SURVEY OF ACUTE REHABILITATION IN CANADIAN INTENSIVE CARE UNITS

By

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A Thesis Submitted to the School of Graduate Studies
In Partial Fulfillment of the Requirements for the Degree
Master of Sciences in Health Research Methodology
McMaster University

MASTER OF SCIENCES (2012) McMaster University

(Health Research Methodology) Hamilton, Ontario, Canada

TITLE: Survey of Acute Rehabilitation in Canadian Intensive Care Units

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NUMBER OF PAGES: ix, 107

ABSTRACT

Background & Rationale: Early mobilization (EM) can minimize intensive care unit aquired weakness (ICUAW) among survivors of critical illness. Clinician awareness of ICUAW, perceived barriers to EM, and acute rehabilitation in Canadian ICUs have not been well described.
Objective: To assess (1) awareness of ICUAW and EM, (2) perceived institutional, clinician, patient level barriers to EM, (3) stated practice of acute rehabilitation in Canadian ICUs.
*Design***:** A cross-sectional, self administered postal survey
Setting: Academic Intensive Care Units (ICUs) in Canada
Subjects: 134 physiotherapists and 302 critical care physicians
Interventions & Measurements: Item generation followed a review of relevant literature and discussion with 26 content experts. We reduced the survey to 10 domains and 29 specific questions. The survey intrument was piloted and evaluated for clinical sensibility and intra-rater reliability. Up to 3 surveys were mailed to potential respondents. Descriptive statistics were reported as proportions, means (+/- SD) or mode, as appropriate. We used the chi-squared test to compare proportions and multi-variate logisitc regressions to test for association between independent and dependent variables.
Main Results: The survey instrument had excellent clinical sensibility and good intra-rater reliability (Cohen's kappa > 0.4). The overall response rate was 71.3% (311/436) including 87.3% (117/134) of physiotherapists and 64.2% (194/302) of physicians. The incidence of ICUAW in the general medical-surgical population was under-recognized by 68.8% of clinicians and 59.8% of clinicians stated they were either insufficiently trained or informed to mobilize mechanically ventilated patients. Excessive sedation and medical instability were perceived as the most important patient barriers. Limited staffing, safety concerns (by nurses) and delayed clinician recognition to initiate EM were key provider barriers to EM. Important institutional barriers to EM included insufficient guidelines and equipment. Only 19.9% of clinicians stated that patients with suspected ICUAW were referred to an out-patient clinic after ICU discharge for long term rehabilitation.
Conclusions: Over 60% of respondents to this national survey underestimated the incidence of ICUAW and do not feel adequately trained to mobilize mechanically ventilated patients. Multiple patient, provider and institutional barriers may also contribute. Clinical leaders and administrators should consider these modifiable factors when designing EM programs in the ICU.

ACKNOWLEDGEMENTS

I am forever grateful to my supervisor, Dr. Maureen Meade, who has inspired my academic pursuits and provided steady personal and professional mentorship for the past seven years. I am also grateful to Dr. Deborah Cook for her dedicated support, guidance, and unwavering belief in me. I wish to thank my thesis committee members, Drs. Karen Choong, Margaret Herridge, and Gordon Guyatt for sharing their wisdom and help in bringing this work to fruition.

This research project was fostered by the *A*cademy of *C*ritical *C*are *D*evelopment, *E*valuation, and *M*ethodolog*y* (ACCADEMY*)* research group and enriched by the generous contributions of my colleagues: Anastasia Newman, Vincent Lo, Karen Burns, Francois Lamontagne, Fran Priestap, Eileen Campbell, Aylish McLeod, John Soer, Val Schulz, Bryan Young, Brenda Morgan, Cathy Mawdsley, Johanna Fraser, Lisa Moorhouse, Michelle Kho, Neill Adhikari, Sangeeta Mehta, Andrew Seely, Rob Fowler, Raymond Kao and Claudio Martin on behalf of the *C*anadian *C*ritical *C*are *T*rials *G*roup (CCCTG).

This research was funded by grants from the Lawson Health Research Institute, The Academic Medical Organization of Southwestern Ontario, and the University of Western Ontario, Canada.

I dedicate this work to my grandmother and my parents for their unconditional love and support. Finally, I thank my husband, Jack Sun, for bringing love, happiness, and meaning to my life.

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LISE OF ABBREVIATIONS

APACHE	acute physiology and chronic health evaluation
AROM	active range of motion
BE	bedside cycle ergometer
CCCTG	Canadian Critical Care Trials Group
CIM	critical illness myopathy
CIP	critical illness polyneuropathy
CINM	critical illness neuromyopathy
CMAP	compound muscle action potential
CS	consultant specialists
CVICU	cardiovascular intensive care unit
ICC	intra-class correlation coefficient
IQR	interquartile range
ICU	intensive care unit
ICUAW	intensive care unit acquired weakness
EM	early mobilization
EMG	electromyography
EPV	events per variable
FiO_2	fraction of inspired oxygen
NCS	nerve conduction study
MAR	missing at random
MCAR	missing completely at random
MNAR	missing not at random
MD	medical doctor
MRC	Medical Research Council
MSICU	medical surgical intensive care unit
OR	odds ratio
OT	occupational therapist
PEEP	positive end expiratory pressure
PROM	passive range of motion
PT	physiotherapist
RCPSC	Royal College of Physician and Surgeons of Canada
RCT	randomized controlled trial
REB	research ethics board
RICU	respiratory intensive care unit
RN	registered nurse
RT	respiratory therapist
SD	standard deviation
SIRS	systemic inflammatory response syndrome
SNAP	synaptic nerve action potential
SP	standard physiotherapy
6MWD	six minute walk distance

DECLARATION OF ACADEMIC ACHIEVEMENT

The following is a declaration that all contents of this document have been written by Karen Koo. Karen Koo is the principal investigator of this original research and contributed to the conceptualization, literature review, survey design, development, testing, administration, analysis, and interpretation and prepared all drafts of the thesis including the final manuscript. Maureen Meade supervised all components of the survey work and thesis preparation. Deborah Cook participated in the survey design, development, testing, analysis and interpretation of the work. Karen Choong participated in item generation, item reduction and instrument testing. Margaret Herridge is a content expert in ICU rehabilitation and participated in survey development, testing and interpretation. As statistical advisor for this thesis, Gordon Guyatt reviewed the survey items, analytical plan and facilitated the author's interpretation of the results. Anastasia Newman and Vincent Lo are physiotherapists who contributed to the design, development and administration of the survey. Karen Burns and Francois Lamontagne provided guidance on survey methodology and contributed to survey development. Fran Priestap conducted the statistical analysis. Eileen Campbell and Aylish McLeod provided administrative support. John Soer created the data entry and storage program for the study. Val Schulz, Bryan Young, Brenda Morgan, Cathy Mawdsley, Johanna Fraser and Lisa Moorhouse participated in clinical sensibility testing. Michelle Kho, Neill Adhikari, Sangeeta Mehta, Andrew Seely, Rob Fowler and Claudio Martin participated in item reduction. Raymond Kao is a bilingual intensivist who reviewed both English and French surveys for conceptual equivalence.

Chapter 1
Overview of ICU Acquired Weakness & Early Mobilization in the ICU

1.0 Overview

Patients in the intensive care unit (ICU) are often sedated and confined to bed rest.[1] Immobility, however, has little clinical benefit.[2] In the ICU, interventions to restore acute organ function are typically prioritized ahead of rehabilitation to preserve and restore neuromuscular function. However, cumulative research in the last quarter century has revealed that immobility contributes to the pathogenesis of neuromuscular weakness, which in turn, can contribute to physical and mental disability.[3]

Early mobilization (EM) is an effective intervention to reduce ICU-acquired weakness (ICUAW) in the general medical ICU population.[4] Early mobilization encompasses a progressive range of activities from active range of motion at one extreme to full ambulation as early as possible during the ICU stay. There are, however, significant challenges to the provision of acute rehabilitation in the ICU, though the actual prevalence and relative importance of such barriers remain uncertain.

This chapter provides a narrative review on ICU acquired weakness and clinical studies evaluating the feasibility, safety and efficacy of early mobilization in the ICU.

1.1 Methods for this Literature Review of ICU-acquired weakness and Early Mobilization in ICU

To capture relevant articles published in English, I searched OVID versions of MEDLINE (1950 – February, week 1, 2011), EMBASE (1980 – 2011 Week 06) and CENTRAL (Cochrane Central Register of Controlled Trials, The Cochrane Library, First quarter, 2011). The MEDLINE search strategy for literature on ICU-acquired weakness retrieved citations containing the text words *intensive care* or *critical care or ICU* in combination with *paresis*, *weakness, polyneuropathy, myopathy, neuropathy, neuromyopathy* or *neuromuscular abnormalities*. The MEDLINE search strategy for literature on early mobilization in the ICU retrieved citations containing the MeSH subject headings *Early Ambulation* or the text words *early* or *immediate* in combination with *mobilization*/mobilization, *ambulation, exercises/exercise, rehabilitation,* or *physiotherapy*. In addition, I sought unpublished research by (1) attending international critical care conferences including the American Thoracic Conference Post-graduate session on ICU-acquired weakness May 2010 and the 2nd Annual International Physical Medicine & Rehabilitation May 2010 and (2) from content experts.

