LAS, 2) The factors affecting the implementation of current research evidence in the management of LAS, and 3) The identification of preferred methods to receive current research evidence in the management of LAS.

4.1 Methods

This study was approved through the University of Toronto, Health Sciences Research Ethics Board and was coordinated through the Director General Military Personnel Research and Analysis for the Department of National Defense.

4.1.1 Participant recruitment

Participants for this study were recruited from a cohort of CAF Physiotherapists who responded to our recent survey of LAS management practices (Robitaille et al. 2013). Nineteen survey respondents initially indicated their interest to participate in a focus group discussion. All 19 were sent an email invitation that included an overview of the focus group procedure, a comprehensive LAS rehabilitation program and an informed consent form. Those that returned a completed consent form were enrolled in the focus group. In order to accommodate scheduling conflicts between enrolled participants, 2 separate focus group discussions were required for a total of 2-3 hours each, which were held in November & December 2011.
4.1.2 Rehabilitation program as a framework for discussion

A comprehensive LAS rehabilitation program was drafted in order to provide a practical framework for participants to discuss interventions and outcome measures, and demonstrate how current research evidence in LAS management may be integrated into everyday clinical practice (Appendix 2). Current research evidence was determined through a literature review on the management of acute LAS previously reported by Robitaille et al. (2013). The literature review revealed several interventions reported to provide statistically significant benefits for individuals with an acute LAS including: functional treatment (early weight bearing as tolerated with external support in the form of bandaging, bracing or taping), intermittent ice with compression, early neuromuscular exercise (balance/proprioception, range of motion and strength) and manual ankle mobilizations. The above interventions were consolidated into a comprehensive LAS rehabilitation program structured to respect the stages of connective tissue healing, with dosages based upon their reported use (Safran et al. 1999; Mattacola & Dwyer 2000; Bleakley et al. 2011) or if absent based on recommendations in healthy adults (Ewing et al. 2011). The rehabilitation program was revised to reflect best practices in a military setting, including space and equipment limitations so as to be conducive to use either in garrison or on deployment, based upon feedback provided by a convenience sample of CAF Physiotherapists.

4.1.3 Focus group questions

A focus group question guide was used to address the study objectives through a semi-structured discussion (see Box 1). The focus group question guide was pilot tested on a convenience sample of CAF Physiotherapists.
Box 1 Focus group question guide

1. What indications are required for you to prescribe and discontinue the following interventions: Protecting injured tissues, balance/balance/proprioception exercises, range of motion exercises, muscular strengthening exercises, manual therapy articular interventions, electrophysical modalities?

2. How do you select the type and dosage of the above interventions?

3. What advantages and/or disadvantages do you see in the uptake of the proposed comprehensive LAS rehabilitation program?

4. What barriers and/or facilitators may affect your utilization of the proposed comprehensive LAS rehabilitation program in your practice?

5. How do you apply current evidence in your management of LAS?

6. How would you prefer current evidence on injury management presented to you?

4.1.4 Data collection and analysis.

Immediately prior to the focus group discussion, a procedural overview was verbalized including ground rules to facilitate communication (Morgan 1996). Participants were informed that the discussion would be audio-recorded for data analysis purposes (Olympus Digital Voice Recorder WS-710M, Olympus Imaging America, PA, USA).

The verbal data recording from the focus group discussion was transcribed verbatim into a Microsoft Word document. The transcribed data set was then confirmed against the original recordings for accuracy and then edited to eliminate participant identifiers to ensure anonymity. The de-identified data set was then coded inclusively to identify data items that formed repeated or interesting patterns. Codes were then collated into themes, which were defined as data that captured important meanings in relation to addressing the research questions. Data extracts were then selected to represent each theme in relation to addressing the research questions.

The focus group discussion was analyzed using a thematic analysis framework as described by Braun & Clarke (2006), where it is defined broadly as a method to identify, analyze, and report
themes within qualitative data sets. Due to the variety of methods to perform thematic analysis, Braun & Clarke recommend that qualitative researchers explicitly acknowledge the theoretical frameworks guiding their data analysis. Hence, the frameworks directing this data analysis included a realist method, where largely unidirectional relationships are assumed between meaning, experience and language. Secondly, a semantic and deductive approach was used in order to facilitate an analysis of the data for relevant information that addressed the research questions.

4.2 Results

Seven CAF Physiotherapists (2 female and 5 male) agreed to participate in the focus group discussion; 3 civilian and 4 military Physiotherapists. The average work experience of participants was 8.3 ±3.9 years with a range of 2-14 years, while average work experience with CAF members was 5.7 ±2.2 years with a range of 2-8 years.

In order to address our research objectives, the responses to our focus group questions were grouped as; factors influencing current LAS management practices (questions 1 & 2), factors influencing the implementation of the comprehensive LAS rehabilitation program (questions 3 & 4), and preferred knowledge dissemination strategies (5 & 6).

4.2.1 Factors influencing current LAS management practices

Current LAS management practices were influenced by the following factors; patient self-reported information, objective outcome measures and habitual practices.

4.2.1.1 Patient self-reported information

Most participants emphasized that a patients’ self-reported information influenced their current practices in LAS management. Patient self-reported information was commonly in the form of symptomatic complaints of pain, a sense of “instability” or “giving away,” or tolerance to prescribed interventions. For example, to determine if external support such as bandaging, brace or taping was indicated to protect acute LAS a participant reported: “...[I] compare their pain levels with gait when they are wearing...[and] when they are not wearing the [ankle] brace, and also...any sense of instability” (X5).
Participants also discussed the importance of attending to a patients’ self-reported information when selecting which type of external support to prescribe. A participant reported: “And in terms of protecting it [the ankle], I’ll tape sometimes but again that’s sometimes in request to the individual. If they are really into playing basketball or volleyball the next day or that evening, then I’ll tape up the ankle for them if they feel it provides better support than the ASO [ASO lace up ankle brace, North Carolina, USA]” (X2). In this case, while the decision to prescribe an external support was established, the type provided was open to debate based upon the patients’ self-reported feelings of support.

The participants frequently reported consideration of patients’ complaints of pain when progressing or discontinuing interventions. When asked about dosage for muscular strengthening exercises, a respondent reported: “I start off with isometrics [isometric ankle strengthening exercises] early depending on [their] pain...if there is no pain...then I start with concentrics [concentric ankle strengthening exercises]” (X2). Similarly, when discussing hop tests as functional performance measures: “Let’s give 3 examples...If you have pain only and good quality – it’s a fail. If you have bad quality and no pain – it’s still fail. If you have both – it’s a fail” (X7). Therefore, patients’ complaints of pain have an evident priority when considering current practices in LAS management.

4.2.1.2 Objective outcome measures

Participants reported a range of practices when discussing the use of objective outcome measures to evaluate the effectiveness of prescribed interventions. Respondents reported fewer objective outcome measures to evaluate balance/proprrioception exercise interventions or functional performance compared to measures of range of motion and strength. For example, outcome measures reported to measure balance/proprrioception included only the “single leg balance test” (X2, X4) and the “star excursion balance test” (X1), while measures reported to measure functional testing at discharge included “jump/hop tests” (X1, X7). Conversely, participants discussed measuring range of motion with: “visual estimation (X2), knee to wall measurements/bent knee dorsi flexion (X1, X4, X5), goniometry (X1, X5) or a digital inclinometer” (X1, X7) and strength with: “manual muscle testing (X4, X5), single leg calf raises (X6), microfit [Microfit Inc. Health & Fitness Systems, California, USA ] (X7) and hand held dynamometry” (X6).
The variety of objective outcome measures may be partially explained by equipment availability. For example, when discussing measuring strength a participant reported: “I use it [the Chatillon Hand Held Dynamometer, Chatillon Force Measurement Systems, Florida, USA] for everything except the [ankle] plantarflexion, of course because plantarflexion is too strong to measure with the Chatillon. So what I’m doing is the old school measure because we don’t have any Biodex [Biodex Isokinetic Dynamometer, Biodex Medical Systems, New York, USA]…calf raises powerfully, comparing right to left” (X6). In this excerpt, the participant relates the decision to use single leg calf raises, where 25 single leg calf raises is considered the standard for a grade of ‘normal’ ankle plantar flexion strength (Lunsford & Perry 1995), due to a lack of access to an isokinetic dynamometer.

Participants acknowledged that the annual Fitness for Operational Requirements of CAF Employment (FORCE) evaluation was the recognized standard for functional performance in the CAF. However, the importance of each member’s occupational & recreational requirements was also emphasized in the selection of outcome measures: “I’ll use the Patient Specific Functional Scale to look at some of the activities that would be more dependent on balance/proprioception” (X1). Another participant reported: “I’m looking at their functional specific goals, to what do they need to be able to do for their employment. What do they need to do with respect to unit physical training?” (X4). The Patient Specific Functional Scale is a patient-specific outcome measure which investigates functional status through self-reported activity limitations (Stratford et al. 1995; Hom et al. 2012). In this way, the participant discussed using self-reported difficulties during habitual physical demands as an outcome measure rather than existing balance outcome measures.

4.2.1.3 Habitual practices

Some interventions were habitually prescribed immediately by participants for most CAF members with LAS, while other interventions were delayed or not prescribed. For example, when discussing the prescription of balance/proprioception exercises, a participant reported: “I will start all members presenting with ankle sprains on a balance/proprioception program early in their rehabilitation, regardless of their stage of presentation” (X1). Similarly, during the discussion of range of motion exercises a participant reported: “With range of motion exercises, we start them [CAF members with LAS] right off the bat” (X2).
In contrast, during the discussion of prescribing strengthening exercise interventions, one participant reported: “What I’ve realized is the isotonic phase is not always necessary. Sometimes just with balance/proprioception, very aggressive balance/proprioception, early, you measure it [ankle strength] two weeks after and there’s not a strength loss. So it’s not always necessary for the good old theraband [ankle isotonic strengthening using Theraband®] exercise” (X4). Another participant agreed: “I find with balance and balance/proprioception training you can skip some of the strengthening exercises” (X5). In the above excerpts, the decision not to prescribe strengthening exercises appears selective based upon clinical findings and clinician experience.

The decision to prescribe manual ankle mobilizations is also selective, as one participant reported: “The indication [to apply manual therapy interventions] is...if the patient is not able to regain [ankle range of motion] independently, I will do manual therapy” (X7). Similarly, another reported: “I apply manual therapy once the acute phase appears to be winding down and the person [with LAS] isn’t progressing in terms of regaining their motion with self-management strategies such as exercise” (X5). In these excerpts the participants describe manual ankle mobilizations as an adjunct intervention which may be used should active exercise strategies not prove effective to restore ankle range of motion.

4.2.2 Factors influencing the implementation of the comprehensive LAS rehabilitation program

Participants denied any specific barriers to the implementation of the comprehensive LAS rehabilitation program. They proposed that the comprehensive LAS rehabilitation program provided a practical solution to the issue of limited patient availability for follow up, but emphasized that the program may need to be customized to meet the needs of some CAF members.

4.2.2.1 Patient availability

Participants who had deployed on operation discussed the reality of CAF member availability issues on operation, and the advantage of having a standardized, comprehensive LAS rehabilitation program: “In KAF [Kandahar Air Field International Military Base, Kandahar, Afghanistan] I wouldn’t necessarily have someone who had a LAS for more than a week, perhaps 2 depending on what their job was. It would be very handy to have something that
could be laid out, so they could do it on their own” (X5).Similarly another participant reported: “I have deployed and it is something you could use out there...I like this [LAS rehabilitation program] because it does put a lot of onus on the patient...making sure they’re doing it correctly and sending them on their way. That does work very well in the deployed environment” (X1).
These excerpts outlined the value of having a standardized comprehensive LAS rehabilitation program for instances when member availability was limited or uncertain, so that the CAF member could continue progressing independently.

4.2.2.2 Customization
Some participants expressed concern that there would be the expectation that they would exclusively follow the standardized comprehensive LAS rehabilitation program for all CAF members with a LAS. One participant reported: “They [CAF Physiotherapists] have to remember that there is a live person in front of them, who will come with their own baggage, needs, expectations, and other conditions that may affect how you manage them” (X5). Another participant echoed similar concerns: “The only problem I see with having a program that we put everybody into, is not having treatment as tailored towards the individual. As long as we keep in mind that this type of program is flexible, and we will change it according to the findings we have in our examination, then I don’t think we would have anything bad coming out of it” (X2).
Participants appreciated the value of a standardized program, but emphasized the importance of considering the individual presentation and needs of each CAF member in order to select the most appropriate LAS interventions and outcome measures as components of the comprehensive LAS rehabilitation program.

4.2.2.3 Preferred knowledge translation strategies
When asked in which manner participants prefer to receive current research evidence, several methods were discussed. One participant reported: “We mostly use an interactive, presentation format where they [CAF Physiotherapists] present their findings [from a literature search] and we have a discussion about it. I find that works well because people can ask questions and they can challenge the research, you know they can see what the pitfalls of the articles, the different evidence is out there, and they can see if they can ask those questions and go through that process, they are more likely to adopt it” (X1). Another participant concurred: “I would prefer [current research evidence] updates at our staff meetings, because it tends to be very practical
when we do that so I learn more” (X5). In these excerpts the value of group interaction was highlighted in order to analyze the evidence and its’ clinical value.