1.2 Literature Review of ICU-acquired weakness

1.2.1 ICU-acquired weakness: Taxonomy of a syndrome

Patients with critical illness can acquire a myopathy (with metabolic or inflammatory muscle derangements and/or membrane inexcitability), a polyneuropathy (with sensory-motor axonopathy), or a polyneuromyopathy.[4] Efforts to accurately and comprehensively describe the syndrome with unifying classification have been challenging. There are a number of reasons for this including limitations in the understanding of the etiology and pathophysiology, the lack of sensitivity and specificity in the symptoms and signs of myopathy and neuropathy,[5] and the growing awareness of an entire spectrum of neuromuscular manifestations in affected patients. With aims to unify and simplify terminology, content experts have suggested generic terms to describe this syndrome of neuromuscular dysfunction. *ICU-acquired weakness (ICUAW)* refers to clinically detected weakness in patients in whom there is no other etiology for the weakness other than critical illness. These patients may be further categorized. Those affected by *critical illness myopathy (CIM)* have clinically detected weakness and electrophysiological and/or histologically defined myopathy. Those with *critical illness polyneuropathy (CIP)* have clinical weakness and electrophysiological evidence of an axonal polyneuropathy. Critical illness neuromyopathy (CINM) denotes a condition where affected patients have electrophysiological and/or histological features of CIM and CIP.[6]

In 1977, MacFarlane and Rosenthal first detected acquired myopathy using electrophysiological testing in a quadriplegic woman who had received neuromuscular blocking agents and corticosteroids for status asthmaticus.[7] Subsequent cohort studies reported a wide range of myopathic abnormalities on muscle biopsy which are now termed *CIM*.[8,9,10,11] Through histological and immunohistological staining, the predominant abnormalities of *CIM* include acute necrosis,[8] regeneration,[12] type II (fast twitch) fibre atrophy,[13] and patchy loss of thick filaments (myosin).[14]

In 1984, Bolton et al. described *critical illness CIP* in a series of five patients who had flaccid and areflexic limbs and were unable to wean from mechanical ventilation.[15] Electrophysiological testing demonstrated severely reduced motor and sensory nerve action potential amplitudes. Nerve histopathology showed moderate to severe primary axonal degeneration with mixed motor and sensory involvement and distal predominance. There was no evidence of demyelination or inflammation.

It wasn't known until 1996 that CIM and CIP could coexist. Latronico et al. discovered CINM in a series of 24 ventilator-dependent patients who had a primary myopathy in addition to axonal degeneration using electromyography (EMG) and nerve conduction studies (NCS).[16] Examination of the histopathology

of the peroneus brevis muscle revealed that 58% of patients had evidence of primary myopathy, 21% had polyneuromyopathy, and 92% had muscle atrophy.

1.2.2 Diagnosis of ICU-acquired weakness

Not only may a patient with apparent clinical weakness have polyneuropathy, myopathy, or both (i.e. polyneuromyopathy), some patients may also have significant weakness from muscle atrophy. Methods to diagnose critical illness neuromuscular abnormalities include clinical assessments of muscle strength, electrophysiological testing, and histological analysis of muscle or nerve tissue.

Historically, affected patients will have generalized limb weakness following the onset of a critical illness. Patients may have history of sepsis, cardiac arrest, acute respiratory distress syndrome or other varied risk factors. A comprehensive historical review should exclude primary causes of generalized weakness related to the central or peripheral nervous systems, including bilateral brain or brainstem lesions, spinal cord disorders, anterior horn cell disorders, polyradiculopathies, peripheral nervous disorders and neuromuscular junction disorders.[17] A common historical feature of ICUAW may be difficulty in weaning from mechanical ventilation as a result of diaphragmatic weakness.[18] Although not specific to ICUAW, affected patients may have low forced vital capacities, low negative inspiratory forces and a rapid shallow breathing pattern during a spontaneous breathing trial.[19] On neurological examination, a majority of affected patients will have diffuse and symmetrical limb weakness in all extremities, decreased tone, normal cranial nerves and either normal or abnormal deep tendon reflexes.[17]

The clinical assessment of muscle strength can be evaluated by manual muscle testing and hand dynamometry. One functional assessment of muscle strength is the Medical Research Council (MRC) score. This score grades functional muscle group strength from 0 to 5 in each extremity.[20] The individual MRC scores from functional muscle groups can be added together to give a total score that provides a global estimate of overall muscle strength. In prospective studies of critically ill patients on mechanical ventilators, a total MRC score of less than 48 (or mean MRC < 4 per functional muscle group) has been used to define 'ICU-acquired paresis'.[18,21,22] The MRC score is simple and easy to perform in a fully awake, cooperative, motivated and capable patient with available limbs. Although it has been shown to have good inter-rater reliability in patients with Guillain-Barre syndrome,[23] it has poor sensitivity in critically ill patients.[24] In a study of 34 patients, the inter-observer agreement was poor while patients were in the ICU (Cohen's kappa = 0.38) and excellent after ICU discharge (Cohen's kappa = 1.0) suggesting manual muscle testing is insufficient for detection of early muscle weakness.[24] In addition, many critically ill patients were excluded from the study because of coma, delirium or injury. MRC scores

can also vary with patient positioning, are insensitive to small changes in muscle strength, and unable to evaluate distal extremity function which may be the first to be affected in myopathies.[17] Hand dynamometry evaluates grip strength and has been proposed as a surrogate measure for global strength. It has been shown to correlate with MRC scores but routine application in the ICU is limited given the proximal over distal distribution of ICUAW and volitional efforts required to reliably assess for weakness.[25]

Electrophysiological testing for ICUAW includes EMG and NCS. EMG involves testing of the electrical activity of the muscles and is performed in awake and cooperative patients- at rest, at minimum voluntary muscle contraction and at maximal voluntary muscle contraction.[26] EMG detects abnormal muscle activity (in the forms of fibrillation potentials and positive sharp waves), which indicates in turn either denervation or muscle necrosis. Short duration, low amplitude motor unit potentials on volitional muscle contraction testing suggest a myopathy while long duration and high amplitude polyphasic motor unit potentials suggest a neuropathy. Thus, patient cooperation is necessary to distinguish neuropathic from myopathic processes. NCSs capture muscular and nervous electrical activity to determine nerve conduction velocities. They can be used to distinguish axonal abnormalities (i.e. normal nerve conduction velocity with low compound muscle action potential [CMAP] and synaptic nerve action potential [SNAP]) from demyelinating polyneuropathies (i.e. low nerve conduction velocity with normal CMAP and SNAP).[17] The routine evaluation of ICUAW in critically ill patients with EMG and NCS outside of scientific investigations is currently not feasible. Challenges include the limited availability of equipment and expertise to perform the tests, technical difficulties to obtain reliable measurements (e.g. due to limb edema, electrical interferences),[17] and the inability to distinguish between neuromuscular abnormalities[27] and lack of specificity of such tests[28]. Therefore, a clinical approach to the recognition of functional weakness of an individual patient suspected to have ICUAW remains favoured by many scientific experts.[29]

1.2.3 Incidence of ICU-acquired weakness

The reported incidence of ICUAW in patients in medical and surgical ICUs is high. In a systematic review of 24 studies using both clinical and electrophysiological testing, 655 of 1421 (46%) of critically ill patients had neuromuscular complications, which were associated with increased duration of mechanical ventilation, ICU and hospital stay.[30] In a prospective cohort of 95 patients who were mechanically ventilated for at least 7 days, clinically defined ICUAW was found in 25% of patients.[21] In another prospective study utilizing electrophysiological testing, the incidence of ICUAW was 58% for patients ventilated for at least 7 days.[31] Among patients who have sepsis, the incidence of ICUAW is as high as 50-100%.[32,33]

1.2.4 Long-Term Disability

Persistent physical and non-physical impairment is common in patients recovering from critical illness. In an elegant prospective study, Herridge et al. systematically evaluated 109 survivors of acute respiratory distress syndrome (ARDS) and found persistent functional disability 1 year after discharge from the ICU.[34] Patients had severe muscle atrophy and on average, lost 18% of their baseline body weight in the ICU. Patients stated that their physical functional impairment was due to loss of muscle bulk, proximal muscle weakness, and fatigue. Entrapment neuropathies, foot drop, joint immobility, persistent pain at chest tube insertion sites and dyspnea were also described by these patients. At 1 year, over half of the patients could not return to work because they continued to experience fatigue and weakness. In a 5-year follow-up study, all patients in this cohort had perceived physical weakness and demonstrated reduced exercise tolerance during a 6 minute walk test (mean distance 436 m; interquartile range (IQR) 324-512; 76% of the distance in an age-matched and sex-matched control population).[35]

Beyond the physical disability, survivors of critical illness are also burdened by non-physical morbidity including depression, anxiety, post-traumatic stress disorder, delirium, and cognitive impairment.[36] The global impact of severe critical illness may result in debilitating disability that results in ongoing requirements for medical care, financial strain, and caregiver burnout.[37]

1.2.5 Multifactorial genesis of ICU-acquired weakness

While bed rest is often thought to be necessary for recovery, immobility beyond 24 to 48 hours is associated with many detrimental physiological consequences (Figure 1.1).[38] Bed-bound patients sustain muscle atrophy from the loss of mechanical loading required to maintain muscle length. [39] These unloaded muscles have reduced actin filaments resulting in a lower force per cross sectional area, which manifests clinically as muscle weakness.[39] Unloaded muscles also have decreased protein synthesis[40] and accelerated protein degradation.[41,42] Muscle atrophy can occur within hours of immobility in healthy subjects,[43] leading to up to 5% loss of muscle strength for each week of bed rest.[44]

Immobility increases production of pro-inflammatory cytokines and reactive oxygen species, resulting in further muscle proteolysis, with a net loss of muscle protein and subsequent muscle weakness.[45] The interaction of critical illness with immobility can further accelerate muscle loss.[46] Catabolic protein loss can be up to 2% per day in critically ill patients.[47] The muscle fibre area decreases by 4% per day with severe atrophy in contractile myosin filaments.[48] Increased severity of illness has also been associated with ICUAW.[4,49,50] The systematic inflammatory response syndrome (SIRS) has an additive adverse effect on muscle loss compared to immobilization alone.[51,52] Inactive septic patients have decreased muscle protein synthesis, increased urinary nitrogen excretion

suggesting increased muscle catabolism) and decreased lower extremity muscle mass.[53]

Corticosteroids, neuromuscular blocking agents and hyperglycemia are putative risk factors for ICUAW. The strongest level of evidence with respect to corticosteroids and neuromuscular blocking agents as causal factors is inconsistent and stems from 4 observational studies in severe asthma, that did not assess systematically for ICUAW. Corticosteroid use has been associated with significant muscle atrophy in animal studies.[54] While observational studies in humans have not confirmed a significant association between corticosteroids and ICUAW,[10,55,56,57] post-hoc analysis of a randomized control trial (RCT) evaluating use of methylprednisolone in ARDS showed that ICUAW occurred only in the corticosteroid group.[58] Neuromuscular blocker use has been an independent risk factor for ICUAW in one observational study but not found to be associated in large prospective studies.[59] In a recent RCT of a 2-day cisatracurium infusion in patients with ARDS, incidence of ICUAW (as measured by MRC scores) at day 28 or ICU discharge was not different between the groups.[60] However, there was no functional assessment of neuromuscular function at ICU discharge and the MRC score is insensitive to the detection of weakness in individual muscle groups. Hyperglycemia has also been associated with ICUAW and there is a post-hoc analysis from a RCT to suggest that tighter glycemic control may be protective.[61]

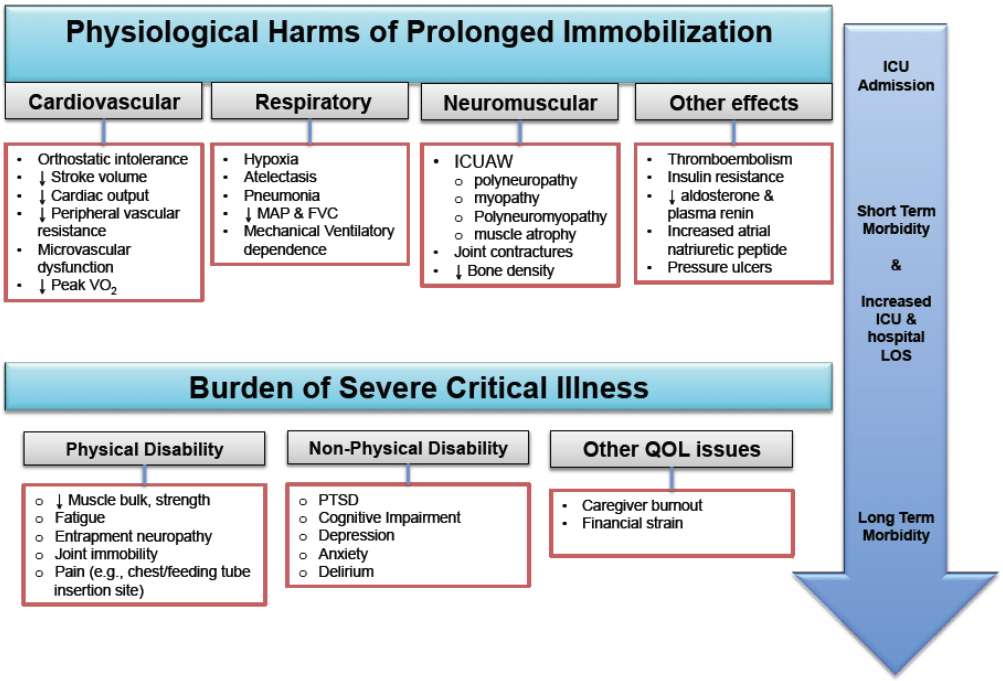

Figure 1.1: Physiological sequelae of immobilization and the burden of severe critical illness.

ICU, intensive care unit; VO_2, oxygen delivery; MAP, maximal inspiratory pressure; FVC, forced vital capacity; ICUAW, ICU-acquired weakness; PTSD, post traumatic distress disorder; LOS, length of stay

1.3 The Feasibility and Safety of Acute Rehabilitation in Respiratory ICUs

Prospective studies of critically ill patients admitted to respiratory ICUs (RICUs) were among the first clinical trials to show that acute rehabilitation was safe and feasible. In a prospective single center cohort of 103 patients admitted to a RICU, Bailey et al. were the first to demonstrate the safety and feasibility of an early activity protocol to initiate mobilization.[62] Once patients were considered physiologically stable based on neurologic, respiratory, and circulatory criteria, they were progressively mobilized. Neurologically, patients had to respond purposefully to verbal commands. The respiratory criteria included a FiO_2 less than or equal to 60% and positive end expiratory pressure (PEEP) less than or equal to 10 cmH_2O, meaning that patients could be mobilized while still requiring mechanical ventilation. From a cardiovascular perspective, patients had to be free of orthostatic hypotension and vasoactive drug infusions. Authors reported a necessary change in RICU culture, work habits and 'prolonged' (undisclosed duration) training prior to the study period. The positive findings were that 69% of participants were able to ambulate over 100 feet before ICU discharge and adverse events, specified a priori, were rare. However, the trial was uncontrolled, lacked clinician blinding to the intervention and lacked blinding of outcome assessments for safety and feasibility. Even though all patients were assessed to see if they met 'early activity' criteria within 24 hours of admission to the RICU, the intervention was not so 'early' since 94% of the patients were admitted to another ICU before being transferred to the RICU (mean time to RICU admission 10.5 +/- 9.9 days). The patients were also less severely ill (mean Acute Physiology and Chronic Health Evaluation (APACHE) II in RICU, 17+/-4.8) compared to their initial ICU admission (mean APACHE II 21+/-6.3). In a similar cohort of 104 patients admitted to an RICU (mean days in ICU prior to RICU admission 10.3 +/- 7.5 days), Thomsen et al. found that 88% of patients who were promptly mobilized, were able to walk over 200 feet before ICU discharge.[63] In this uncontrolled trial, each patient's pre-RICU transfer ambulation level was compared their post-RICU ambulation level. Authors conducted a multivariate logistic regression model to evaluate variables associated with increased ambulation. After adjustment using the bootstrap method, they found RICU transfer (OR 2.5, CI 1.9-3.4, $p<0.01$), absence of sedation (OR 1.9, CI 1.2-3.2, $p<0.01$), female sex (OR1.9, CI 1.1-3.2, $p=0.02$) and lower APACHE II (OR 1.1, CI 1.1-1.2, $p=0.02$) to be predictors of increased ambulation. These studies, though limited by lack of blinding and lack of comparator groups, demonstrated the feasibility and apparent safety of early mobilization in critically ill patients.

Morris et al. assessed in a prospective cohort of 330 patients with respiratory failure admitted to a medical ICU, whether an early mobility protocol initiated within 48 hours of ICU by a mobility team could increase the proportion of patients receiving physical therapy when compared to standard rehabilitation. Patients who had been admitted from another ICU for > 72 hours were excluded. The proactive mobility team (physical therapist, registered nurse and nursing

assistant), which was activated in response to automated orders for physiotherapy, increased the frequency of physical therapy by one-session more than usual rehabilitative measures (80% vs. 47%, p<0.001).[64] There was also a reduction in ICU length of stay (5.5 vs. 6.9 days, p = 0.025) and hospital length of stay (11.2 vs. 14.5, p<0.01) in patients who received protocolized mobilization. Methodological limitations to the study included the lack of randomization and blinding. Patients were allocated to intervention arms in groups in a non-random sequence based on bed availability. Furthermore a treatment bias was also possible since nurses, physiotherapists, respiratory therapists and physicians were aware of group assignments for the study patients. Nevertheless, this study suggested that the additional resources and costs of a mobility team could be offset by a reduction in the length of stay by patients.

In 1998, Nava pioneered a small prospective randomized study of 80 patients with chronic obstructive pulmonary disease to receive stepwise pulmonary rehabilitation (n=60) or standard medical therapy (n=20) in a RICU.[65] The intervention protocol consisted of 30 minutes, twice a day, of EM with a progression of activity from passive range of motion of the extremities to use of a treadmill even during mechanical ventilation. Although length of stay in the RICU and mortality were comparable between groups, patients mobilized early had greater mean 6 minute walk distances by ICU discharge than patients randomized to usual care (225+/-125 vs. 150+/-75 p<0.001). 52/60 (87%) of patients in the EM group regained independent ambulation and autonomy in daily living activities. Authors reported no deaths during rehabilitation sessions. The use of unequal allocation was an interesting feature of this study. Unequal allocation, if undertaken randomly as in this study, should still result in an equal distribution of confounder variables. Although the randomization system utilized computer-generated random number sequences, the baseline characteristics for each group were not reported. Furthermore, unequal allocation was not used as a measure to reduce costs or burden of a learning curve,[66] but rather because there was lack of equipoise by the research ethics board who felt that a 1:1 randomization scheme was not in keeping with the rehabilitative mission of the hospital. This prospective study provided further evidence of the safety and feasibility of early mobilization in the ICU.

Table 1.1 Prospective studies of Acute Rehabilitation in Respiratory ICUs

Study Design	Intervention	Main Outcomes	Limitations
Prospective cohort N = 103 (Bailey et al. *CCM* 2007; 35: 139-145.)	- EM protocol 24h after RICU admission -staff training	- 69% patients ambulate > 100" prior ICU discharge -adverse events rare	-lack blinding -uncontrolled -94% patients admitted from another ICU (mean 10.5 +/- 9.9 days) -less severely ill than
Prospective cohort N = 104 (Thomson et al. *CCM* 2008; 36: 1119-1124.)	- EM protocol 24h after RICU admission -staff training	-88% patients ambulate > 200" prior ICU discharge	-no blinding - uncontrolled
Prospective cohort N = 330 (Morris et al. *CCM* 2008; 36: 2238-2243)	- EM protocol 48h after ICU admission by a mobility team	-ICU length of stay (5.5 vs. 6.9 days, p = 0.025) -hospital length of stay (11.2 vs. 14.5, p<0.01)	-lack randomization -no blinding
Randomized study N = 80 (Nava, S. *APMR* 1998, 79: 849-852)	- step-wise pulmonary rehabilitation vs. standard medical therapy	-6MWD (225+/-125 vs. 150+/-75 p<0.001) -52/60 (87%) regained independent ambulation & ADLs	-baseline characteristics not reported

1.4 Randomized Trials of Acute Rehabilitation in the ICU

The most compelling evidence to support early mobilization (EM) in critically ill patients, at least in medical ICUs, was conducted by Schweickert et al. where 104 patients were randomized to either EM during periods of interrupted sedation versus interrupted sedation alone.[3] The study was performed in 2 university hospitals using a multidisciplinary approach. Patients were randomized to either EM or standard care as delivered by the primary care team. Neither site had dedicated physical therapists or routinely provided physical therapy for mechanically ventilated patients for less than 2 weeks. Unresponsive patients who were enrolled in the intervention arm were provided passive range of motion exercise in all limbs, sedation interruption and progressive activity as patient interaction improved. The therapy was delivered by a physical and occupational therapist who coordinated sedation interruptions with bedside nurses. The study standardized co-interventions among all patients with the use of protocols for weaning from mechanical ventilation, glycemic control, daily interruption of sedation and daily spontaneous breathing trials. There was appropriate blinding of outcome assessment of functional status at hospital discharge and validated functional scales of measurement were used. Patients in the intervention group began physiotherapy at a median of 1.5 days (1.0-2.1) after intubation compared to those in the control group who began physiotherapy at 7.4 days (6.0-10.9) after intubation (p<0.0001). EM was associated with significant improvement in composite independent neuromuscular function at hospital discharge in 29 (59%)

of patients compared to 19 (35%) of patients in the control group (OR 2.7, CI 1.2-6.1, p=0.02). There were fewer days of delirium (median 2.0 days, IQR 0.0-6.0 vs. 4.0 days, 2.0-8.0, p=0.02) and days on mechanical ventilation (23.5 days, 7.4-25.6 vs. 21.1 days, 0.0-23.8; p=0.05) in those who received therapy sooner in the 28-day follow-up period. The study methodology was overall excellent. Because of the nature of the intervention, blinding of bedside clinicians to group assignments was not possible and outcomes may have been confounded by biased clinician decisions (i.e. when to extubate, when to discharge from the ICU etc.). Prior to ICU admission, study participants had independent functional status and had lower severity of illness scores than non-participants (median APACHE 19.5, interquartile range (IQR) 14.5-23.5), therefore it is uncertain whether the benefits would be seen in patients with functional and/cognitive impairment or higher severity of illness.