As an isolated Physiotherapist, there was concern expressed over the difficulty of remaining aware of research evidence. “Sometimes there is not enough time in the day to head home and go into MEDLINE/PubMed and search…it doesn’t happen. In terms of preference, generally from prof tech net [Physiotherapy Professional Technical Network]. They send me… the current literature in evidence-based treatment, that’s generally how I’ve been getting my articles. That works out well. It would obviously be nice to sit down with other therapists and talk about things, but that doesn’t happen here” (X2). The Professional Technical Network refers to the collection of all CAF Physiotherapists across Canada, both military and civilian, supported geographically by their Regional Practice Leaders, and centrally by the National Physiotherapy Training Director and Advisor. Participants discussed maximizing the Professional Technical Network to overcome the common barriers such as CAF Physiotherapists working independently on remote bases and those Physiotherapy Sections with less material resources required to remain abreast of current research evidence.

One participant proposed using the Professional Technical Network to share printed materials electronically: “Actually, with the technology that’s available to us and the amount of people who should be reading things, it should be very easy to push information CAF wide. I think what would be helpful is if any literature that is available out there, if they can be disseminated through email. That would help out quite a bit” (X4). Another participant reported alternating responsibilities between Physiotherapy Sections to provide interactive research evidence information sharing: “One great way of doing that would be to have an informal information session where one clinic [Physiotherapy Section] presents. With today’s technology it would be easy to set up Skype calls [live web based communication software] or anything along those lines, where you could get a large number of individuals together on a technological platform to share evidence, ideas, advice” (X1). Participants discussed several examples of local initiatives/programs such as a back stabilization exercise program that were derived from internal collaborative efforts within their respective Physiotherapy Sections that were successfully used to solve local issues. The worth of information sharing amongst the CAF Physiotherapy Professional Technical Network may be summarized by the following excerpt: “There needs to
be more communication with other Physiotherapists about evidence based practice. If it’s working at one clinic [Physiotherapy Section] it should be shared with everybody” (X2).

4.1 Limitations

Although our results suggest a large effect size, our calculated sample size was insufficient to validate this finding. Furthermore, while this study reported clinically relevant changes in self-reported function and pain, it was not sufficiently powered to infer a statistically significant change in these measures. A true control group was not included in this study. Sham mobilizations were included to conceal subject group allocation and standardize patient care time in order to limit the risk of attention bias. However, a true control group receiving only the comprehensive rehabilitation program may have revealed its’ isolated effects on ankle dorsiflexion, self-reported function and pain. While the manual ankle mobilization techniques in this study were standardized in their application, their selection per treatment session was not. As the efficacy of each mobilization technique has not been compared, this may have introduced a confounding variable. The treating Physiotherapists requested that the mobilization technique selection remain at their discretion, in order to respect each participant’s presentation and treatment response.

4.2 Discussion

This is the first qualitative study investigating the factors influencing the management practices of CAF Physiotherapists. In a cohort of CAF Physiotherapists this focus group discussion explored; factors influencing current LAS management practices, factors influencing the implementation of the comprehensive LAS rehabilitation program and preferred knowledge dissemination strategies. The information gained from this focus group discussion enhances some of the results of our previous survey, proposes additions that may optimize the comprehensive LAS rehabilitation program and suggests knowledge dissemination strategies that are conducive to the preferences of CAF Physiotherapists and feasible for CAF Physiotherapy.

Participants frequently prioritized reports of pain when making clinical decisions regarding the management of LAS. The importance of pain is reflected in the literature where it is considered the 5th vital sign, and it is recommended that pain is documented regularly by health care professionals (Williamson & Boggart 2005). In the early stage of a ligament sprain, acute pain is
believed to be an indication of mechanical tissue damage, i.e., the disruption of fragile fibrin bonds. Thus, a failure to respect acute pain may result in further tissue damage, interrupted healing and delayed rehabilitation. Furthermore, pain intensity during high load activities has been recommended as one of the primary outcomes of interest for measuring self-reported recovery in adults following acute LAS (van Rijn et al. 2011). Consequently, the Numeric Pain Rating Scale is included in the comprehensive LAS rehabilitation program to measure pain due to its’ ease of use, responsiveness and high compliance (Williamson & Boggart 2005; Hjermsted et al. 2011).

However, the relative weight placed on a military member’s subjective reports of pain may require some context. Is has been established that military personnel are trained in a culture that promotes pain suppression (Harper 2006) and report higher thresholds before acknowledging pain (Dar et al. 1995). In fact, there are several reports in the literature of military members with LAS having returned to full activities despite acknowledging persistent pain (Detorri et al. 1994; Gerber et al. 1998). These studies may reflect the cultural expectation that military members minimize reporting pain in order to hasten their return to duty. Military members may desire a sooner return to duty following LAS for several reasons. Gerber et al. (1998) reported that military cadets may feel this urgency to avoid: perceived scorn from their supervisors, a loss of their position on a sports team, not completing their cadet course due to training time loss, or the need to feel psychologically healthy. Trained military members may wish to avoid prolonged medical employment limitations that; encumber their peers with their workload, and restrict their participation in military task/training which may delay rank promotions. While such stoicism is valuable under operational conditions, the potential influence of the military culture on subjective outcomes measures should not be overlooked. Should CAF Physiotherapists prioritize minimal subjective reports of pain during clinical decision making in LAS management without considering objective outcome measures, CAF members may be progressed or discharged prematurely, potentially contributing to the high LAS recurrence rates reported among military personnel (Jones et al. 1993; Knapik 1999). Therefore, it would be prudent to concurrently consider both subjective and objective outcome measures in the comprehensive LAS rehabilitation program when determining appropriate discharge criteria.

The limited report of outcome measures to evaluate balance and functional performance as well as the variety of outcome measures reported to evaluate range of motion and strength, are
consistent with the findings of our recent survey (Robitaille et al. 2013). Objective outcome measures that may be quantified are essential, as they promote the credibility of CAF Physiotherapists by transparently communicating progress with patients and interdisciplinary health care team members. Some participants in this focus group reported that a lack of equipment in their work setting influenced their use of certain objective outcome measures. However, it is known that several CAF Physiotherapy Sections have returned their isokinetic dynamometers to the CAF central depot as their staff were not using it. Therefore, although procuring additional equipment would improve accessibility this may not increase utilization. Furthermore, as CAF Physiotherapists are regularly tasked or deployed where facilities and equipment are limited; their management practices may depend on the environment in which they treat CAF members. Therefore, outcome measures ideal for use by CAF Physiotherapists would not only have established psychometric properties, but also be portable, easy to utilize and interpret with minimal equipment.

There are existing objective outcome measures with these characteristics which have been studied in athletic subjects and/or military personnel to evaluate balance such as the; Timed Foam Test (Perron & Hébert 2006), Star Excursion Balance Test (Hertel et al. 2000; Clark et al. 2010) and various hop tests (Gerber et al. 1998; Ross et al. 2002; Perron et al. 2008; Eechaute et al. 2011) which could easily be integrated into the comprehensive LAS rehabilitation program to increase their utilization. Similarly, incorporating objective outcome measures of strength with the above qualities such as Hand Held Dynamometry (Stark et al. 2011), rather than Manual Muscle Testing which has been criticized for its’ subjectivity (Hayes & Falconer 1992), into the comprehensive LAS rehabilitation program may promote convenient and robust outcome measures for CAF Physiotherapists employed in garrison or on deployment. Participants acknowledged that the existing CAF annual operational requirements evaluation was the recognized standard for functional performance (Reilly 2012). However, participants discussed that the different military occupations and units of CAF members impose a variety of physical requirements that may not be captured with this one functional performance test. Therefore, the inclusion of the Patient Specific Functional Scale (Hom et al. 2012) to the comprehensive LAS rehabilitation program would allow CAF Physiotherapists to measure activity limitations that are relevant to the military occupations and units of individual CAF members.
Our previous survey reported a relative delay in the prescription of balance and strengthening exercises until the sub-acute stage of rehabilitation (Robitaille et al. 2013). These findings may be seen as a discrepancy between knowledge and practice, as they conflict with the recommendations of Wikstrom et al. (2010) and Bleakley et al. (2011), whom recommended immediate balance and strengthening exercises following acute LAS. While all of the focus group participants reported prescribing early balance exercises, they did acknowledge delaying or omitting strengthening exercises. Participants justified their decision as an efficiency, as they reported no loss of strength at re-evaluation despite solely prescribing early balance exercises. This finding highlights the complexity of evidence based practice, as clinical decisions are not limited to the strict application of research evidence but incorporate a clinician’s experience and the patients’ preferences (Sackett et al. 2000). However, CAF Physiotherapists should recognize that LAS management practices that are in conflict with research evidence may require justification, which emphasizes the importance of using outcome measures with strong psychometric properties to validate clinical decision making.

The comprehensive LAS rehabilitation program was designed to demonstrate how current research evidence could be clinically applied in a military context. Overall, participants supported the concept of a standardized, comprehensive LAS rehabilitation program which could be distributed to CAF members on deployment if required when opportunities for follow up are limited (Hébert & Rowe 2007). In addition, the comprehensive LAS rehabilitation program addresses many of the commonly reported barriers to implementing research evidence and thereby providing optimal healthcare. Cabana et al. (1999) concluded that a lack of awareness of research evidence and a lack of barriers to implementation were the most frequent factors affecting physician adherence to research evidence. The comprehensive LAS rehabilitation program promotes awareness of current research evidence by being presented as a synergistic combination of interventions reported to provide statistically significant benefits for individuals with acute LAS. Furthermore, participants reported no specific barriers to implementing this program as long as modifications could be made to meet the needs of individuals if required. Cochrane et al. (2007) reported that insufficient support/resources and behaviours/characteristics of the health care provider were the most frequent barriers to providing optimal healthcare. Respondents agreed that the comprehensive LAS rehabilitation program requires minimal resources and as long as the program could be modified as required, they considered it easy to
use whether in garrison or on deployment. Based on our findings related to the lack of barriers, nominal resource demands, and ease of use reported by participants, the comprehensive LAS rehabilitation program should not meet significant restrictions to implementation (Graham et al. 2007; Francke et al. 2008).

Efforts to improve the awareness of research to CAF Physiotherapists are essential, as lack of awareness is a frequently reported barrier to knowledge to practice (Cabana et al. 1999; Sudsawad et al. 2007; Francke et al. 2008). Consistent with the findings of our previous survey (Robitaille et al. 2013), focus group participants reported a preference for research knowledge dissemination through interactive discussions, followed by distance education presentations and summarized research articles. Previous research supports the concept of providing clinicians opportunities to interact with their colleagues in order to influence the uptake and utilization of research evidence (Graham et al. 2006; Sudsawad et al. 2007; Francke et al. 2008). Similarly, in their survey of physiotherapists in the Netherlands to determine compliance with the Dutch acute LAS guidelines, Leemrijse et al. (2006) reported that a positive attitude towards guidelines in general (69%) and knowledge of colleagues using the guidelines (76%) was associated with compliance to the guidelines. Furthermore, although 82% of respondents reported participating in educational activities regarding the guidelines, there was no significant relationship between the activities and guideline compliance. However, they did report a relationship between the number of educational activities undertaken and compliance to the guidelines, which is in line with a recent systematic review of knowledge translation strategies among rehabilitation professionals. Menon et al. (2009) published a systematic review of 12 articles investigating the effectiveness of knowledge translation interventions for improving the knowledge, attitudes and practice behaviors of occupational and physical therapists. The authors summarized that participating in active, multi-component knowledge translation interventions such as interactive education sessions, outreach visits and printed materials, resulted in significant improvements in the self-perceived knowledge and practice behaviors of physiotherapists. Therefore, interactive, multi-component interventions for research evidence dissemination are both preferred by our participants and supported by research evidence to improve the knowledge and practice behaviours of physiotherapists.

Issues raised in the focus group discussion were that some CAF Physiotherapists work independently of peers, and certain CAF Physiotherapy Sections have more human and material
resources to seek out and summarize research evidence, which Cochrane et al. (2007) would define as support barriers. One way to resolve such discrepancies would be to share the existing research knowledge dissemination strategies amongst CAF Physiotherapy Sections. In the interest of resource sharing, research knowledge under consideration for implementation (i.e., educational presentations, summarized research articles) could be uploaded to an internet based drop box, i.e., Sharepoint, which could be accessible by all CAF Physiotherapists via the Department of National Defense Intranet. This strategy would enable all CAF Physiotherapists to have access to a growing database of research evidence to promote evidence based practice that may optimize health care and maximizes the value of the CAF Physiotherapy Professional Technical Network. Once the research evidence is retrieved, local or telephone/internet based interactive educational sessions may be planned between Physiotherapy Sections, with the objective of facilitating collegial interaction so as to positively influencing the uptake and utilization of research evidence. Future research may investigate such a multi-component knowledge dissemination strategy to measure the uptake and utilization of the comprehensive LAS rehabilitation program among CAF Physiotherapists.

4.3 Limitations

A realist theoretical framework with an deductive approach guided the thematic analysis of the focus group discussion. The use of alternative frameworks such as a constructionist framework and/or an inductive approach may have produced different conclusions. While the use of these methods may have provided a broader data set, it would have made it difficult to specifically address our research questions. This focus group had only 7 participants. Therefore, it is unknown if the discussion in this sample is representative of all CAF Physiotherapists. However, a similar distribution of both civilian and military CAF Physiotherapists was represented, limiting significant bias from employment type. Our sample was not randomly selected but recruited through convenience and therefore the findings may be at risk of selection or sampling bias.

4.4 Conclusions

This is the first qualitative study investigating the factors influencing the management practices of CAF Physiotherapists. In this focus group, a cohort of CAF Physiotherapists explored; factors influencing their current LAS management practices, factors influencing the implementation of a
comprehensive LAS rehabilitation program and identified their preferred knowledge dissemination strategies. The information gained from this focus group discussion enhances some of the results of our previous survey, proposed metrics which may optimize how the results of the comprehensive LAS rehabilitation program may be measured and suggests a knowledge dissemination strategy conducive with the preferences of CAF Physiotherapists.

Participants reported prioritizing reports of pain in clinical decision making when managing LAS in CAF members. While this is appropriate in the acute stage of LAS rehabilitation, it is recommended that both subjective and objective outcome measures are considered as discharge criteria to avoid precipitate decisions that may contribute to LAS recurrences. Consistent with our survey findings, participants discussed using a limited number of outcome measures for balance and functional performance. To address this issue, objective and quantifiable outcome measures of balance and functional performance reported in athletic or military subjects were proposed which could be easily integrated to capture the results of the comprehensive LAS rehabilitation program. Those participants who delayed their prescription of strengthening exercises explained their decision within the context of their clinical findings and experience. Such clinical decisions may not always be valid, as clinical experience and patient preferences should be considered alongside current best research evidence in the context of providing evidence based practice. It was recommended that CAF Physiotherapists employ outcome measures with strong psychometric properties to validate any clinical decisions which may appear to conflict with research evidence.

Participants considered the comprehensive LAS rehabilitation program a clinically practical tool that applied current research evidence on LAS management without requiring significant support/resources, and did not foresee any barriers to implementing it in garrison or on deployment. This suggests that the comprehensive LAS rehabilitation program should not meet significant restrictions to implementation. With this end state in mind, having a cohort of CAF Physiotherapists actively involved in reviewing the comprehensive LAS rehabilitation program was intentional. Strategies that engage the end users of research knowledge, are easy to understand and trialed without being resource intensive have been reported as more likely to be applied in clinical practice (Graham et al. 2007; Francke et al. 2008). Future research may investigate the implementation the comprehensive LAS rehabilitation program to determine if it
improves outcomes for CAF members with LAS, as research knowledge is unlikely to improve patient health outcomes unless it is applied by health care professionals (Graham et al. 2006).

Interactive, distance education and summarized resources were the preferred knowledge dissemination strategies of CAF Physiotherapists. Creating digital resource collection depots and facilitating opportunities for collegial interaction between Physiotherapy Sections using existing technologies are feasible approaches to promoting awareness of research knowledge and promoting the uptake and utilization of research evidence by CAF Physiotherapists. Such dissemination strategies may not only improve the evidence based practice in LAS management, but may be used as a framework for other MSKC common in the CAF.
Chapter 5
Ankle Mobilizations to Improve Ankle Dorsiflexion Following LAS: A Pilot Study in CAF Members

In this pilot study the logistic and statistical feasibility of carrying out a randomized trial to investigate the value of manual ankle mobilizations as an adjunct to a comprehensive rehabilitation LAS program during normal course of care was investigated in CAF members.

5 Introduction

LAS (Lateral Ankle Sprains) are among the 3 most common musculoskeletal injuries sustained by soldiers in the CAF (Hébert 2005), the US Armed Services (Cameron et al. 2010), and the British Army (Strowbridge & Burgess 2002). The LAS incidence rate of United States Armed Services soldiers has been reported to be 35 per 1,000 person years, which is considerably higher than those reported by civilians of 5 to 7 per 1,000 person years (Cameron et al. 2010). Moreover, Knapik et al. (1999) reported that soldiers were 6 times more likely to experience a LAS recurrence if they had sustained a LAS in the 5 year period before attending military training. The considerable LAS incidence and recurrence rates reported by soldiers may lead to functional and operational consequences.

Soldiers have reported pain and swelling, and have demonstrated mobility, strength, balance and functional deficits following LAS (Detorri et al. 1994; Gerber et al. 1998; Perron et al. 2008). Such symptoms and impairments may lead to activity limitations and restrictions to participation that may result in; non-completion of certain military tasks/training, repatriation from deployment, and if persistent, premature military release. Lost personnel hours, disrupted duties, and rehabilitation workload further exacerbate the burden of LAS in the military (Gerber et al. 1998; Strowbridge & Burgess 2002), which may impact operational readiness (Cameron et al. 2010). Therefore, the sequelae of LAS in the military must be minimized through the implementation of effective management strategies.

Comprehensive rehabilitation programs integrating early mobilization, cryotherapy and neuromuscular exercise have been reported to decrease pain and improve self-reported function
in soldiers with LAS (Detorri et al. 1994; Gerber et al. 1998). However despite these interventions, 40% of soldiers continue reporting pain, impairments, and activity limitations at 6 months (Gerber et al. 1998) and up to 44% remain symptomatic at 1 year (Detorri et al. 1994). These findings suggest that the use of comprehensive rehabilitation programs alone for treating LAS may not effectively address some of the impairments crucial for asymptomatic ankle function.

Ankle dorsiflexion hypomobility is a common impairment in soldiers following acute LAS (Perron et al. 2008), which may cause difficulties walking and running (Green et al. 2001), and increase recurrence risk (Pope et al. 1998). Dorsiflexion hypomobility prevents the ankle from reaching a stable closed pack position of the talocrural joint, exposing it to plantar flexion and/or inversion injuries (Hertel 2002). Therefore, dorsiflexion hypomobility may be an impairment sustained by soldiers following LAS that prevents asymptomatic function and increases recurrence risk.

Two recent systematic reviews report moderate level evidence that Physiotherapists applying manual ankle mobilizations may rapidly improve ankle dorsiflexion following LAS (van Der Wees et al. 2006b; Bleakley et al. 2008). However, due to methodological limitations, short term follow ups and laboratory study conditions, the clinical relevance of improved ankle dorsiflexion following manual ankle mobilizations is unknown. Ninety-six percent of CAF Physiotherapists report using manual mobilizations when managing LAS across all stages of healing. CAF Physiotherapists may consider manual ankle mobilizations an appealing adjunct treatment to use on deployment, where there is pressure to rapidly and efficiently resolve impairments due to higher caseload volumes, limited clinical resources and follow up opportunities (Rowe & Carpenter 2011). Based on the risks associated with dorsiflexion hypomobility following LAS, and the evidence of improvements in ankle dorsiflexion following manual ankle mobilizations, research is warranted to determine their practical value as part of a comprehensive rehabilitation program for CAF members.

A pragmatic trial investigating the use of manual ankle mobilizations to improve ankle dorsiflexion in a military population with acute LAS could not be located. Therefore, a pilot study was planned to determine the logistic and statistical feasibility of carrying out a randomized trial in a CAF setting during normal course of care. The feasibility objectives of this
study included identifying the demands of the; processes (eligibility screening, study procedures, outcome measures), resources (human, equipment), and management (data, risk) of a randomized trial in a clinical CAF setting. The scientific objectives of this study included; estimating the treatment effect and variance of improved ankle dorsiflexion when adding manual or sham ankle mobilizations to a comprehensive rehabilitation program in CAF members 2 weeks following LAS, and; investigating any between group differences in ankle dorsiflexion, lower extremity function, days before return to work, recurrences and pain at 2 and 12 weeks.

5.1 Methods

This study was approved by the Health Sciences Division of the Research Ethics Board at the University of Toronto, Ontario, Canada, and the board of CAF Surgeon General’s Health Research Program.

5.1.1 Eligibility screening

Between 30 June 2012 and 30 June 2013, consecutive CAF members of the Regular or Reserve Force between 18-60 years of age who reported to a Care Delivery Unit in CAF Base Borden, Ontario, Canada with a suspected LAS within 7 days were referred to the Physiotherapy Section for eligibility screening. Four CAF Physiotherapists (2 military officers & 2 civilians) with a mean 13 years (± 9.29) of clinical experience in musculoskeletal physiotherapy used a standardized history and examination to determine study eligibility. Subjects were excluded if they; were unavailable for follow up over 12 weeks, had a lower extremity co-morbidity, or a medical history potentially contraindicating mobilizations (ligamentous instability; radiographic evidence of fracture/dislocation; syndesmosis injury; lower extremity neurologic impairment; medical history: bone or connective tissue disease or diabetes or local malignancy or rheumatoid arthritis or vascular disease or >3 months of anticoagulant or corticosteroid medications or prior surgery to the lower leg/ankle). Subjects expressing interest in participation were directed to a research assistant where the study procedures and consent form were explained. It was emphasized that study participation was completely voluntary, and that subjects could discontinue the study or refuse to answer any questions at any time without any repercussions.
5.1.2 Study procedures

Upon return of the signed consent form to a research assistant, 20 subjects were randomly allocated into the mobilization or sham group (Figure 1). Group allocation was concealed from the research assistant using identical, sequentially numbered, opaque, sealed envelopes. All subjects were instructed in a standardized comprehensive rehabilitation program by their treating Physiotherapist that integrated early mobilization, cryotherapy and early progressive neuromuscular exercise (Appendix 2). At the discretion of the treating Physiotherapist, the experimental group received between 1 - 3 standardized manual ankle mobilizations (Appendix 3) while the sham group received sham mobilizations, for up to 6 total treatment sessions over 2 weeks. At 2 and 12 weeks a Physiotherapist blinded to group allocation measured ankle dorsiflexion, while the treating Physiotherapist administered the self-reported measures.

**Figure 3. Flow diagram of subject recruitment and retention**
5.1.3 Outcome measures

A combination of quantitative and qualitative outcome measures commonly used by Physiotherapists in the study setting was used to capture the results of this study (Robitaille et al. 2013).

The Bent Knee Dorsi Flexion (BKDF) is a reliable, functional test of mobility used to quantify ankle dorsiflexion using a tape measure or inclinometer, where 1 centimeter was reported to equal approximately 3.5 degrees (Bennell et al. 1998). The BKDF has a reported Minimal Detectable Change at a 90% confidence level (MDC90) of approximately 10 mm on the affected limb, or 15mm between the affected and unaffected limb (Chisholm et al. 2012).

The Lower Extremity Functional Scale (LEFS) is a self-reported Likert scale instrument designed to assess functional limitations of general lower extremity musculoskeletal conditions where higher scores represent less disability, and a reported minimally clinically important difference (MCID) of 9 points (Binkley et al. 1999).

The Foot and Ankle Disability Index (FADI) is a two part activities of daily living/pain (ADL) and sporting activities (SPORT) self-report Likert scale instrument designed to assess functional limitations related to foot/ankle conditions, where scores are converted into percentages, with 100% representing no dysfunction (Martin et al. 1999). The FADI was revised as the Foot & Ankle Abilities Measure which reports a MCID of 8% for its’ ADL and 9% for SPORT components (Martin et al. 2005).

Return to full duties was defined as being cleared by a medical officer or by successfully completing the CAF operational fitness evaluation (Canada, Canadian Forces Morale & Welfare Services, 2013). Recurrences were defined as a sudden rolling of the same ankle, which caused the subject to stop their current activity or resulted in them not participating fully in work/unit physical training.

The Visual Analogue Scale (VAS) is a pain instrument where subjects indicate their perceived pain intensity on a 10 cm horizontal line with "no pain" marked at 0 and "worst pain imaginable" marked at 10 (Katz & Melzack 1999). An MCID of 2.0 centimeters has been reported in subjects with lower extremity musculoskeletal dysfunction (Crossley et al. 2004).
5.1.4 Data Analysis

Data was analyzed using SPSS version 21 (IBM SPSS Inc. Chicago, Illinois). Baseline demographic variables were calculated using chi square analysis for categorical data and Mann-Whitney-U tests for continuous data. In our primary analysis, the differences in mean outcome measure scores between both groups at 2 and 12 weeks were analyzed using Independent-T tests or Mann-Whitney-U tests as appropriate. BKDF results were also expressed as a deficit relative to the subjects’ uninjured limb and as the standardized mean difference/effect size (Cohen et al. 1998). In our secondary analysis, the differences in mean BKDF scores within both groups at 2 and 12 weeks were calculated using a mixed analysis of variance (MANOVA) for repeated measures including a Greenhouse-Gessier correction. Correlational relationships between outcome measure scores at 2 and 12 weeks were calculated using a bivariate analysis. The sample size calculation for this pilot study was based on the mean change in BKDF observed in our first 5 participants completing 2 week follow up. Using an observed mean change of 50.6mm, a standard deviation (SD) of 35.89mm, a 2-tailed test with an α of 0.05 and 80% power would be able to determine a medium effect size (0.5 of the SD or 17.95mm) (Cohen et al. 1998) with a sample size of 10 subjects per group. A medium ES was selected as an adequate clinically relevant difference between groups, as it is greater than the accepted MDC90 on the injured limb (10mm) or between the injured and uninjured limb (15mm) (Chisolm et al. 2012).