Burtin et al. conducted a RCT of 90 critically ill patients admitted to medical and surgical ICUs to evaluate daily exercise sessions using a bedside cycle ergometer (BE) versus standard physiotherapy (SP).[67] Patients were randomized by use of sealed opaque envelopes in random block sizes with blinding of outcome assessors to allocation. Validated measures of functional status were used. Even though the length of ICU stay (BE 14d +/- 10 vs. SP 10+/-8), days of sedation (BE 11d [8.5-16] vs. SP 8d [3.4-13.5]) and cumulative dose of neuromuscular blocking agents (BE 150mg[100-300] vs. SP 75mg [50-100]) was greater in the treatment group, the primary outcome of 6 min walking distance (6MWD) at hospital discharge was higher in the treatment group compared to control group (196m[126-329] vs. 13m [37-226], p<0.05). Handgrip force was similar in both groups at hospital discharge (46 +/- 20% pred. vs. 47 +/-11% pred., p=0.83). Authors reported that the treatment group received more 20 minutes more of physiotherapy per day than the control group so it is unclear if benefits were related to increased duration of physiotherapy rather than use of bedside ergometer. The feasibility of this intervention to other ICUs remains a serious challenge as few patients ever reached target cardio-pulmonary goals due to patient's self reported exercise intolerance and high consumption of staff time to safely set-up, monitor, and assesses patients on the bedside cycle ergometer (median duration of BE session was 3-4 hours per patient). This randomized trial demonstrated improved functional status in patients who were able to tolerate daily exercise with a cycle ergometer.

Table 1.2 RCTs of Acute Rehabilitation in the ICU

Study - Population	Intervention	Comparison	Main Outcomes	Limitations
Schweickert et al. - Medical ICUs N = 104	EM during interrupted sedation	Standard acute rehabilitation	- *Independent neuromuscular function** at hospital discharge (29 vs. 19, OR 2.7, CI 1.2-6.1, p=0.02). - *Delirium* (median 2.0 days, IQR 0.0-6.0 vs. 4.0 days, 2.0-8.0, p=0.02) - *Mechanical ventilation duration* (23.5 days, 7.4-25.6 vs. 21.1 days, 0.0-23.8; p=0.05)	- Blinding not possible - Patients with previous functional impairment excluded - Medical ICU only
Burtin et al. - Medical & Surgical ICUs N = 90	Bedside cycle ergometer	Standard acute rehabilitation	- *6 min walking distance (6MWD)* at hospital discharge (196m[126-329] vs. 13m [37-226], p<0.05) - *Handgrip force* (46 +/- 20% pred. vs. 47 +/-11% pred., p=0.83)	- Blinding not possible - Feasibility of cycle ergometer limited by staff experience & patient tolerance

** Independent neuromuscular function = walking independently + ability to bath, dress, eat, groom, transfer from bed to chair & use a toilet*

1.5 Challenges to Acute Rehabilitation in the ICU

Although EM can reduce ICUAW in critically ill patients, the extent of delay in mobilizing patients varies across ICUs.[68,69] Numerous patient, health care provider and institutional level barriers – both actual and perceived - prevent EM in the ICU. According to clinicians, medical instability, cognitive impairment, obesity, endotracheal intubation, vascular devices, excessive sedation and inadequate analgesia are all important barriers to timely mobilization of critically ill patients.[44-48] The lack of portable equipment and health care personnel further limit recovery and are perceived in national surveys from India,[70] Europe,[44] Canada,[71,72] and the US[45] to impede the mobilization of suitable patients. 25% of European ICUs and 20% of ICUs in India do not have designated physiotherapists.[46] In addition, health care providers may have concerns about the safety of early mobilization and feel inadequately trained to ambulate mechanically ventilated patients.[48] These concerns are compounded by a paucity of guidelines about which patients should begin ICU rehabilitation, and when.[73,74] In a national survey of US hospitals, only 10% of all ICUs had established criteria for initiation of activity and fewer than 1% of all ICUs had automatic physiotherapy consultations.[45] Hospital administrators may perceive the intervention of early rehabilitation in the ICU to be costly.[51] However, the potential for decreased ICU and hospital length of stay from EM programs may lead to enhanced resource utilization and improved patient satisfaction, resulting in a net cost savings on a larger scale.[75]

1.6 Conclusions

Adult survivors of critical illness suffer from severe physical deconditioning, weight loss, profound weakness and functional impairment. Although prospective studies have revealed the incidence of ICUAW to be as high as 25-58%, the pathophysiology remains poorly understood. Acute rehabilitation initiated as soon as possible may minimize ICU acquired weakness in adult critically ill patients. Although, prospective studies support the safety and feasibility of acute rehabilitation in mechanically ventilated patients, international efforts reveal there are still many challenges to the provision of therapy. Understanding these challenges in the current Canadian context will be vital to establishing effective rehabilitation strategies.

The timing of initiation, types and intensity of rehabilitation is currently unknown in Canada. Barriers to mobility and knowledge of physical therapy in the ICU have also not been characterized. The proposed survey will evaluate the current knowledge, perspectives and practice of rehabilitation in the critically ill in academic centres across Canada. This study will provide a framework of understanding on which to build future research studies in a national research program and related educational initiatives.

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Chapter 2
The Design and Testing of a Survey of Acute Rehabilitation in Canadian Intensive Care Units

2.0 Development of a Rigorous Survey Instrument

Surveys can provide meaningful insight into the perspectives and experiences of a collective group of individuals. However, many factors can bias individuals' responses.[1] Some respondents select socially desirable responses to provide positive impressions called *faking good*[2] while extremists may select radical options to *deviate* or *fake bad*.[3] Disinterested participants may randomly select options to minimize survey completion time. Passionate participants may write many thoughts in free text spaces expecting all of the information to be captured, read, and analyzed. These examples of responder bias can result in inaccurate reflections and invalid survey results. Thus the goal in survey design, development, testing and administration is to construct a rigorous questionnaire to minimize responder bias as much as possible.[4]

2.1 Research Question

The main question of this survey was, "Among physicians and physiotherapists working in multidisciplinary, academic, Canadian intensive care units, what is the current knowledge of, perceived barriers to and stated practice of acute rehabilitation of critically ill adults?''

2.2 Sampling

2.2.1 Choosing the Sampling Frame

Sampling bias can be minimized when every person within a target population is surveyed. It is, however, impractical to survey all respondants in an entire population given limited resources and time. On the other hand, bias could be introduced into a study if an investigator samples by convenience alone. Investigators choose feasible sampling methods based on their research questions and select sampling methods to determine representative groups of individuals within the population called "the sampling frame". These individuals known as "the sampling element" can be either selected randomly or non-randomly.

Random sampling may be an effective way to capture a representative sample of the target population but requires a complete list of all individuals within the target population. Random sampling of a population can be conducted using *simple random sampling, systematic random sampling, stratified random sampling* or *cluster random sampling*. *Simple random sampling* occurs when all indivduals have an equal chance of selection by either a computer number generator or lottery system. *Systematic random sampling* involves selection of sampling elements at pre-specified intervals. *Stratified sampling* occurs when individuals are either randomly or systematically sampled within categories or

strata. *Cluster sampling* involves selecting individuals within mututally exclusive groups or clusters.

Non-random sampling of a population includes *purposive sampling, quota sampling, chunk sampling, and snowball sampling*. *Purposive sampling* surveys all individuals meeting a specific group criteria. *Quota sampling* is when individuals are indentified by desired personal qualities. *Chunk sampling* is based on availability or location in time. *Snowball sampling* involves the stepwise identification of a group of individuals meeting criteria who then in turn further identify others also meeting criteria.

The main objective of the current survey was to understand the knowledge, perpectives and stated practice of clinicians who *direct* physiotherapy practices in Canadian ICUs. The health care members who primarily meet this criteria include physiotherapists and physicians. Critical care nurses have also been identified by expert research consortia as important clinicians who influence acute rehabilitation as well. The survey of nursing knowledge, perspectives and practices on this subject is an important future study but beyond the scope of this component of my thesis.