5.2 Results

In terms of feasibility of conducting a randomized trial in a CAF clinical environment, the treating Physiotherapists reported that completing the eligibility screening, standardized procedures and data collection processes of this study added approximately 5-10 minutes/subject to their appointment times. Physiotherapists whom were blinded to allocation group to perform the BKDF reported requiring approximately 5 minutes/subject. The research assistant reported that explaining the consent form to potential subjects required approximately 5 minutes/subject, while data management required approximately 5-10 minutes/subject/week. No additional equipment was required for study processes, and no adverse events were reported during the study period.
There were 112 CAF members screened for eligibility, 22 met the criteria and of those 20 voluntarily consented to participate. There were no statistically significant differences (p>0.05) reported between groups at baseline (Table 4). The four subjects who did not report for 12 week follow up had greater initial LEFS scores at baseline (p=0.02).

Table 4. Baseline demographics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mobilization group</th>
<th>Sham group</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age*</td>
<td>34.9±10.9</td>
<td>33.4±5.8</td>
<td>0.579</td>
</tr>
<tr>
<td># Subjects</td>
<td>N=10</td>
<td>N=10</td>
<td>1.000</td>
</tr>
<tr>
<td># ♂</td>
<td>9</td>
<td>9</td>
<td>1.000</td>
</tr>
<tr>
<td># ♀</td>
<td>1</td>
<td>1</td>
<td>1.000</td>
</tr>
<tr>
<td>First LAS</td>
<td>7</td>
<td>6</td>
<td>1.000</td>
</tr>
<tr>
<td>Recurrent LAS</td>
<td>3</td>
<td>4</td>
<td>1.000</td>
</tr>
<tr>
<td>Grade 1 LAS</td>
<td>4</td>
<td>3</td>
<td>1.000</td>
</tr>
<tr>
<td>Grade 2 LAS</td>
<td>6</td>
<td>7</td>
<td>1.000</td>
</tr>
<tr>
<td># Days since LAS*</td>
<td>3.3±1.6</td>
<td>4.8±1.6</td>
<td>0.075</td>
</tr>
</tbody>
</table>

*Mann-Whitney-U tests expressed as mean ± SD

The primary analysis showed that at 2 weeks there were no statistically significant differences between groups in BKDF, VAS or FADI (Table 5). However, there were significant differences reported between groups in LEFS (p=0.03) and FADI SPORT (p=0.04) in favour of the sham group at 2 weeks. The results of both groups exceeded the MDC90 for BKDF and the MCID for VAS, LEFS, FADI and FADI SPORT at 2 weeks. There were no recurrences, nor any significant differences reported between groups in any outcome measures at 12 weeks (p>0.05).
Table 5. Primary analysis at baseline, 2 & 12 weeks

<table>
<thead>
<tr>
<th></th>
<th>Baseline</th>
<th></th>
<th>2 weeks</th>
<th></th>
<th>12 weeks</th>
<th></th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Mobilization</td>
<td>Sham</td>
<td>P</td>
<td>Mobilization</td>
<td>Sham</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>n=10</td>
<td>n=10</td>
<td></td>
<td>n=9</td>
<td>n=10</td>
<td></td>
</tr>
<tr>
<td>BKDF (mm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>44.7±35.3</td>
<td>60.8±51.9</td>
<td>0.68</td>
<td>95.2±47.5</td>
<td>94.7±36.9</td>
<td>0.84</td>
</tr>
<tr>
<td>BKDF relative deficit (mm)</td>
<td>-66.6</td>
<td>-53.6</td>
<td>-----</td>
<td>-15.8</td>
<td>-19.7</td>
<td>-----</td>
</tr>
<tr>
<td></td>
<td>(59.7%)</td>
<td>(46.9%)</td>
<td></td>
<td>(4.2%)</td>
<td>(17.2%)</td>
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<tr>
<td>Cohens’ d</td>
<td></td>
<td></td>
<td></td>
<td>1.2</td>
<td>0.8</td>
<td></td>
</tr>
<tr>
<td>VAS /10</td>
<td>3.9±3.0</td>
<td>4.7±2.4</td>
<td>0.80</td>
<td>0.6±1.3</td>
<td>0.4±0.6</td>
<td>0.91</td>
</tr>
<tr>
<td>LEFS /80</td>
<td>31.5±12.5</td>
<td>31.9±12.9</td>
<td>0.58</td>
<td>59.0±13.7</td>
<td>71.0±6.8</td>
<td>0.03*</td>
</tr>
<tr>
<td>FADI /104, (%)</td>
<td>49.3±19.2</td>
<td>54.7±14.4</td>
<td>0.48</td>
<td>88.8±11.8</td>
<td>95.9±8.4</td>
<td>0.18</td>
</tr>
<tr>
<td></td>
<td>(47.4%)</td>
<td>(52.6%)</td>
<td></td>
<td>(85.4%)</td>
<td>(92.2%)</td>
<td></td>
</tr>
<tr>
<td>FADI SPORT /32, (%)</td>
<td>6.4±7.6</td>
<td>5.1±3.9</td>
<td>0.63</td>
<td>13.9±9.0</td>
<td>23.1±5.0</td>
<td>0.04*</td>
</tr>
<tr>
<td></td>
<td>(20.0%)</td>
<td>(15.8%)</td>
<td></td>
<td>(43.3%)</td>
<td>(72.2%)</td>
<td></td>
</tr>
<tr>
<td>RTW (days)</td>
<td></td>
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<td></td>
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</tbody>
</table>
| Values expressed as mean ± SD as available

*=Significant difference (p<0.05)

†=Exceeds known minimal detectable change at 90% (MDC90)

‡=Exceeds known minimally clinically important difference (MCID)

The magnitude of change in individual LEFS scores between baseline and 12 weeks were greater in the mobilization group for all questions (Figure 4). The use of manual ankle mobilization technique A, B &/or C was similar between both groups (Figure 5). Overall, mobilization A was used 1.4 times more frequently than mobilization B and over 8 times more frequently than mobilization C.
Figure 4. Magnitude of change in LEFS between groups at baseline & 12 weeks

LEFS Questions

Magnitude of change of the Lower Extremity Functional Scale (LEFS) questions from baseline (dashed) to 12 weeks (solid) for the mobilization □ and sham group □.

Figure 5. Mobilization utilization rate
The secondary analysis determined that the mean BKDF scores differed significantly between baseline to 12 weeks ($F_{1.4,16.9}=27.4$, $p=0.00$, partial eta$^2$ 0.7). However, there was no significant difference between groups ($F_{1.4,16.9}=0.7$, $p=0.46$, partial eta$^2$ 0.1), nor any significant interaction between time and group ($F_{1,12}=0.0$, $p=1.00$, partial eta$^2$ 0.0). Post hoc testing including the Bonferri correction revealed statistically significant differences in the BKDF scores between baseline and 2 weeks 39.7mm±11.3 (64.2-15.3), and baseline and 12 weeks 56.2mm±10.5 (78.9-33.4) at $p=0.00$.

The bivariate analysis revealed that the BKDF scores were moderately positively correlated with LEFS & FADI, and VAS scores were moderately negatively correlated with BKDF, LEFS and FADI, at both 2 and 12 weeks respectively (Table 6).

**Table 6. Bivariate analysis at 2 & 12 weeks**

<table>
<thead>
<tr>
<th></th>
<th>BKDF Correlation</th>
<th>VAS</th>
<th>LEFS</th>
<th>FADI</th>
<th>FADI SPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 weeks</td>
<td>Pearson’s</td>
<td>0.36</td>
<td>0.48</td>
<td>0.55</td>
<td>0.36</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.12</td>
<td>0.04*</td>
<td>0.02*</td>
<td>0.13</td>
</tr>
<tr>
<td>12 weeks</td>
<td>Pearson’s</td>
<td>-0.24</td>
<td>0.62</td>
<td>0.64</td>
<td>0.43</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.37</td>
<td>0.01*</td>
<td>0.01**</td>
<td>0.10</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>VAS Correlation</th>
<th>BKDF</th>
<th>LEFS</th>
<th>FADI</th>
<th>FADI SPORT</th>
</tr>
</thead>
<tbody>
<tr>
<td>2 weeks</td>
<td>Spearman’s</td>
<td>-0.61</td>
<td>-0.60</td>
<td>-0.66</td>
<td>-0.31</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.01**</td>
<td>0.01**</td>
<td>0.00**</td>
<td>0.11</td>
</tr>
<tr>
<td>12 weeks</td>
<td>Spearman’s</td>
<td>-0.37</td>
<td>-0.70</td>
<td>-0.75</td>
<td>-0.78</td>
</tr>
<tr>
<td></td>
<td>P value</td>
<td>0.16</td>
<td>0.00**</td>
<td>0.01**</td>
<td>0.00**</td>
</tr>
</tbody>
</table>

* $p<0.05$

**$p<0.01$**
5.3 Discussion

The minimal process, resource and management demands required in this study suggest that it is feasible to implement such a pragmatic trial in a typical CAF clinical setting. The minimal disruption to normal practices was likely due to the fact that the assessment, interventions and outcome measures were previously being used by Physiotherapists in the study setting. The additional time required to complete study processes may be met by adding approximately 10 minutes/subject for Physiotherapy follow up appointments and the same time/week for administrative data management. Our pilot study design contributes to the literature investigating manual ankle mobilizations to improve ankle dorsiflexion following LAS by addressing several methodological limitations reported by previous studies (van Der Wees et al. 2006b; Bleakley et al. 2008) and by providing a longer follow up of 12 weeks. Overall, the reported study procedures would be feasible under normal practice conditions, with low resource demands and adverse event risk.

The large number of subjects excluded from participating in this pilot study was unanticipated. The exclusion criteria were adapted from previous studies investigating ankle mobilization interventions following LAS, to ensure that subjects had no contraindications to receiving manual therapy. Regrettably, the specific reasons for exclusions were misfiled and are irretrievable. By recall, the research assistant proposed that most exclusions were due to potential subjects being unable to commit to attending the 12 week follow up, due to their military duties or training demands, followed by lower extremity co-morbidities. Limited availability is likely due to the study site being on primarily a training base, where students transiently attend their occupational trade schools where missed class time has considerable consequences. Furthermore, our recruitment period began over the summer, which is when the base is inundated with Reserve Force CAF members participating in seasonal summer training of only 8-12 weeks duration. Lower extremity co-morbidities sustained previously or during the LAS may have confounded the results of our outcome measures, and require individualized exercise programming, which were inconsistent with the standardization of our comprehensive LAS rehabilitation program. Therefore, we believe the eligibility criteria were sound, however our research site, recruitment period & co-morbidities presented some challenges to recruitment rates which will need to be addressed in follow up studies.
Our sample size of 10 per group was able to determine a medium effect size in BKDF. Recruiting a larger sample size is warranted, as the effect sizes reported by both groups suggest large changes in BKDF at 2 weeks. While the sham group met the 0.8 threshold for clinical relevance, the mobilization group exceeded this value at 1.2. Similarly, the mean relative change in BKDF at 2 weeks compared to the uninjured limb at baseline reported by both groups exceed its’ MDC90 with a mean improvement of 50.5 mm in the mobilization group and 33.9 mm in the sham group, representing a 55% and 30% change from baseline, respectively. These findings are suggestive of a difference between groups which may be determined as statistically significant with a larger sample size.

Interestingly, the magnitude of change in the mean scores for all questions of the LEFS between baseline and 12 weeks was greater for mobilization group than sham group subjects (Figure 2). In fact, for half of the LEFS questions, including those regarding higher levels of function such as usual recreational/sporting activities, running and hopping (questions 2, 16 & 19 respectively), the size of change was twice as large. These findings are relevant due to the requirement of CAF members’ to perform such strenuous activities during their military occupational duties (Hébert 2005; Robitaille et al. 2013) and existing evidence of similar activity limitations in CAF members 6 months following LAS (Perron et al. 2008). Therefore, the addition of manual ankle mobilizations to a comprehensive rehabilitation program may be of value to improve self-reported functional limitations following the acute phase. This impression is consistent with the findings of a recently published randomized trial of 74 subjects with LAS by Cleland et al. (2013) where the addition of manual ankle mobilizations to an exercise program was shown to significantly improve pain and self-reported function at 4 weeks and 6 months.

This study demonstrated no statistically significant differences in mean ankle dorsiflexion at 2 weeks following acute LAS, when either manual ankle mobilizations or a sham were added to a comprehensive rehabilitation program. Several reasons may explain the lack of significant differences between groups. As subjects in the sub-acute and chronic phase of recovery have demonstrated significant improvements in dorsiflexion following only 1 mobilization treatment (van Der Wees et al. 2006b; Bleakley et al. 2008), they may be more likely to respond to these interventions than subjects in the acute phase. The large variability in pain reported by experimental group subjects at 2 weeks may have prevented Physiotherapists from applying sufficiently intensive mobilization forces, or in a range of motion more likely to promote
changes in joint mobility (Green et al. 2001). In addition, the MANOVA results at 2 weeks demonstrated significant differences in dorsiflexion in both groups, suggesting that the improvements may represent normal changes occurring over the acute phase.

Despite a lack of statistically significant differences in BKDF, VAS & FADI between groups, the mean changes reported by both groups outside of their respective MDC90/MCIDs at 2 weeks suggest clinically relevant changes. This may have been due to all subjects participating in the comprehensive rehabilitation program, whose components of early mobilization, cryotherapy and early progressive neuromuscular exercise have been shown to improve pain and self-reported function following LAS (Detorri et al. 1994; Gerber et al. 1998; Robitaille et al. 2013).

At 12 weeks all outcome measures had improved in both groups such that any further changes were smaller than their reported MCID/MDC90 and therefore of unknown clinical value, except for FADI SPORT scores. The questions in the FADI SPORT subscale scored lowest in both groups at 12 weeks included; landing, squatting/stopping and cutting/lateral movements. These results reinforce the importance of integrating such demanding activities into the early progressive neuromuscular exercise component of the comprehensive rehabilitation program for CAF members with LAS (Perron et al. 2008).

5.4 Conclusion

The burden of LAS in military organizations warrants research into determining the most effective strategies for their management. The challenges of providing rehabilitation to deployed soldiers demand that Physiotherapists prioritize clinical efficiency. The results of this pilot study suggest that a full scale randomized trial is both feasible in a clinical CAF setting and warranted due to our preliminary findings. It is recommended that the study design is modified to include; a larger sample size in order to explore the value of individual ankle mobilization techniques on ankle dorsiflexion and self-reported functional limitations, ankle mobilization technique delivery following the acute phase following LAS, a true control group and prolonged follow up times.
Chapter 6
Conclusion

6  Review

6.1 Purpose of thesis
The overall purpose of this thesis was to offer practical recommendations to optimize the LAS management practices of CAF Physiotherapists, in order to promote efficient and effective evidence based practices that are aligned with the CAF Physiotherapy slogan: “Physical and measurable solutions to maintain and enhance operational readiness, anywhere, anytime.”

6.2 Research questions
In order to optimize the LAS management practice of CAF Physiotherapists, 3 studies were conducted to address the following research questions; 1) What LAS management practices are recommended by the current best research evidence? 2) What are the current LAS management practices of CAF Physiotherapists? 3) What factors influence the implementation of current best research evidence in the LAS management by CAF Physiotherapists? And 4) Is there value in adding manual mobilizations to a comprehensive rehabilitation program designed from current best research evidence in CAF members with LAS? The first study consisted of a literature review and survey to address questions 1 & 2, the second study used a focus group design to address question 3, and the third study was a pilot study to address question 4.

6.3 Survey results

6.3.1 Overall findings
In the first paper, a literature review was carried out to answer our first research question and determine the current best research evidence in LAS management. The literature review results supported the use of; functional treatment (weight bearing as tolerated with external support as required), intermittent ice with compression, exercise and manual mobilizations, while not supporting the use of electrophysical modalities. To answer our second research question, CAF Physiotherapists were then surveyed to determine their current LAS management practices, and these two data sources were compared in order to determine any discrepancies between research
and practice. While several of the LAS management practices reported by survey respondents throughout the stages of healing were consistent with the results of our current best research evidence literature review including; functional treatment and exercise, others such as electrotherapy modalities were not. As the use of electrotherapy modalities is not recommended by current research evidence to improve outcomes following LAS, it was proposed that CAF Physiotherapists analyze their management practices to ensure evidence based clinical decision making.

6.3.2 Relative delay in prescription of strengthening & balance exercises

Survey respondents reported a relative delay of prescribing balance and strengthening exercises from the acute until the sub-acute or rehabilitative stages of LAS healing. It was proposed that these findings were inconsistent with the conclusions of recent studies that have recommended isometric strengthening exercises to improve ankle function (Bleakley et al. 2010), and bilateral balance training to improve balance (Wikstrom et al. 2010) immediately as tolerated in subjects with acute LAS. Consequently, it was recommended that early balance and strengthening exercises be integrated immediately into the rehabilitation of CAF members with acute LAS. It is intended that when these exercise interventions are integrated early in LAS rehabilitation they will efficiently resolve these impairments, which have persisted for up to 6 months in CAF members with LAS (Perron et al. 2008) and have been reported in subjects with recurrent LAS (Hiller et al. 2011). Furthermore, it was recommended that exercise prescriptions for CAF members with LAS reflect an intensity and dosage consistent with the rigorous physical demand of military occupational duties (Berkowitz et al. 1999; Bergman & Miller 2000).

6.3.3 Limited use of balance & functional performance outcome measures

Survey respondents reported a limited use of balance and functional performance outcome measures throughout the stages of healing. It was proposed that failing to measure balance and functional performance may result in premature discharge of CAF members with LAS, and thereby may contribute to the increased recurrences reported in this survey and in previous military literature (Milgrom et al. 1991; Jones et al. 1993; Detorri et al. 1994; Gerber et al. 1998; Knapik et al. 1999). Several existing balance tests including military and/or athletic subjects with LAS and otherwise healthy controls were proposed for consideration, including the Timed Foam Test (Perron & Hébert 2006), the Star Excursion Balance Test (Hertel et al. 2000; Clark et
al. 2010) and hop tests (Gerber et al. 1998; Ross et al. 2002; Perron et al. 2008). There are limited studies investigating appropriate guidance for measuring functional performance following musculoskeletal injuries (Creighton et al. 2010) and none to our knowledge for LAS. Without appropriate guidelines, it was recommended that functional performance measures should at a minimum reflect the CAF’s annual evaluation of occupational requirements (Canada, Canadian Forces Morale & Welfare Services, 2013), as well as considering each individual CAF members’ usual military duties and physical training requirements.

6.4 Focus group results

The rationale for survey respondents reporting a relative delay in prescribing balance and strengthening exercises and limited outcome measurements in balance and functional performance could not be determined from our close ended questionnaire. Furthermore, the factors potentially affecting the implementation of current best research evidence in LAS management into practice had not been previously investigated in CAF Physiotherapists. These factors proposed an opportunity for further qualitative research to explore the LAS management practices of CAF Physiotherapists. Therefore, in the second paper a focus group design was used to answer our third research question as well as explore; 1) the factors influencing the use of interventions and outcome measures in the management of LAS, and 2) the factors affecting the implementation of current research evidence on LAS management into the clinical practice of CAF Physiotherapists and 3) the identification of preferred methods to receive current research evidence in the management of LAS.

6.4.1 Prioritized pain outcomes

Focus group participants prioritized reports of pain during clinical decision making when managing CAF members with LAS. While this is appropriate in the acute stage of healing, it was cautioned that due to the stoic culture of the military, clinical decision making should carefully evaluate both subjective and objective outcome measures in order to avoid premature discharge which may increase recurrence risk.
6.4.2 Verified limited use of balance & functional performance outcome measures

Focus group participants verified the limited use of balance & functional performance measures reported by our survey respondents. Some participants reported that a lack of equipment in their work setting influenced their use of certain outcome measures. While procuring equipment may improve accessibility, it is unknown if this would improve utilization, as CAF Physiotherapists are regularly tasked where there are limited equipment. To address this issue, it was proposed that outcome measures ideal for use by CAF Physiotherapists would not only have strong psychometric properties, but also be portable, easy to utilize and interpret with minimal equipment. Several balance and functional performance outcome measures meeting these criteria and evaluated in athletic/military subjects were recommended (Perron & Hébert 2006; Hertel et al. 2000; Clark et al. 2010; Gerber et al. 1998; Ross et al. 2002; Perron et al. 2008). However, some participants reported that the specific requirements of individual CAF members could not be met by one functional performance measure. It was therefore recommended that the CAF’s annual operational requirements evaluation be considered as a general functional performance measure (Canada, Canadian Forces Morale & Welfare Services, 2013), while the Patient Specific Functional Scale (Stratford et al. 1995; Hom et al. 2012) could be considered in order to capture specific activity limitations of interest to individual CAF members, based on their specific military duties or physical training requirements.

6.4.3 Verified delayed prescription of strengthening exercises

While all of the focus group participants reported prescribing early balance exercises, they verified delaying their prescription of strengthening exercises in the context of their patients’ presentation and their clinical experience. As the decision not to initiate strengthening exercises may be seen to be in contrast of current recommendations (Bleakley et al. 2010), it was proposed that clinical decisions should always be validated through the use of objective outcome measures with strong psychometric properties.

6.4.4 Lack of barriers to implementation

Participants considered the comprehensive LAS rehabilitation program a clinically practical tool that applied current research evidence without requiring significant support or resources, and did not forsee any barriers to its’ implementation in garrison or on deployment as long as
modifications could be made to meet the needs of individuals if required. Engaging CAF Physiotherapists to confirm; a lack of implementation barriers, minimal resource demands, and ease of utilization, was intentional to increase the likelihood of having the comprehensive rehabilitation program applied in their clinical practice (Graham et al. 2007; Sudsawad 2007; Francke et al. 2008).

### 6.4.5 Established knowledge dissemination preferences

Focus group participants reported a preference for research knowledge dissemination through interactive discussion, which was consistent with our survey respondents. These results compare to the conclusions of Menon et al. (2009) who reported in their systematic review that participating in active, multi-component knowledge translation interventions resulted in significant improvements in the self-perceived knowledge and practice behaviors of Physiotherapists. However, some participants discussed the challenge of remaining current with research evidence due to being employed where there are limited material and human resources. It was recommended that these support barriers may be overcome by facilitating opportunities to share knowledge amongst CAF Physiotherapy Sections electronically, and then arrange for distance based collegial interaction initiatives to positively influence the uptake and utilization of research evidence into practice across CAF Physiotherapy Sections.

### 6.5 Pilot study results

Despite participating in comprehensive rehabilitation programs, 40% of soldiers continue reporting pain, impairments, and activity limitations at 6 months (Gerber et al. 1998) and up to 44% remain symptomatic at 1 year (Detorri et al. 1994). These findings suggest that the use of comprehensive rehabilitation programs alone for treating LAS may not effectively address some of the impairments crucial for asymptomatic ankle function in military members. Ankle dorsiflexion hypomobility is a common impairment in soldiers following acute LAS, which may cause difficulties walking and running (Green et al. 2001) and increase recurrence risk (Pope et al. 1998). Recent systematic reviews have reported moderate level evidence that manual ankle mobilizations may rapidly improve ankle dorsiflexion. CAF Physiotherapists may consider manual ankle mobilizations an appealing adjunct treatment to use on deployment, where there is pressure to rapidly and efficiently resolve impairments due to higher caseload volumes, limited clinical resources and limited follow up opportunities. Based on the risks associated with
dorsiflexion hypomobility following LAS, and the evidence of improvements in ankle
dorsiflexion following manual ankle mobilizations, research is warranted to determine their
practical value as part of a comprehensive rehabilitation program for CAF members.

The pilot study investigated 1) the feasibility of implementing a randomized trial in a clinical
CAF setting and 2) the value of adding manual ankle mobilizations to a comprehensive
rehabilitation program to improve ankle dorsiflexion in CAF members 2 weeks following LAS.
It was determined that the minimal process, resource and management demands required by this
pilot study suggested that it is feasible to implement such a pragmatic trial in a typical CAF
clinical setting. Interestingly, the pilot study demonstrated no statistically significant differences
in mean ankle dorsiflexion at 2 weeks following acute LAS, when either manual ankle
mobilizations or a sham were added to a comprehensive rehabilitation program. These
preliminary results suggest that manual ankle mobilizations may not be necessary to improve
ankle dorsiflexion during the acute phase following LAS. However, despite a lack of statistically
significant differences between groups, the changes in ankle dorsiflexion, pain and self-reported
function reported by both groups outside of their respective MDC90/MCIDs at 2 weeks
suggested clinically relevant changes. These results suggest that a full scale randomized trial is
both feasible in a clinical CAF setting and warranted to confirm or refute our preliminary
findings with a larger sample size.

6.6 Recommendations to optimize LAS management practices

A review of the findings from these 3 papers proposes several strategies to optimize LAS
management practices among CAF Physiotherapists. These strategies will be summarized using
evidence based and best practice recommendations for CAF Physiotherapists regarding which
outcome measures and interventions may be optimal for CAF members with LAS. In addition,
in order to align with the CAF Physiotherapy slogan “Physical and measurable solutions to
maintain and enhance operational readiness, anywhere, anytime” the recommendations will
favour LAS management practices; with strong psychometric properties, have been tested in a
military population, which may be quantified, are portable and easy to administer with minimal
equipment. Furthermore, as 25 of the survey respondents (50.0%) estimated that 25-50% of
members reported their LAS as a recurrence (Robitaille et al. 2013), recommendations from the
literature will also be made for this subgroup.
6.6.1 Outcome measures

6.6.1.1 Subjective outcome measures

6.6.1.1.1 Self-reported functional questionnaires

Survey respondents reported using the LEFS self-reported functional questionnaire more frequently than the FADI or the FAAM throughout the stages of healing (Robitaille et al. 2013). While each of these self-reported questionnaires are considered appropriate for individuals sustaining LAS (Martin & Irrgang 2007), there are some inherent clinimetric properties to the latter which make them more appropriate for the CAF population. When general self-report questionnaires such as the LEFS are used in athletic populations, ceiling effects or scores at the high end of normal function, decrease the sensitivity of the questionnaire to determine activity limitations or responsiveness to interventions. A ceiling effect was demonstrated in the 12 week pilot study results as the LEFS and FADI ADL subscale scores had improved to the point where further change could not be measured, while clinical improvements could still be measured with the FADI SPORT subscale. The self-reported activity limitations reported by the pilot study at 12 weeks (landing, squatting/stopping and cutting/lateral movements) and by Perron et al. (2008) at 6 months (running on uneven ground or while changing direction, hopping) may suggest an increase LAS recurrence risk with these activities. Failure to inquire as to any perceived difficulty with such intense sporting activities may lead CAF Physiotherapists to overlook the integration these activities into rehabilitation, potentially exposing CAF members to LAS recurrence.