Purposive sampling of all practicing physiotherapists and physicians in both non-university and university based hospitals in Canada was not feasible given the extremely large population, limited resources and difficulty in identifying all elements within the sampling frame. Consequently, *purposive sampling* of physiotherapists and physicians practising in university based hosptials were selected for the sampling frame. '*University based ICUs*' were defined as academic ICUs with Royal College of Physician and Surgeon of Canada (RCPSC) residency based training programs in critical care medicine. '*University affiliated ICUs'* were defined as ICUs without formal residency education programs. We excluded university affiliated ICUs because it would be difficult to identify all non-university based clinicians who practice in settings with variable roles in resident education and models of care including 'open' ICUs. Patients admitted to open ICUs are usually not cared for by a trained attending intensivist, but rather by specialists (surgeons, hospitalists, or internists) who become the most responsible physician. A majority of non-university based ICUs are comprised of community ICUs which, during the period of study, were in variable stages of transition from 'open to closed' ICU models. The implications of selection bias here would include a lack of perspectives from the non-university based clinicians who practice in community or university affiliated sites and therefore a possible lack of generalizability. We also considered *simple random sampling* from the university based clincians to reduce the administrative workload, however we considered that this method may exclude individuals with insightful experiences. Further, it would not be efficient since the entire list of individuals had to be identifed nonetheless prior to selection with any

randomization strategy. Another option was to limit the sampling frame to clinicians from a national research organization such as the Canadian Critical Care Trials Group (CCCTG) membership with the benefit of likely a high response rate and decreased workload. This *quota sampling* of only members within the CCCTG could lead to bias as there may be differences in knowledge and stated practice compared to non-CCCTG members who may have less interest and experience in research and quality improvement. Table 2.1 highlights the different sampling frames that were considered for the current survey in the context of positive and negative attributes including risk of bias.

Table 2.1 Possible Sampling Frames for the Mobility Survey

Sampling Frames	Benefits	Risk of Bias	Limitations
- all physcians and physiotherapists from non-university and university based hospitals	- most comprehensive sampling frame - able to contrast clinicians from non-university and university based practice - higher generalizability unless low response rate	- risk of lower response rates with non-university clinicians - difficult to identify non-university based clinicians	- most expensive and administratively challenging - many non-university ICUs are community ICUs in transition from 'open to closed' model
- all physcians and physiotherapists from university affiliated and university based hospitals	-comprehensive sampling frame of practice in all teaching hospitals	- exclusion of community practice - difficult to identify non-university based clinicians	- many non-university ICUs are community ICUs in transition from 'open to closed' model
- all physcians and physiotherapists from university based hospitals only	- comprehensive sampling frame of practice in closed ICUs -improved response rate	- exclusion of university affiliated and community ICUs	-results less generalizable
- all physcians and physiotherapists from a national research organization (i.e. CCCTG)	- higher response rate from respondents already engaged in active collaborative research	- limits to researchers or members of a specific group	-results less generalizable
- all physcians and physiotherapists from English speaking univeristy based hosptials	- no need to translate survey	- language bias	-results less generalizable

2.2.2 Identifying Individuals and Mailing Addresses within the Sampling Frame

We sought to identify current practicing critical care physicians from the directories of the Royal College of Physicians and Surgeons of Canada (RCPSC) and the CCCTG websites. We compiled initial listings of physicians from the RCPSC and CCCTG websites and quickly discovered that these lists were incomplete and inaccurate. We learned some members did not provide up to date information and that retired members sometimes remained on the website. With the assistance of a member (i.e. division chiefs, residency program directors or active member) within each university critical care division, we were able to compile accurate lists of all critical care physicians within each hospital. This step

was necessary to identify retired, deceased, newly recruited, or members who were no longer practicing in critical care. We then looked up their respective mailing addresses through respective provincial college of physicians and surgeons websites. We were unable to find the names of physiotherapists on most of the provincial physiotherapy association or hospital websites. We telephoned clinician educators or physiotherapists at each of the teaching hospitals to obtain names of practicing physiotherapists. We obtained the mailing address of physiotherapy department at the hospital from local clinicians. We learned that a comprehensive and accurate approach to identifying individuals within the sampling frame includes contact with a clinician who is currently in practice.

2.3 Item Generation

During the item generation phase, a comprehensive review for concepts and ideas should be conducted using a variety of search strategies. Systematic reviews of relevant published literature and focused interviews with content experts can help investigators navigate through voluminous medical information to construct important survey items (i.e. questions) that address key research domains. The process of item generation should continue until all subtopics within each domain have been addressed and no new items emerge. Items can be reviewed, rated and adjudicated by investigators until consensus has been reached.[1]

To generate items for the mobility survey, two investigators (KK, KC) independently searched the OVID versions of MEDLINE (1950 – April, week 1, 2010), EMBASE (1980 – 2010 Week 13) and CENTRAL (Cochrane Central Register of Controlled Trials, The Cochrane Library, Second quarter, 2010) for relevant published evidence (observational studies, randomized controlled trials, systematic reviews and meta-analyses) on mobilization practices in the ICU. The MEDLINE search strategy retrieved citations containing the MeSH subject headings *Early Ambulation* or the text words *early* or *immediate* in combination with *mobilization*/mobilization, *ambulation, exercises/exercise, rehabilitation,* or *physiotherapy,* We limited citations to the critical care patients using the terms: *intensive care, ICU, critical care, critically ill*. We modified these searches for other databases (Table 2.2).

In addition, we reviewed the allied health specific electronic bibliographic databases including The Physiotherapy Evidence Database (PEDro 1929 to April 2010 www.pedro.fhs.usyd.edu.au/), the Allied and Complementary Medicine Database (www.bl.uk/collections/health/amed.html, AMED 1985 to April 2010), CINAHL (www.cinahl.com/, 1982- April 2010), and REHABDATA (http://www.maric.com/research/rehab/ searched 1956 to April 2010). Additional abstracts from recent conference proceedings and new studies were obtained from content experts.

Thematic domains were identified into subtopics of knowledge, perspectives and practice. Subtopics within each thematic domain were listed in an excell spread sheet until no new items emerged. The items within the list of subtopics were presented and discussed with a panel of 26 content experts at the 3rd International Physical Medicine & Rehabiliation meeting (New Orleans, USA, May 2010) until no new constucts (ideas, concepts) emerged. The group of context experts were comprised of internationally reknowned physiotherapists, nurses, occupational therapists, physicians (intensivists), rehabilitation experts and scientists. The final 12 domains included in the survey were:

1. Personal view of early mobilization in the ICU
2. Barriers to early mobilization in the ICU
3. Criteria to initiate early mobilization in the ICU
4. Permissable level of activity according to diagnosis, device or drugs, or physiological criteria
5. Knowledge of ICUAW
6. Knowledge of clinical trials evaluating early mobilization in the ICU
7. Practical and technical skills
8. Assessment for the need of rehabiliation
9. Modes, intensity and frequency of rehabilitation
10. Staffing & workload of physical therapists in the ICU
11. Sedation according to patient level of activity
12. Rehabilitation following ICU discharge

Table 2.2 Literature Search for Item Generation

Database	Include Terms	Excluded Terms	Citations Found
MEDLINE	**MeSH**: *Early Ambulation* **Text words:** -(*early* or *immediate)* in combination with *(mobilization* or *mobilization* or *rehabilitation* or *ambulation* or *exercise/exercises or physiotherapy*)	**MeSH:** - the following terms are too broad, lack Specificity *Physiotherapy*, *Rehabilitation; Exercises; Walking; Ambulation; Exercise Therapy; Best Rest* **Text words:** Text words below are too broad/lack of Specificity/yield no additional trials identified not already captured by INCLUDED MeSH or terms -*mobilization/mobilization* (alone), *physiotherapy* (alone) - *exercise/exercises* (alone), (*prompt* or *timely* or *fast-tract* or *advanced* or *advance)* and *(mobilization* or *mobilization* or *rehabilitation* or *ambulation*) - *fast-track rehabilitation* (is used at times for surgical studies involving multimodal interventions that may or may not include early mobilization (early feeds, fluid optimization etc.) -*Bed rest* (alone)	62
EMBASE	**EMTREE terms**: *Mobilization* **Free text terms:** -(*early* or *immediate)* in combination with *(mobilization* or *mobilization* or *rehabilitation* or *ambulation* or *exercise/exercises or physiotherapy*)	**EMTREE terms**: *Bed Rest; Range of Motion; Walking; Sitting; Standing; Exercise; Physiotherapy; Physiotherapy Practice; Rehabilitation; Rehabilitation Care* *Rehabilitation Research; Rehabilitation Medicine; Geriatric Rehabilitation; Heart Rehabilitation; Pulmonary Rehabilitation; Immobilization* **Free text terms:** - *physiotherapy* (alone), *exercise/exercises* (alone) - *rehabilitation* (alone)	16
CENTRAL	**MeSH**: *Early Ambulation* **Text words:** -(*early* or *immediate)* in combination with *(mobilization* or *mobilization* or *rehabilitation* or	**MeSH**: - terms below are too broad/lack of Specificity *Movement; Motion; Exercise Therapy/mt [Methods]* *Physical Therapy Modalities; Rehabilitation; Walking* *Rest; Exercise; Bed Rest/ae [Adverse Events]*	4

	ambulation or *exercise/exercises or physiotherapy*)	**Text words:** - *mobilization/mobilization* (alone), *physiotherapy* (alone *exercise/exercises* (alone), *early or immediate mobility* (in combination)	
AMED	**MeSH**: *Mobilisation* *Early Ambulation* **Text words:** -(*early* or *immediate)* in combination with *(mobilization* or *mobilization* or *rehabilitation* or *ambulation* or *exercise/exercises or physiotherapy*) -*mobilization* (alone) -*mobilisation*(alone) -*ambulation*(alone)	**MeSH**: *Locomotion* *Rehabilitation* *Physiotherapy* *Range of Motion* **Text words:** -exercise/exercises (alone) -rehabilitation (alone) -physiotherapy (alone)	6
CINAHL	**MeSH**: *Early Ambulation* **Text words:** (early or immediate) with (ambulation or mobilization, or exercise$, or rehabilitation or physiotherapy)	**MeSH**: *Early Ambulation* **Text words:** *Mobilization, exercise, rehabilitation*	0
PEDro			1
REHAB-DATA			0

2.4 Item Reduction

Long surveys can be time consuming and have been shown to reduce response rates. The length of a survey can be optimized by limiting the number of questions. Most surveys can address objectives with 25 or fewer items. A focus group of respondents can help identify redundant, complex or time consuming questions.

We reduced potentially relavent questions with the assistance of 3 focus groups. The first group comprised of 10 clinical epidemiologists with formal training from the Health Research Methodology Programme of McMaster University co-chaired by Drs. Cook and Meade called the ACCADEMY research group (*Hamilton, ON,* June 3, 2010). The survey questions were reviewed in detail by each member, and relevant contructs and redundant questions were identified. The second focus group comprised of members attending the Canadian Critical Care Trials Group Spring meeting (*Georgetown, P.E.I.* June 15,

2010). This group consists of clinicians and scientists from across Canada with an interest in critical care research. The members reviewed paper copies listing the potentially relevant survey questions and were asked to indentify the most clinically important questions, highlight areas of redundancy, and provide any constructive feedback. The final focus group was comprised of 6 experienced clinicians (2 critical care nurses and 4 physicians). The large number of potentially relevant questions (70) were reduced to a feasible number (29) without excluding core domains or important constructs.