Therefore, it is recommended that CAF Physiotherapists include a self-report functional questionnaire such as the FADI or FAAM, which both include a sport subscale that address the intense activity limitations encountered during soldiering. Following factor analysis and item theory investigations, the sleeping and pain related items were excluded from the FADI and the revised questionnaire was renamed the FAAM (Martin et al. 2005). The MCIDs established in the FAAM ADL and SPORT subscales may make it an appealing self-report functional questionnaire for CAF Physiotherapists to assist in determining the clinical relevance of changes in individual scores (Martin et al. 2005). Eechaute et al. (2007) completed a systematic review of the clinimetric qualities of patient-assessed instruments for individuals with CAI and confirmed that either the FADI or the FAAM were appropriate for use with this population.
Focus group participants discussed that the different military occupations, operational units and each CAF members’ preferred recreation activities impose a variety of physical requirements, which may not be captured with a single functional performance test. Therefore, the inclusion of the Patient Specific Functional Scale (Stratford et al. 1995; Hom et al. 2012) would allow CAF Physiotherapists to measure the activity limitations that are relevant to the unique needs of individual CAF members, considering their physically demanding operational tasks.

6.6.1.1.2 Summary of recommendations for subjective outcome measures

In addition to the Visual Analogue Scale or Numeric Pain Rating Scale (Hjermstad et al. 2011) which survey respondents have already reported using frequently (Robitaille et al. 2013), it is recommended that when assessing the subjective activity limitations of CAF members with LAS CAF Physiotherapists consider including; a regional self-reported functional questionnaire which includes a sport subscale such as the FADI or FAAM to capture those activity limitations encountered during intense physical activity and in order to avoid the ceiling effects of general questionnaires, as well as the Patient Specific Functional Scale to facilitate the integration of activities of importance to the occupation, unit, and/or recreational preferences of individual CAF members.

6.6.1.2 Objective outcome measures

6.6.1.2.1 Balance outcome measures

Survey respondents reported a limited use of balance outcome measures throughout the stages of healing. In their systematic review and meta-analysis on balance impairments after LAS, Wikstrom et al. confirmed the existence of balance impairments in individuals sustaining both acute and recurrent LAS (2010). Furthermore, secondary to strong evidence that balance deficits are bilateral after acute LAS, Wikstrom et al. discouraged the use of the uninjured limb as a criterion for a normal score. If balance is impaired on both limbs and one is used as a reference, individuals may be discharged from rehabilitation prematurely and potentially at risk for a recurrence. In lieu of the uninjured limb, Wikstrom et al. recommended a healthy reference group or preferably baseline testing results within the same subjects to be used as when evaluating balance deficits post-acute LAS. In addition, as there is no accepted gold standard for the measurement of balance, a prudent consideration is to include static and dynamic tests for a
comprehensive assessment. There are existing balance tests including military and/or athletic individuals with LAS and otherwise healthy controls which may be used for comparison.

Perron & Hébert (2006) investigated the use of the static Timed Foam Test in 28 CAF members with second-degree LAS and 30 healthy controls. These authors reported that the performance of subjects with LAS was similar between the injured and non-injured sides. The finding of bilateral balance impairments in CAF members after LAS supports the conclusions made by Wikstrom et al. (2010) in a military population. Secondly, the authors reported significant differences between all conditions except for those conditions with the eyes open. The authors concluded from these results that CAF members with LAS rely mostly on visual inputs to maintain balance, and hence they recommended occluding vision to more accurately identify balance deficits in this population. Furthermore, this study provided a healthy reference standard in a sample of CAF members. Clinically, with equipment and space requirements limited to a timer and a piece of foam, the Timed Foam Test appears to be an easily implementable method for evaluation of static balance.

Hertel et al. (2000) investigated a dynamic test of balance entitled the Star Excursion Balance Test (SEBT), which has been reported to identify statistically significant differences between limbs with and without chronic ankle instability (Hertel et al. 2006). Similar to the Timed Foam Test, reference standards exist for the SEBT in a sample of healthy CAF members (Bastien et al. 2014) and healthy military controls (Clark et al. 2010) for comparison.

In their systematic review with meta-analyses of characteristics of individuals with recurrent LAS Hiller et al. (2011) reported that compared to healthy controls, people with recurrent LAS demonstrate greater postural sway when standing with eyes closed and on unstable surfaces and prolonged time until stabilization after a jump. This suggests that the vision occlusion and uneven surfaces progressions of the Timed Foam Test may be appropriate for individuals with recurrent LAS.

6.6.1.2.2 Strength outcome measures

Survey respondents reported the use of Manual Muscle Testing (MMT) frequently and consistently throughout the stages of healing, while the use of Hand Held Dynamometry (HHD) was very limited. These results are interesting, as while the use of MMT has several advantages,
requiring no equipment and being easily applied in any setting, these benefits are challenged by the disadvantages of its’ inherent subjective measurement. While this shortcoming may not be apparent when testing weak individuals or when testing against gravity, at the higher levels of measurement the assessors’ strength becomes a significant limitation (Knepler & Bohannon 1988; Mulroy et al. 1997).

Isokinetic dynamometry is considered the gold standard for measuring strength, however the disadvantages of cost, space and time required to use isokinetic machines may limit its’ clinical use. The results of a recent systematic review investigating the current evidence regarding the reliability and validity of HHD for assessment of muscle strength in the clinical setting demonstrated minimal differences between HHD and isokinetic testing (Stark et al. 2011). Considering the portability and ease of use of HHD it may be regarded as a reliable and valid instrument for muscle strength assessment in a clinical setting when isokinetic dynamometry is unavailable or inconvenient.

Once the method of strength assessment is made, the muscles to be assessed are the remaining decision. Interestingly, there are some conflicting recommendations between acute and recurrent LAS. In a prospective observational study including 23 CAF members with acute LAS, strength deficits in the ankle plantar flexors and evertors determined by isometric dynamometry remained significantly different in the injured limb compared to the uninjured limb at 6 months (Perron et al. 2008). Furthermore, Perron et al. were able to correlate changes in ankle strength with self-reported improvements on the LEFS (2007). To ensure that CAF members are adequately prepared for the challenges of military duties and training, these authors strongly recommended restoring full ankle strength.

In contrast, in a systematic review with meta-analyses of characteristics of individuals with recurrent ankle sprains Hiller et al. (2011) reported that when people with recurrent sprains are compared to healthy controls strength differences do not appear to be a distinguishing factor. Pooled concentric and eccentric invertor and evertor peak torque data demonstrated a significant large effect only for concentric inversion strength, which is in contrast to previous assumptions of evertor weakness or latency. However, decreased ipsilateral hip strength has been reported in the chronic ankle instability population (Friel et al. 2006). A review of the above findings
proposes that it may be prudent to assess all major lower extremity muscle groups following LAS.

6.6.1.2.3 Functional performance outcome measures

Survey respondents and focus group participants reported a limited use of functional performance outcome measures throughout the stages of healing. This was surprising as functional performance outcome measures are frequently used as discharge criteria (Creighton et al. 2010). Failing to assess functional performance may result in premature discharge and may have contributed to the increased recurrences reported in this survey and previous military literature (Jones et al. 1993; Detorri et al. 1994; Gerber et al. 1998; Knapik et al. 1999). Hop tests with established psychometric properties, such as the single-limb forward hop and crossover hop, have been reported in a group of healthy military subjects (Ross et al. 2002; Clark et al. 2010) and CAF members with LAS (Perron et al. 2008) and may be used as functional performance measures in acute LAS. Subjects with recurrent LAS including symptoms of ‘giving away’ may be best assessed using hop tests which involve direction changes and reproduce the symptoms, such as the figure of 8 and square hop test (Caffrey et al. 2009; Sharma et al. 2011).

However, hopping tests do not simulate the military duties required of CAF members. Functional performance measures are intended to reproduce the demands of a sport in order to assess the integration of physical impairments and activity limitations concurrently with the stress of competition (Creighton et al. 2010). There are limited studies investigating appropriate guidance for return to play in sport following musculoskeletal injuries (Hudson et al. 2009; Creighton et al. 2010) and none to our knowledge for LAS. Without appropriate guidelines, it is recommended that the rehabilitation of CAF members with LAS include normalizing all body function impairments, followed by a progressive integration of a CAF member’s usual military duties, which at a minimum should reflect the components of the CAF’s annual operational requirements evaluation (Canada, Canadian Forces Morale & Welfare Services, 2013). In addition, consideration should be given to the CAF members’ military occupation, operational unit requirements and preferred recreation activities, which may impose a variety of physical requirements not captured the CAF operational requirements evaluation. These activities may be measured using the Patient Specific Functional Scale (Stratford et al. 1995; Hom et al. 2012).
6.6.1.2.4 Summary of recommendations for objective outcome measures

In addition to the Figure of 8 at 20 degrees ankle swelling measurement (Rohner-Spengler et al. 2008) and goniometry (Martin & McPoil 2005) or BKDF ankle mobility measurements (Konor et al. 2012) which survey respondents have already reported using frequently (Robitaille et al. 2013), it is recommended that when assessing objective measures of body function impairment in CAF members with LAS, CAF Physiotherapists should consider measures of; static and dynamic balance such as the Timed Foam Test and SEBT respectively, strength such as the HHD and functional performance such as hop testing, the FORCE test and the PSFS.

6.6.1.3 Summary of outcome measures

In order to optimize their LAS management practices the outcome measures selected by CAF Physiotherapists should; have strong psychometric properties, be able to be quantified, have been tested in a military population, be portable and easy to utilize with minimal equipment. Using outcome measures with these qualities will promote evidence based practices in line with the CAF Physiotherapy slogan so as to best meet the requirements of CAF members with LAS whether in garrison or on deployment. When assessing the subjective activity limitations of CAF members with LAS it was recommended that CAF Physiotherapists consider including the FADI or FAAM as well as the Patient Specific Functional Scale. When assessing objective measures of body function impairment in CAF members with LAS it was recommended that CAF Physiotherapists consider measures of; static and dynamic balance such as the Timed Foam Test and SEBT respectively, strength such as the HHD and functional performance such as hop testing, the FORCE test and the PSFS. The concurrent assessment of both subjective and objective outcome measures are recommended in order to prevent discharge of CAF members with LAS with persistent activity limitations, as this may increase the risk of LAS recurrence. These recommended outcome measures could be integrated into the comprehensive LAS rehabilitation program as a visual reminder to prompt CAF Physiotherapists for their implementation.

6.6.2 Interventions

In order to promote evidence based and best practices in the LAS management practices of CAF Physiotherapists, it is recommended that the interventions selected for CAF members with LAS;
normalize the persistent body function impairments & activity limitations commonly reported by military members, be prescribed at an intensity and dosage reflective of their physical occupational demands, and include components designed to minimize LAS recurrence risk.

6.6.2.1 Normalize persistent body function impairments & activity limitations

CAF and other military members have reported persistent body function impairments in ankle dorsiflexion and strength (Perron et al. 2008) as well as activity limitations in dynamic balance and functional performance (Detorri et al. 1994, Gerber et al. 1998, Perron et al. 2008, Robitaille et al. 2014). Therefore, rehabilitation programs for military members should emphasize interventions known to normalize these body function impairments such as gastrocnemius/soleus stretching and neuromuscular training as part of a progressive comprehensive LAS rehabilitation program structured to respect the stages of connective tissue healing (Safran et al. 1999; Mattacola & Dwyer 2000).

6.6.2.2 Prescribed at an intensity & dosage reflective of occupational demands

Military members have physically demanding occupations (Hollander & Bell 2010) which some components have been shown to demand near maximum lower extremity strength levels in CAF members (Hébert 2012). In fact, authors have compared the strenuous job demands of military members to a competitive athlete (Jones & Knapik 1999). However, in contrast even to professional athletes, military members must perform their unique job tasks while encumbered by tactical equipment, navigating unpredictable environments with limited visual input and potentially while under assault. Therefore, comprehensive LAS rehabilitation programs should progressively include exercises prescribed at the appropriate dosage to elicit improvements in muscular endurance and strength (Ewing et al. 2011) so as to best prepare them for the physical demands of their occupation. Furthermore, rehabilitation exercises should progressively integrate replicating occupational tasks while in uniform, equipped with tactical gear and in simulative environments so as to prepare them for the operational demands of soldiering.