2.5 Survey Formatting

2.5.1 Wording

We reviewed survey questions and response options to ensure they were phrased clearly using short sentences and simple wording. We phrased the question stems in a neutral tone, without being overly positive or negative, to avoid influencing response option selection or inducing acquiesence response bias. We edited *compound* questions where more than one issue but only one answer was provided to eliminate confusion. Closed ended questions were followed by limited response options (rather than text boxes) to facilitate data analysis and ease of interpretation. When possible, we avoided misleading respondents to assign cauality. For example, we did not use the question, “What complications of early mobility have you observed?”

2.5.2 Order/Layout of survey items

The layout of survey questions requires careful planning. It is important to capture interest early and to persuade target respondents that the questionnaire will be brief and easy to complete, not to mention important and worthy of their time. The least challenging and most interesting survey items should be introduced first.

In one of the earlier versions of the survey, the first few questions related to barriers to mobilization. However, one content expert involved in item reduction remarked that a barrier is commonly perceived as negative and suggested the survey begin with a neutrally worded question. The question asking clinicians about their personal view of early mobility was neutral and relevant to clinicians and therefore placed as the first question in the survey. Knowledge questions were perceived to test skill and may discourage participation in those less familiar with the clinical topic so they were reduced in number and placed in the middle of the questionnaire. Researchers should be sensitive to the possibility that the ordering of questions can introduce bias. For instance in the present survey, the definition of *early mobilization* was provided and then various barriers to early mobilization were assessed. These questions were placed before questions regarding how soon mobilization should begin (i.e. when to initiate mobilization in the ICU generally speaking and also dependent on various scenarios.). This ordering was later reversed to prevent a respondent

from confusing their own perspective on how soon a patient should be mobilized with the pre-defined term of *early mobilization* used throughout the rest of the survey.

Testing the Survey Instrument

2.6 Pre-testing

The purpose of pretesting a questionnaire is to evaluate whether respondents understand survey items as intended by researchers. During this evaluation process, a group of individuals similar to the sampling frame reviews questions and response options in the survey. The reviewers also evaluate whether the phrasing and wording of survey items are appropriate for the education level of the respondents and the language in which the survey will be administered.

We conducted pre-testing of our survey during a focus group session with the ACCADEMY research group (*Hamilton, ON,* June 3, 2010) before item reduction was completed. The survey group included 6 critical care physicians, a physiotherapist, a pediatrian, a pharmacist and non-critical care physcian. During this step, reviewers identified any poorly worded or ambiguous terms. When a question was poorly worded, investigators would phrase the question in simple terms and reviewers provided constructive feedback on how to articulate such questions with clarity. The survey was revised with these considerations by three critical care clinicians (KC, MM, KK) prior to pilot testing.

2.7 Pilot testing

During pilot testing, the dynamics of the questionnaire are assessed in a semi-structured format. In this mobility survey, 10 health care professionals completed pilot testing. The group was comprised of critical care physicians, nurses, respiratory therapists and physiotherapists. Participants of the pilot test commented on the flow, salience, acceptability and administrative ease of the questionnaire. They were asked to identify any redundant, unusual, or confusing wording. They are also asked to record the time it took to complete the questionnaire.

2.8 Assessment of Survey Reliabity

2.8.1 Theory

Reliability is the consistency of a set of measurements or of a measuring instrument. The total reliability between respondents is the measurement error of the survey instrument and the systematic variation between participants of the survey. A survey instrument with 100% reliability would have a measurement error of zero. Reliability can be defined as the ratio of subject variability to total reliability.[2]

$$\text{Reliability} = \frac{\text{Subject Variabilty}}{\text{Subject Variability + Measurement Error}}$$

Since the variance (σ^2) is a statistical measurement of variability, a relability coefficient can be reported as the variance between subjects (σ^2_s) over the total variance in the measurements ($\sigma^2_s + \sigma^2_e$). The total variance in measurements is the sum of variance between subjects (σ^2_s) and the variance in measurement error (σ^2_e).

Reliability relates to the results obtained by a survey instrument and is not a property of the instrument itself. Reliability is dependent on the interaction among the instrument, the survey respondents and the situation. Therefore, just because a survey instrument has been shown to be highly reliable in one particular group of respondents (i.e. physicians) does not mean it will be equally reliabile in another group of different respondents (i.e. health administrators). Similarly, a survey instrument shown to be unreliable in one population (i.e. critical care patients) does not necessarily mean it will be unreliable in another (i.e. coronary care patients). Testing the reliabilty of a survey instrument may be impratical for different respondent groups or populations and clinical judgement can be used to guage whether they are similar enough.

Intra-rater reliabiliy or test-retest reliability evaluates the consistency of responses to a survey question by the same person at different time points. For example, intra-rater reliability can be assessed by administering the survey to 20 content experts on 2 occasions, 2 weeks apart. The intra-rater reliability can be affected by recall bias and changes to the surveyed topic over time. The *inter-rater reliability* evaluates the consistency of responses to survey questions between different respondents. The *internal consistency* assesess the correlation between different survey questions that address the same construct.

Different methods of examining agreement include the intraclass correlation coefficient (ICC), the pearson product-moment correlation, cohen's kappa and the Bland and Altman method.[2] Based on regression analysis, the pearson correlation measures the relationship between two variables by a straight line. The kappa coefficient determines the proportion of concordence of responses between agreement cells (yes/yes, no/no) in relation to the proportion of responses in these cells which would be expected by chance – other words, the chance-corrected agreement.

2.8.1 Intra-rater Reliability of the Survey

After administering the survey to 20 respondants on 2 separate occations, 2 weeks apart, we estimated intra-rater reliability using Cohen's kappa. We found most survey items had good agreement (Cohen's kappa > 0.4,

representing moderate to good agreement; Table 2.3). If a survey item had a kappa of less than 0.4, we rephrased the wording of the question and or response options.

We found clinicians had lower intra-rater reliability when they were asked to complete the long tables of scenario questions on permissible level of activity depending on diagnostic variables. The range of kappas for this long table was 0.12 to 0.86. We modified several features in this table including enlarging the font size to improve readability, reducing the number of diagnostic scenarios, and rephrasing terminology when necessary. We also found some respondents skipped over some diagnoses in the table. This may have been related to the small fonts in the table, a missed error or uncertainty of the respondent. We added an option of "not sure" to each possible survey item in the scenario tables.

One challenge with the reliability testing was the lack of commitment from respondents who would complete the first phase but not the second phase of the testing. To overcome this issue we invited more participants. In addition, we clarified the objectives and methods of the intra-rater reliabilty testing in email invitations and the cover letter.

Table 2.3 Intra-rater Reliability of Survey Items

Domain	Description	# Survey Items	% Mean Agreement	Kappa (Weighted Kappa)
Perception	Institutional barriers	9	91	0.70
	Provider barriers – Staffing	6	91	0.65
	Provider barriers – EM supported but not priority	6	86	0.57
	Provider barriers – EM priority but not supported	6	82	0.45
	Provider barriers – Poor communication handover	6	78	0.48
	Provider barriers – Poor communication general	6	94	0.83
	Provider barriers – Lack of coordination	6	80	0.53
	Provider barriers – Slow to recognize	6	85	0.58
	Provider barriers – Lack of decision making power	6	81	0.56
	Provider barriers – Conflicting perceptions	6	86	0.67
	Provider barriers – Safety concerns	6	83	0.56
	Provider barriers – Inadequate training	6	89	0.61
	Provider barriers – Other	1	100	1
	Patient barriers	12	93	0.63
	Level of activity by diagnosis, device or drug	28	51	0.30 (0.40)
	When to initiate mobilization	1	80	0.63
	Level of activity by physiological parameters	12	58	0.40 (0.53)
Knowledge	Incidence of ICU acquired weakness	1	45	0.27 (0.48)
	Familiarity with literature on EM	1	94	0.87
	Current understanding of evidence	6	86	0.66
Practice	Automatic PT consultation with admission	1	70	0.53
	First clinician to identify need for EM	1	79	0.53
	MD order required prior to PT assessment	1	90	0.78
	Written protocols	1	80	0.61
	Clinician champion for EM	1	85	0.77
	Champion that promotes	1	100	1
	Daily duration of mobilization	4	67	0.47
	Frequency of mobilization	4	75	0.68
	Participants of mobilization	7	92	0.74
	PT work hours	3	92	1
	PT techniques used	13	86	0.81
	Daily interruption of sedation	1	50	0.36 (0.58)
	Use of standardized sedation scales	1	60	0.51 (0.57)
	Routine referral for patients with ICUAW	1	70	0.49
	Follow-up of patient with ICUAW	1	72	0.64

2.9 Assessment of Survey Validity

The validity of a measurement tool is the degree to which the tool measures what it is supposed to (i.e. corresponding accurately to the true response). Surveys are important tools that are used to elict knowledge, perspectives and/or stated practice of participants. We evaluated the comprehensiveness, face validity and content validity of the mobility survey using a modified version of a previously validated survey tool (Figure 2.1).[4]

In this phase of survey testing, 12 content experts with clinical and/or research knowledge in the area of interest were identified. These content experts were asked to use the clinical sensibility tool to comment on the following areas: a) the extent to which survey questions were directed at important issues pertaining to mobization research in critically ill patients, b) if there were any important issues pertaining to mobilization research in critically ill patients that were omitted, c) the extent that the instructions for the questionnaire would be clear and easy to understand for potential respondents, d) the extent the response options provided were simple and easy to understand, e) to what extent questions were likely to elicit information pertaining to a clinician's experiences, beliefs and practices, f) any inappropriate or redundant responses, and g) how likely the survey would elicit a clinician's experiences, beliefs and practices. All content experts completed the survey. 10 content experts completed the clinical sensibility tool while 2 content experts prefered to provide free text comments instead (Table 2.4).