6.6.2.3 Integrate interventions known to reduce recurrence risk

When considering the LAS recurrence rate among CAF and other military members (Jones et al. 1993; Detorri et al. 1994; Gerber et al. 1998; Knapik et al. 1999; Robitaille et al. 2013), it is
recommended that CAF Physiotherapists consider those risk factors associated with LAS in military members and integrate the methods that have demonstrated significant efficacy and cost efficiency to prevent LAS recurrence into their LAS management practices.

6.6.2.3.1 LAS risk factors

Despite the prevalence of LAS, there appears to be limited research into the risk factors for LAS. A review of the literature into risk factors for LAS suggest that in athletes and military personnel a previous history of LAS and higher body mass index values may predispose them to LAS (Jones et al. 1993; Knapik et al. 1999; Milgrom et al. 2001; Benyonn et al. 2002; Fong et al. 2009; Waterman et al. 2010; Brinkman & Evans 2011). In addition, athletes with limited balance/proprioception and military personnel with limited ankle dorsiflexion may be at a greater risk for LAS than those without such limitations (DeNoronha et al. 2006). However, the methodological quality of the studies investigating the risk factors for LAS is limited, and studies including military subjects are few, limiting the strength of any practical recommendations on minimizing the risk factors of LAS in military personnel.

6.6.2.3.2 Effective interventions that reduce LAS recurrence risk

Verhagen & Bay (2010) updated a previous critical review of the literature on strategies to prevent acute LAS published in 2001. These authors performed an electronic literature search of the PUBMED, SPORTDISCUS and EMBASE databases for randomized and/or controlled trials on this topic published between January 1999 to 2009 which used LAS incidence rates as an outcome and reported a pre-determined methodological quality score. Twenty-four articles met the above criteria as well as a methodological quality of ≥9/14 scored independently by 2 reviewers.

Overall, external support (taping or bracing) and neuromuscular training programs were shown to be effective for the prevention of LAS recurrence. The Relative Risk (RR) of these measures were similar, reporting a range of 0.15-0.5 and 0.15-0.4 respectively when compared against control groups. Both external support methods and neuromuscular were reported to be more effective in preventing LAS recurrence (secondary prevention) versus first time LAS (primary prevention). When studies comparing taping and bracing interventions were compared, the results were inconclusive. Without definitive research evidence favouring the use of taping or
bracing, CAF Physiotherapists may consider patient preferences, the risk of complications, clinical efficiency and cost effectiveness in their selection of external support. Neuromuscular training programs were reported to be more effective than strength training alone, with supervised and unsupervised neuromuscular training programs both demonstrating prophylactic efficacy.

Based on these results, the authors proposed that a combination of an external support and participation in neuromuscular training offered the best short and long term LAS preventative outcomes. External supports such as bracing have been recommended to be worn by athletes with moderate or severe sprains for a minimum of 6 months during intense sporting activities to avoid LAS recurrence (Thacker et al. 1999). Although external supports support the ankle immediately when worn, they do not rehabilitate body function impairments. Although the mechanism of prophylaxis offered by external supports was generally believed to be due to restricting range of motion, the reviewed studies propose that the mechanism is more likely to be as a result of supporting the limited neuromuscular function following LAS. On the other hand, neuromuscular training is purported to develop neuromuscular function by improving muscular strength, proprioception and restoring ankle reflexes. However, the rehabilitation of relevant body function impairments requires a minimum of 8 to 10 weeks of participation in an intensive neuromuscular training program (Holme et al. 1999; Hupperets et al. 2009). Therefore the optimal strategy may be to utilize external supports during potentially or high risk activities to immediately reduce LAS recurrence risk, while regularly participating in a neuromuscular training program intended to normalize body function impairments and reduce the long term LAS recurrence risk.

The use of lace-up ankle braces worn inside military footwear has been reported to be feasible in a military population. Newman et al. (2012) investigated dynamic lower extremity reach and obstacle course performance in 37 military cadets across 3 conditions: no brace, unilateral, or bilateral brace wearing. These authors reported that ankle bracing had a small effect on decreasing lower extremity reach distance but no effect on obstacle course performance.

6.6.2.3.3 Cost-effective interventions that reduce LAS recurrence risk

Furthermore, a combination of external support and neuromuscular training appear to be the most cost-effective prophylactic strategies. Olmstead et al. (2004) examined the effectiveness of
ankle taping and bracing in reducing LAS through a numbers-needed-to-treat (NNT) and cost benefit analysis. An electronic search of relevant articles in PUBMED, CINAHL, SPORT DISCUS and PEDRO databases from 1966 to 2002 produced 8 articles, 3 of which permitted calculation of NNT. In a study of 2,544 collegiate intramural basketball players the prevention of one LAS during one game required the taping of 26 athletes with a history of LAS and 143 without. In a study of 1,601 military cadets on an intramural basketball team the prevention of one LAS over one season required the bracing of 18 athletes with a history of LAS and 39 without (Sitler et al. 1994). In a study of 504 soccer players the prevention of one LAS over one season required the bracing of 5 athletes with a history of LAS and 57 without. The authors reported that their cost benefit analysis revealed that taping was 3 times more expensive than bracing. Furthermore, it is evidently more time consuming to tape an athlete for each practice or game when compared to fitting them with a brace which may be worn for the entire season.

While the varying length of interventions of each study makes direct comparison different, the results of this study suggest that bracing is a more cost effective and efficient method of external support.

Hupperets et al. (2009) completed an economic evaluation to determine if an unsupervised neuromuscular training program to reduce LAS recurrence risk reduced overall health care costs. Five hundred and twenty-two athletes with a LAS less than 2 months old received treatment according to usual care. Two hundred and fifty-six were randomized to also receive an 8 week neuromuscular training program 3 days per week for 30 minutes. Costs per athlete were calculated and costs related to LAS recurrence were measured from a societal perspective. There was a significantly lower risk of LAS recurrence in the intervention group (RR 0.63; 0.45-088). The prevention of 1 LAS required that 9 subjects participate in the neuromuscular training program. Statistically significant differences in total costs were found per athlete (-€69, -€200 to -€2) and per injured athlete (-€332; -€741--€62) in favour of the intervention group (p<0.05). Therefore, an unsupervised neuromuscular training program is a cost-effective intervention for the prevention of LAS recurrence when compared to usual care alone.

These studies support external supports in the form of bracing and unsupervised neuromuscular training as the most effective & cost-efficient methods to prevent LAS recurrence (Verhagen et al. 2010, Lin et al. 2012). It is recommended that these components be integrated simultaneously in the LAS management practices of CAF Physiotherapists to minimize the risk of LAS.
recurrence and their sequelae. Although it is acknowledged that the parachute ankle brace has been demonstrated to be an effective and cost efficient strategy to reduce the risk of LAS in a military population (Knapik et al. 2010), these results apply only to military parachutists and not the general military population.

6.6.2.3.4 Summary of recommendations for interventions

The knowledge of persistent body function impairments in ankle mobility and strength and activity limitations in dynamic balance and functional performance in CAF members with LAS warrant the selection of remedial interventions in a comprehensive rehabilitation program. Due to the physically demanding occupations of military members, interventions should be prescribed at an intensity and dosage that promotes muscular endurance and strength so as to best rehabilitate CAF members to resume their daily tasks. Furthermore, rehabilitation exercises should progressively integrate the replication of occupational tasks, in uniform and military footwear, equipped with tactical gear and in simulative environments. Lastly, in order to effectively reduce LAS recurrence risk among CAF members with LAS in a cost-efficient manner, CAF Physiotherapists should concurrently consider the use external support such as bracing for at least 6 months and promote participation in an intensive neuromuscular training program for a minimum of 8-10 weeks.

6.7 Recommendations for future research

The results from these 3 papers present opportunities for future research which may confirm if the LAS management practices of CAF Physiotherapists have been optimized. The results of the papers initiated an action cycle from the ‘knowledge to action’ process framework as described by Graham et al. (2006). In this framework, the action cycle represents the activities recommended to facilitate the implementation of research knowledge into practice, beginning with the identification of an issue requiring resolution and the research knowledge relevant to resolving that issue. The next step is to adapt the research knowledge to suit the local context, followed by determining potential barriers to implementing the research knowledge under consideration. This information may then be used to strategize an approach to overcome any barriers and promote the implementation of research knowledge into practice. Once the implementation strategy is executed, the next stage is to monitor the implementation to determine the uptake and utilization of the research knowledge. Lastly, it is necessary to
evaluate the impact the research knowledge has made on patient health outcomes and if improved, to strategize an approach to sustain the implementation of research knowledge over time.

In this project, the survey and focus group results demonstrated that although CAF Physiotherapists are using evidence based practices throughout the stages of healing when managing CAF members with LAS, some areas for improvement were noted. For example, in contrast with the recommendations of recent research several respondents reported a limited prescription of strengthening and balance exercises in the acute stage of healing and frequently reported the use of electrotherapy modalities in the management of CAF members with LAS. Therefore, the comprehensive LAS rehabilitation program was drafted to include early strengthening and balance exercises and exclude the use of electrophysical modalities. The focus group discussion proceeded to engage a group of CAF Physiotherapists to identify any barriers to implementing these interventions as part of the comprehensive rehabilitation program. No barriers were reported to the implementation of these interventions as part of the comprehensive rehabilitation program into their usual clinical practice. Therefore, the next step in the ‘knowledge to action cycle’ would be to execute an implementation strategy.

Survey respondents and focus group participants suggested that the knowledge dissemination strategy preferred by CAF Physiotherapists was through interactive education sessions, followed by distance education sessions and summarized printed materials. These knowledge dissemination preferences are consistent with those reported to lead to significant improvements in the self-perceived knowledge and practice behaviours of Physiotherapists (Menon et al. 2009). However, certain participants reported context-specific resource discrepancies that challenged knowledge dissemination or exchange opportunities. Therefore, a strategy was proposed that both acknowledged these preferences yet accommodated those CAF Physiotherapists employed where there are limited human or material resources. It was recommended that summarized printed materials under consideration for implementation, i.e., the comprehensive LAS rehabilitation program, could be uploaded to an internet drop box accessible by all CAF Physiotherapists. Once the materials have been disseminated to CAF Physiotherapists, local outreach visits or distance education sessions could then be scheduled to facilitate collegial interaction, which have been shown to promote the uptake and implementation of research knowledge (Graham et al. 2006; Sudsawad et al. 2007; Francke et al. 2008). Once a reasonable
time frame for implementation has passed, a survey of LAS management practices among CAF Physiotherapists may be repeated to determine if those components of the comprehensive rehabilitation program in question have been implemented into clinical practice.

In order to determine if the comprehensive LAS rehabilitation program contributes to improving patient outcomes, the recommendations made to address the limitations of the pilot study may be conducted in a follow up randomized controlled trial. The pilot study results demonstrated that although not statistically significant, the mean changes in ankle dorsiflexion were clinically important in both groups. Furthermore, the changes in ankle dorsiflexion and self-reported function reported by the mobilization group were greater in magnitude than the sham group. These improved ankle dorsiflexion and self-reported function results may be shown to be statistically significant with a larger sample size. It was proposed that the sample size should be re-calculated based on determining a large effect size (0.8 SD) and/or based on a MCID in self-reported function such as the FADI or FAAM self-reported questionnaire. Based on the pilot study results, a multi-center trial involving other CAF bases in Ontario may be required to collect the appropriate sample size volume. The pilot study did not include a true control group receiving only the comprehensive LAS rehabilitation program. A true control group would have revealed any isolated effects of the program on ankle dorsiflexion, self-reported function and pain. The pilot study also discussed that performing the manual mobilizations during the acute stage of healing when the variability of pain was greatest may have confounded our results. Therefore, an open ended mobilization schedule at the discretion of the Physiotherapist within the first 4 weeks following LAS may alleviate this potentially confounding variable. Two mobilization techniques were most frequently used by treating Physiotherapists. As these mobilizations appear to be preferred by this sample of CAF Physiotherapists, stratifying the groups to compare the efficacy of mobilization A versus B may demonstrate a comparative clinical value. Furthermore, although our 12 week results contribute to the literature investigating the value of manual mobilizations to improve ankle dorsiflexion following LAS (van Der Wees et al. 2006; Bleakley et al. 2008), LAS recurrences have been reported at 6 month (Gerber et al. 1998) and 1 year follow ups (Detorri et al. 1994). Therefore, to determine if the interventions prevent LAS recurrences, we propose similar follow up time points in order to contribute to the literature by investigating the addition of manual mobilizations.
6.8 Conclusion

MSKC impact the military through several measures of burden including; morbidity, occupational duty limitations, limited duty days, attrition and related costs. Consequently, these measures of burden affect the operational readiness of military organizations. Military members whom are unable to perform their occupational duties due to MSKC may affect the preparedness of their military units to perform their function and impact a military forces’ capability to perform their mission. Therefore, determining the most effective evidence based management strategies for the more prevalent MSKC in the military may limit their potential impact on operational readiness and military force strength.

LAS are the one of the most common MSKC sustained by military members, and based on the number of reported recurrences, may be an underestimated threat to operational readiness. The sequelae of LAS in the military include work time loss, persistent symptoms, impairments, recurrences and a substantial rehabilitation workload, which impact the physical readiness of military members and thereby the operational readiness of the military. To limit the potential threat of LAS to operational readiness in the CAF, research into the optimization of LAS management practices is warranted.

This project explored one approach to optimizing the LAS management practices of CAF Physiotherapists. The approach included; establishing the recommended LAS management practices from current best research evidence, comparing these recommendations with the current management practices of CAF Physiotherapists, determining any barriers to the implementation of research evidence into the practice of CAF Physiotherapists and piloting the feasibility of executing a randomized trial investigating the value of adding manual ankle mobilizations to a comprehensive LAS rehabilitation program. The results of this thesis can be considered as a framework for optimizing the management strategies of other MSKC in the military, with the objective of limiting their potential impact on operational readiness and military force strength.
References


Hébert LJ & Rowe PR. (2007). The lessons learned from the Canadian Forces physiotherapy experience during the peacekeeping operations in Bosnia. *Military Medicine, August 172(8)*, 829-34.


## Appendices

### Appendix 1 – Current best research evidence

<table>
<thead>
<tr>
<th>Intervention</th>
<th>Outcome</th>
<th>Evidence</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Functional treatment</td>
<td>↓ # days before RTW</td>
<td>SR</td>
<td>Seah et al. 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CPG</td>
<td>McKay &amp; Cook 2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CPG</td>
<td>Van der Wees et al. 2006</td>
</tr>
<tr>
<td>External support</td>
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<td>SR</td>
<td>Kemler et al. 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>SR</td>
<td>Seah et al. 2011</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCT</td>
<td>Beynnon et al. 2006</td>
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<tr>
<td></td>
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<td>CPG</td>
<td>McKay &amp; Cook 2006</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CPG</td>
<td>Van der Wees et al. 2006</td>
</tr>
<tr>
<td>Ice with compression</td>
<td>↓ pain</td>
<td>RCT</td>
<td>Hing et al. 2011</td>
</tr>
<tr>
<td></td>
<td>↑ function</td>
<td>RCT</td>
<td>Bleakley et al. 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>RCT</td>
<td>Bleakley et al. 2006</td>
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<tr>
<td></td>
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<td>CPG</td>
<td>McKay &amp; Cook 2006</td>
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<tr>
<td></td>
<td></td>
<td>CPG</td>
<td>Van der Wees et al. 2006</td>
</tr>
<tr>
<td>Manual mobilizations</td>
<td>↑ range of motion</td>
<td>SR</td>
<td>Bleakley et al. 2008</td>
</tr>
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<td></td>
<td>CPG</td>
<td>McKay &amp; Cook 2006</td>
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<td></td>
<td>CPG</td>
<td>Van der Wees et al. 2006</td>
</tr>
<tr>
<td>Exercise</td>
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<td>SR</td>
<td>Seah et al. 2011</td>
</tr>
<tr>
<td></td>
<td>↓ recurrence risk</td>
<td>SR</td>
<td>Van Rijn et al. 2010</td>
</tr>
<tr>
<td></td>
<td></td>
<td>CPG</td>
<td>Van der Wees et al. 2006</td>
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</tbody>
</table>

RTW=Return to Work, CPG=Clinical Practice Guideline, SR=Systematic review, RCT=Randomized Controlled Trial
Appendix 2 – Comprehensive rehabilitation program

Phase 1 - Acute Phase - Up to 1 week following ankle sprain

<table>
<thead>
<tr>
<th>Goals</th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Protect injured tissues</td>
<td>Avoid impact activities, sports, uneven ground &amp; the position of ankle sprain.</td>
</tr>
<tr>
<td></td>
<td>Keep the injured ankle braced/bandaged/taped for weight bearing.</td>
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<tr>
<td>Control pain/swelling</td>
<td>Apply ice with compression x 10 min, remove x 10 min &amp; reapply every 2 hours &amp; after exercise.</td>
</tr>
<tr>
<td>Maintain tissue integrity</td>
<td>Maintain cardiorespiratory fitness with non weight bearing activities as tolerated (cycle, row, swim).</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Date</th>
<th>NPRS</th>
<th>/10</th>
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</table>

Exercise program

Proprioception (5 x 30 sec, 3 x day)

Single leg balance progression

Range of motion (3 x 30 sec, 3 x day)

Seated ankle mobilization

Seated towel calf stretch

Active range of motion

Strength (10 x 10 sec, 3 x day)

Ankle dorsiflexion isometrics

Ankle plantarflexion isometrics

Ankle eversion isometrics

Ankle inversion isometrics

Cardiorespiratory (20 - 60 min, moderate intensity, 3-5 x week)

<table>
<thead>
<tr>
<th>NPRS</th>
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</table>

Instructions:
1. Perform exercise program 3 x a day as tolerated. Record exercise completion with a ✓, where 1 ✓ = exercise completed once.
2. Record any pain before & after exercise program using the 0-10 (0=no pain & 10=worst pain) Numeric Pain Rating Scale (NPRS).
3. Inform your Physical Therapist if you note any increased swelling/heat/redness/pain between exercise sessions.
**Phase 2 - Subacute Phase - From 1st week until 3 weeks following ankle sprain**

**Goals**
- Promote tissue healing: Avoid impact activities, sports, uneven ground & the position of ankle sprain.
- Wean from brace/tape/brandage indoors. Wear on uneven ground & for cardiorespiratory fitness.
- Controlled tissue loading: Develop even walking pattern of heel to toe ankle motion & slight knee bend when weight bearing.
- Maintain tissue integrity: Maintain cardiorespiratory fitness with partial weight bearing activities as tolerated (walk, elliptical).

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**Exercises**

- **Proprioception (5 x 30 sec or 3 x 10-15 reps, 3 x day)**
  - Single leg balance progression
  - Dynamic balance progression

- **Range of motion (3 x 30 sec, 3 x day)**
  - High kneeling ankle mobilization
  - Standing straight leg calf stretch
  - Standing bent leg calf stretch

- **Strength (3 x 10 - 15 reps, slow & controlled, 60 sec rest between sets, 3 x week)**
  - Double leg calf raises
  - Ankle dorsi flexion
  - Ankle planter flexion
  - Ankle eversion
  - Ankle inversion

- **Cardiorespiratory (20 - 60 min, moderate intensity, 3-5 x week)**

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<tr>
<th>NPRS</th>
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</table>

**Instructions:**
1. Perform exercise program 3 x a day as tolerated. Record exercise completion with a √, where 1 √ = exercise completed once.
2. Record any pain before & after exercise program using the 0-10 (0=no pain & 10=worst pain) Numeric Pain Rating Scale (NPRS).
3. Inform your Physical Therapist if you note any increased swelling, resting pain, fatigue or weakness between exercise sessions.
# Phase 3 - Rehabilitative Phase - After 3rd week until minimum of 8 weeks following ankle sprain

## Goals

<table>
<thead>
<tr>
<th>Promote tissue healing</th>
<th>Wear brace/bandage/tape on uneven ground, cardiorespiratory fitness &amp; intense/sport activities.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Develop functional scar</td>
<td>Develop dynamic balance and strength in full weight bearing.</td>
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<tr>
<td>Develop pre-injury function</td>
<td>Develop running tolerance to 30 min as tolerated.</td>
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## Date

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</table>

## Exercises

**Proprioception (3 x 5-15 reps, 3 x week)**

- Dynamic balance progression
- Jump progression
- Agility drills

**Range of motion (3 x 30 sec, 3 x week)**

- Standing straight leg calf stretch
- Standing bent leg calf stretch

**Strength (3 x 8-12 reps, slow & controlled, 60 - 120 sec rest between sets, 3 x week)**

- Single leg calf raises
- Ankle dorsiflexion/inversion
- Ankle plantar flexion/eversion

**Cardiorespiratory (20 - 60 min, moderate intensity, 3-5 x week)**

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<thead>
<tr>
<th>NPRS</th>
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</tr>
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</table>

## Instructions:

1. Perform exercise program 3 x a day as tolerated. Record exercise completion with a √, where 1 √ = exercise completed once.
2. Record any pain before & after exercise program using the 0-10 (0=no pain & 10=worst pain) Numeric Pain Rating Scale (NPRS).
3. Inform your Physical Therapist if you note any increased resting pain/fatigue or weakness between sessions.
Appendix 3 – Standardized manual ankle mobilizations

Mobilization A - Talocrural posterior mobilization

Technique:
- Position the member comfortably in supine lying, with a rolled hand towel placed under their knee and their ankle resting over the edge of the treatment surface.
- Adjust the treatment surface so that your straight arm may be positioned over their talocrual joint.
- Stabilize their lower leg at the level of the malleoli with one hand.
- Firmly grasp the anterior talus with the first webspace with the other hand.
- Position the member at the end of their pain free range of ankle dorsiflexion. Ensure that the member reports no pain (a sensation of firm pressure is acceptable). If the member reports pain, mild pronation or supination from the same position may be applied. If the member continues to report pain the angle of ankle dorsiflexion should be decreased until it is pain free.
- Maintain the end of pain free range of ankle dorsiflexion and apply a posterior oscillatory mobilization force to their talus in a direction perpendicular to the plane of their talocrural joint for 60 seconds at a rate of 1 oscillation per second. Ensure the member reports no pain (a sensation of firm pressure is acceptable). If the member reports pain the depth of your oscillation should be decreased until it is pain free. Rest 10 seconds between sets and repeat for 2 more sets for a total of 3 sets of 60 seconds.
- Before beginning each set ensure that the end of pain free dorsiflexion range has been reached.
- If pain free ankle dorsiflexion does not improve in 2 treatments, it is recommended that you progress to the next technique.

Sham:
- The sham technique will replicate the treatment condition with the following exceptions. Both hands will cover the anterior & posterior talocrural joint. The application of a posterior force by both hands into the treatment surface should produce no appreciative mobilization of the talocrural joint. An identical number of repetitions, sets and rest interval will be used.
Mobilization B - Relative talocrural posterior mobilization with movement

Technique:

- Adjust the treatment surface so that it is level with your waist.
- Position the member in high kneeling with the injured ankle closest to you in approximately a right angle of ankle dorsiflexion.
- Place a padded non-elastic belt over the member's distal posterior tibia and fibula at the level of their talocrural joint and around your mid buttock. In this position the belt should be horizontal.
- Stabilize the talus with the webspace with one hand. Reinforce this position with the other hand.
- Engage the restrictive barrier (seek a firm end feel) by maintaining the talar stabilization and leaning backward slightly. Ensure that the member is in no pain (a sensation of firm pressure is acceptable). If the member reports pain, mild adjustments in the direction or amount of your backward lean in the same position should be applied until it is pain free.
- The member is directed to actively lean forward so their knee travels over the second toe to the end of pain free range of ankle dorsiflexion, while simultaneously you are to maintain talar stabilization as you bend your knees to maintain the belt in a direction perpendicular the plane of their talocrural joint until a restrictive barrier is reached (firm end feel), upon which the same path is travelled to return the member to the starting position for 10 repetitions. Rest 60 seconds between sets and repeat for another 2 sets, for a total of 3 sets of 10 repetitions.
- If pain free ankle dorsiflexion does not improve in 2 treatments, it is recommended that you progress accordingly:
  - Instruct the member to lean their weight onto their bent knee to provide overpressure,
  - Position the member in standing.

Sham

- The sham technique will replicate the treatment condition with the following exceptions. The non-elastic belt will be placed over the heel (calcaneus), and only very slight tension will be imparted to take up the slack. Hands will be positioned across the forefoot (metatarsal bases) so that the talocrural joint is not stabilized. Direct the member to actively lean forward so their knee travels over their second toe to the end of pain free range of ankle dorsiflexion, while the seatbelt is maintained perpendicular to the tibia. An identical number of repetitions, sets and rest interval will be used.
Mobilization C - Talocrural distraction manipulation

Technique:
- Position the member comfortably in supine lying, with a rolled hand towel placed under their knee and their ankle resting over the edge of the treatment surface.
- Adjust the treatment surface so that it is level with your waist.
- Bend the knee of the opposite leg so that the foot rests on the treatment surface.
- Grasp the dorsum of the patient’s foot with interlaced fingers as close as possible to the talocrural joint.
- Provide firm opposite pressure with both thumbs in the middle of the plantar surface of the mid/forefoot.
- Engage the restrictive barrier (seek a firm end-feel) by dorsi flexing the ankle and applying long axis distraction. Ensure that the member is in no pain (a sensation of firm pressure is acceptable). If the member is in pain the technique should be discontinued. Apply a high-velocity, low-amplitude thrust in a caudal direction.
- If a joint cavitation is perceived to occur in the area of the talocrural joint the technique is completed. Should a joint cavitation not be perceived the technique may be repeated once more.

Sham:
- The sham technique will replicate the treatment condition with the following exceptions. The lower leg will be grasped superior to the ankle (distal tibia & fibula), and a long axis distraction high-velocity, low-amplitude thrust is to be applied in a caudal direction, causing no appreciative mobilization of the talocrural joint.
Copyright Acknowledgements