We found the survey was perceived as measuring what it was intended to measure and had excellent *face validity*. Content experts stated that the survey contained important issues, and very likely to elicit experiences, beliefs and practices pertaining to mobilization of ICU patients.

We also asked content experts to provide insight into the *content validity* of objective survey domains by reviewing the questionnaire in detail to see if all important apects of a topic were covered in the survey. Most content experts believed that we had high content validity (i.e. all aspects in the topic of interest were comprehensively covered and there are no items that are irrelavent). Some important issues content experts identified as omitted were the unique roles and perspectives of respiratory therapists and nurses to increase the credibility of the questionnaire, the assessment of facilitators of mobilization, the engagement of family members in mobilization, the impact of various spinal injuries on mobilization, and the impact of dose of vasoactive drugs on mobilization. We agreed that nurses and respiratory therapsits were also important individuals involved in the acute rehabilitation of ICU patients. To maximize feasbility, we decided to limit our sampling frame to physicians and physiotherapist in this quesionnaire and repeat the survey at a later date with these other groups.

The role of family members was also a very interesting suggestion and we decided to ask clinicians if family members were currently participating in mobilization practices in their local ICUs. We included both the assessment of cervical spine and lumbar spine injuries into the diagnostic inquiry of permissible

levels of acute rehabilitation. We also expanded the scenario questions on physiological parameters to ask about dose (i.e. minimal, moderate and high; single vs multiple) vasoactive drugs on mobility. We concluded that the comments by the content experts enriched our survey and increased the comprehensiveness, face validity and content validity of the mobilization survey.

We were unable to explore *construct validity* which evaluates how well a survey instrument correlates with a subjective state (i.e. anxiety) or hypothetical construct (i.e. sick role) that it was designed to measure.[2] This type of validity testing is more useful in psychological instruments and health measures that are created to elucidate a particular aspect of a construct when there is no existing measurement tool for the construct or when the existing instrument lacks (a) key aspect(s) of the contruct. It can be futher divided into convergent validity (which is the agreement among ratings of measures that are theoretically related) and divergent validity (which is the lack of agreement among items that are not theoretically related).[5]

We did not investigate *criterion validity* which is the correlation of a scale with an exisiting instrument or variable which is regarded by content experts as the 'gold standard'.[2] There was no previously validated survey with which to compare the current survey. Criterion testing can be used when a previously validated test is expensive, invasive, dangerous or time consuming. It evaluates how a respondent who scores on specific level on the new scale does compared to the exisiting test. Usually, both measures are taken on a group of respondents. The results can be gathered concurrently (*concurrent* criterion validation) or at separate points in time when the criterion measure is not available for some time (*predictive* criterion validation).

Table 2.4 Results of Clinical Sensibility Testing for the Mobility Survey

Question	Small Extent	Limited Extent	Fair Extent	Moderate Extent	Large Extent
To what extend does survey address important issues pertaining to mobization research in critically ill patients?				4/10 (40%)	6/10 (60%)
To what extent are the instructions for ICU physiotherapists and physicians clear and easy to understand?			1/10 (10%)	4/10 (40%)	5/10 (50%)
To what extent are the response options provided simple and easy to understand?		1/10 (10%)	1/10 (10%)	4/10 (40%)	4/10 (40%)
To what extent questions were likely to elicit information pertaining to a clinician's experiences, beliefs and practices?			2/10 (20%)	1/10 (10%)	7/10 (70%)
	Crucial Gaps	**Important Gaps**	**Minor Gaps**	**Minimal Gaps**	**Insignificant Gaps**
Any important issues pertaining to mobilization research in critically ill patients that were omitted?		1/10 (10%)	3/10 (30%)	4/10 (40%)	2/10 (20%)
	Very many	**Many**	**Some**	**A few**	**Hardly Any**
Any inappropriate or redundant responses?			1/10 (10%)	4/10 (40%)	5/10 (50%)

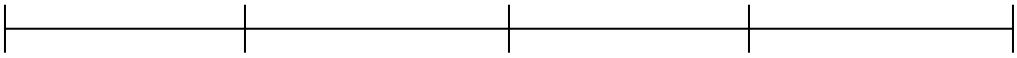
2.10 **Conclusion**

We developed and tested a rigorous questionnaire to minimize responder bias as much as possible. The strength of the design involved incorporating the views of many individuals from a diverse backgrounds. Critical care clinicians (i.e. nurses, physicians, physiothrapsists, respiratory therapists), neurologists, rehabilitation specialists and reknowned scientists (i.e. clinical epidemiology, basic and clincal scientists in critical care and critical care rehabiliation research) contributed to the survey development either by faciliating item generation, item reduction, pre-testing, pilot testing, intra-rater reliability testing or clinical sensibility testing. Although rigorous survey development is time consuming and requires multiple revisions, these necessary steps increase the comprehensiveness, reliability and validity of the instrument. Investigators must

select the most appropriate survey domains and items to include based on the objectives of the survey and the feasibility.

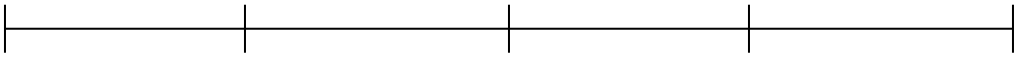
Figure 2.1 Clinical Sensibility Tool Used in the Mobility Survey

1. To what extent are the questions directed at important issues pertaining to Mobilization research in Critically ill patients?
(Please circle your response).



Small Extent	Limited Extent	Fair Extent	Moderate Extent	Large Extent

2. Are there important issues pertaining to Mobilization research in critically ill patients that should be included in the questionnaire which have been omitted?
(Please circle your response).

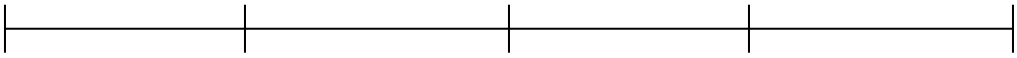


Crucial Gaps	Important Gaps	Minor Gaps	Minimal Gaps	Insignificant Gaps

Please identify any omissions:

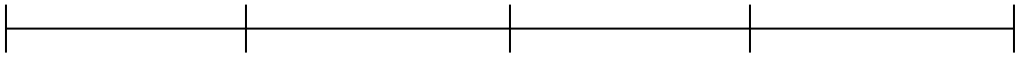
_____

3. To what extent are the instructions for ICU physiotherapists, physicians, and nurses, who will be completing the questionnaire, clear and easy to understand?
(Please circle your response).



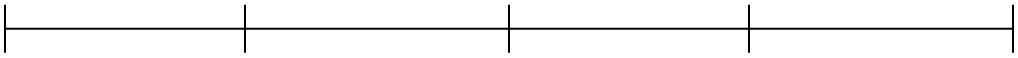
Small Extent	Limited Extent	Fair Extent	Moderate Extent	Large Extent

4. To what extent are the response options provided simple and easily understood?
(Please circle your response).



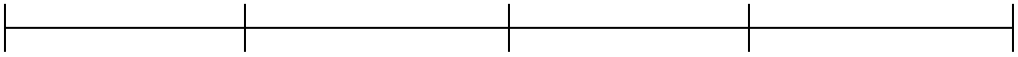
Small Extent	Limited Extent	Fair Extent	Moderate Extent	Large Extent

5. To what extent are questions likely to elicit information pertaining to your experiences, beliefs and practices with Mobilization research in critically ill patients?
(Please circle your response).



Small Extent	Limited Extent	Fair Extent	Moderate Extent	Large Extent

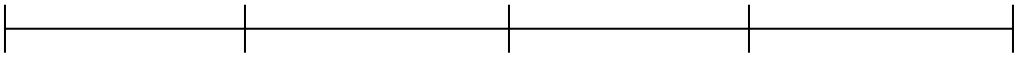
6. How many items are inappropriate or redundant?
(Please circle your response).



Very many	Many	Some	A few	Hardly any

Please identify redundant or inappropriate items:
_____

7. How likely is the questionnaire to elicit your experiences, beliefs and practices pertaining to Mobilization research in critically ill patients?
(Please circle your response).



Very unlikely	Unlikely	Likely	Quite Likely	Very Likely

[1] Streiner DL, Norman GR. (2008). Health Measurement Scales: a practical guide to their development and use. 4th Ed. Oxford: Oxford University Press.
[2] Edwards AL. (1957). The social desirability variable in personality assessment and research. New York: Dryden Press.
[3] Berg IA. (1967). The deviation hypothesis: A broad statement of its assumptions and postulates in response set in personality assessment. (pp. 146-190) Chicago: Aldine.
[4] Burns KEA, Duffett M, Kho ME, Meade MO, Adhikari NKJ, Sinuff T, Cook DJ. A guide for the design and conduct of self-administered surveys of clinicians. *CMAJ* 2008; 179: 245-252.

Chapter 3
Strategies Used in the Mobility Survey to Increase Response Rates

The ability of questionnaires to be valid and generalizable to target populations depends upon the degree of similarity between non-responders and responders. Unfortunately, most of the time, it is not possible to obtain demographic data from all individuals in the sampling frame. Low response rates cause concern for non-response bias and an increased likelihood that a non-responding individual will be systematically different from the target population of interest. In fact, studies have shown demographic and practice related differences between responders and non-responders and between early and late responders.[1,2,3,4]

To reduce the likelihood of non-response in surveys, investigators may employ both design and incentive based strategies to encourage participation.[5, 6] Many survey methodologists consider a response rate of 60% as 'good' and a rate of 70% 'very good' although such thresholds serve as guidelines only and would depend largely on the nature of the survey topic, survey methodology, and respondent population.[5,6] This chapter reviews the strategies used in the mobility survey to augment response rates.

3.1 Challenges to Survey Response

Low response rates among health care providers, particularly in physicians, have been reported in numerous published surveys.[7,8,9,10,11,12] In a systematic review of 321 postal surveys published in medical journals over a one year period, mean non-physician response rates was 68% compared to a 54% in physician surveys.[7] Low partipation has also been found in other health care professions such as nursing and physiotherapy.[13,14,15,16] Various reasons for reluctance in participation have been postulated though not formally evaluated. These include lack of time in an already overburdened schedule, perceived minimal importance of the study questions, uncertainty about the confidentiality of responses, administrative challenges, and poorly constructed survey designs.[17]

3.2 Literature Search

To maximize response rates in the planned survey, I searched the body of literature addressing methods to influence response rates to postal surveys of health care providers. Eligible studies included medical and non-medical surveys, randomized trials, systematic reviews and meta-analyses. Using MEDLINE and CENTRAL databases, I screened titles, abstracts and key words for relevant publications. The MEDLINE search strategy retrieved citations containing the text words *survey or questionnaire* in combination with *response rates, strategies, strategy, research, or methods*.

3.3 Strategies used in the Mobility Survey

We aimed to target a high response rate (> 70%) to reduce biases in response. We selected and employed evidence based methodology that has been shown in randomized controlled trials to improve response rates using the following criteria: (a) consistency across studies, (b) significance level, and (c) feasibility (e.g. cost, resources, time). (Table 3.1)

3.3 Nature of the Survey & Appearance

Physicians and physiotherapists are busy clinicians and time is a precious and limited commodity. During item reduction, we limited the number of survey items included from 70 to 29 questions without omitting relevant content. We informed potential participants of the average time to complete the survey based on pilot testing. Shorter surveys have been shown in meta-analyses to be associated with highter participation rates among respondents in postal surveys.[18] Even small differences in word count (less than 1000 vs. greater than 1000 words) have been shown to influence physician response rates in one study evaluating the response rates to surveys with 30 different lengths.[19] This study was limited by low response rates and non-respondent bias. The response rates ranged from 17% with survey that had greater than 1800 words to 60% with surveys of 849 words. The investigators did not adjust for many confounding factors in the study such as the nature of the survey topic, complexity, wording, administration method and respondent population.

We used closed-ended questions when possible to reduce the amount of missing information collected. Clinicians may find it easier to select a closed ended response option than handwrite personalized open ended responses. In one randomized study of over 1000 physicians comparing the impact of closed versus open ended question formats on the completeness and accuacy of demographic data in a mailed survey, there was a 22% lower proportion of respondents with no missing data in the closed versus opened ended groups ($p<0.001$).[20] Although the randomization method of this study was not reported, this was a large randomized study with a high response rate (80%).

We organized the mobility survey items to ensure that the most relevant items, least complex, and most neutral domains were ordered first. We considered the perception of early mobilization and the percetion of barriers to early mobilization were the most interesting and started the survey with these domains. We believe knowledge questions could be complex and perceived as difficult to respondents and ordered these in the middle of the survey. Mullner et al. found the ordering of more relevant questions was effective to increase response rates to a community based postal survey.[21] Other techniques that have been meta-anlyzed in one systematic review but not shown to be significant include the use of sensitive questions, placing more general questions first, and

placing demographic information first.[22] We did not use any of these latter techniques.

We strived for a legible survey and used a 12 point Arial font with appropriate spacing between survey items ensure questions and response options were clear to potential respondents.[23,24] Although serif fonts with horizontal caps and feet (i.e. times roman typeface) are traditionally perceived as easier to read in printed materials than sans serif (i.e. arial typeface), we used Arial font in the mobility survey for simplicity. Legibility research shows there is no diffence between the readability of the two typefaces.[25,26,27]

We printed the mobility survey on single sheets of standard white bond paper using black ink. Neither paper quality[28] nor ink color[23] have been shown to increase response rates in small randomized studies. However, we elected to print the cover letter in color to enhance the recognizability of the organizations that either supported and or funded the mobility survey. We added colored logos of the *Canadian Critical Care Trials Group*, the *University of Western Ontario*, *McMaster University* and *the Lawson Health Institute of Research* to the cover letter. University sponsorship has been shown to increase response rates to postal surveys[19]. We also printed the names of all co-investigators on the bottom of the survey although endorsments by well known or senior persons have had variable impact on return rates.[29,30]

Each cover letter was personalized with the name of the potential respondent and signed in black ink by the principle investigator. Personalization has been shown to augment response rates with the highest impact found in surveys with personalization and hand written signatues in one meta-anlaysis.[31] The RCTs included in this meta-analysis were not, however, completed in North America and were non health care studies. These results may not be generalizable to other countries or our survey. None of the RCTs reported method of allocation to intervention groups.

We printed the survey on single sheets held together by a single staple in the upper left hand corner for economical reasons. We preferred single sided printing because some participants in the pilot testing phases did not complete the last sheet when double sided printing was used. [32] This is most likely because participants were unaware there were more questions on the reverse side. Therefore, for the actual mobility survey, we numbered each page and printed only on single sides.

3.4 Administration Strategies

We conducted a self administered national postal survey among academic physicians and physiotherapists. We selected the postal route of survey administration because it has been associated with higher response rates than

web-based surveys.[33,34,35] These studies report delayed response times and higher costs with postal administration. These older studies may not be as applicable to current research settings since the internet and email are more widely used among health care workers. The response rates may also widely vary depending on the target sampling frame. We also administered the survey using a "modified" *Dillman* approach. The use of *Dillman's method* has been cited to guareentee high return rates (i.e 75-80% range).[36] In *Dillman's method*, each potential respondent in the sampling frame is mailed a survey in booklet form with a cover page, specified instruction page, a selection box allowing respondent names to be removed from the contact list, and a return envelope. The cover letter contains stated objectives of the survey, explains why the respondent's opinions are important, and is signed by hand in blue ink. Three mailings are sent in predefined time periods. The first mailing includes a survey and return envelope. One week after the initial mailing, a reminder postal card is sent. Follow-up mailings including surveys are sent only to non-respondents at 3 and 7 weeks using registered mailing.

We sent all potential participants a pre-notification letter 2 weeks prior to the first survey package mailing since such pre-notifications have been shown in a meta-analysis of 28 RCTs to improve response rates.[19] Tests for publication bias in these studies were significant in a funnel plot ($p<0.05$) suggesting an overestimation in the benefit of pre-contact in surveys, however we thought that this step could help inform us of ineligiable individuals (i.e. retired from critical care or identification of the wrong individual etc). The pre-notification informed individuals that they would receive a package that would contain an invitation to participate in a national survey on acute rehabilitation in the ICU and a small token of gratuity in the mail shortly. Eligibility criteria (i.e. a physician or physiotherapist who was currently practicing in a university based ICU) was stated in the letter and we asked any individual who did not meet this criterion to notify the priciple investigator via email as soon as possible. We sent an initial mailing of the survey which included a personalized cover letter, a survey, a monetary incentive ($5 Tim Horton's gift card), a self adressed and self-stamped return envelope. A reminder notice was sent 1 week after the mailing of this initial mailing package. Heads of hospital departments were also asked to encourage participation locally at their divisional meeting and through electronic reminders. We sent up to 2 additional mailings with cover letters, surveys, and self-stamped envelopes to non-responders 4 and 6 weeks after the initial mailing. The use of follow-up reminders and such reminders along with the questionnaire in follow-up have also been shown in randomized studies to improve response rates.[19] We also included self-stamped and self-addressed return envelopes to facilitate return to the administration office. We did not use registered mailing

3.5 *Use of Incentives*

We provided a monetary incentive (*$5 Tim Horton's gift card)* to each potential respondent as a small token of gratuity for clinicians to participate in the survey. In a meta-analysis of 49 randomized controlled trials, monetary incentives effectively enhanced response rates in postal questionnaires more than none.[19] Monetary incentives included cash or gift cards from $1 to $50, charitable donations, and opportunities to win lottery draws. Non-monetary incentives compared to none were also effective at improving response rates in postal surveys.[19]

3.6 *Conclusion*

High questionnaire return rates with completed surveys were sought to increase the precision of parameter estimates and reduce the risk of non-response bias. We used design and incentive based techniques that were drawn from this literature review. Most of the techniques including shorter survey length, use of closed ended questions, and ordering of questions helped streamline and increased the feasibility of the mobility survey. The main drawbacks of some of the techniques used included high costs and administrative workloads with uncertain benefit. We would unlikely use hand-written personalization or pre-contact letters in future national survey of such large magnitute. The administrative burden of a postal survey was also costly. The use of techniques highlighted in this chapter, however, may have improved the final survey response rate.

Table 3.1 Strategies Used in the Mobility Survey to Augment Response Rates

Techniques Used to Increase Response Rates in Surveys	Mobility Survey Yes = Technique used No = Technique not used	Justification	References & Limitations
Survey Appearance			
Shorter survey length	Yes	• Shorter surveys consistently demonstrated in RCTs to augment response rates • Shorter surveys reduces administrative costs (i.e. paper, photocopying, postage, staff hours)	• Edwards P et al. *BMJ* 2002; 324: 1183-91 → Randomization method and allocation concealment not reported in most RCTs included in this meta-analysis • Jepson C et al. *J Clin Epid* 2005; 58: 103-105. → Mixed methods of survey & observational study limited by low response rates/non-responder bias & lack of account of confounding variables
Use of closed ended questions	Yes	• Missing information may limit the ability to generalize survey results or make inferences about subgroups of interest	• Griffith LE, et al. *J Clin Epid* 1999; 52: 977-1005. Randomization method and allocation concealment not reported
Relevant questions appear sooner	Yes	• Stimulate interest to participate and provide highlight relevant issues immediately	• Mullen P et al. Public Health Reports 1982; 97:465-9 → small observational cohort, possible confounding however did attempt to evaluate multiple factors including survey length, order of questions, use of cover letter & a promise to share results of survey
General questions first	No	• General and demographic questions maybe less interesting to respondent	• Edwards P et al. Cochrane *Library Issue 2. Oxford: Update Software 2002.* → Randomization method and allocation concealment not reported in most RCTs included in this meta-analysis
Demographic questions first	No		
Inclusion of sensitive questions	No	• Aimed for neutral tone to reduce the possibility of social desirability bias	
Survey font	No	• 12 point Arial font (with exception of 10 point Arial font in some tables to conserve space)	• McColl E, et al. *Health Technol Assess* 2001; 5: 1-256 → no experimental evidence found in survey research
Ink color	No	• Regular black ink most economical option	• Edwards P et al. Cochrane *Library Issue 2. Oxford: Update Software 2002.* → Randomization method and allocation concealment not reported in most RCTs
Paper quality	No	• Office bond paper most economical option	• Clark TJ et al. *BMC Medical Research Methodology* 2001; 1: 12. → low response rates for high and low quality paper groups (22%, 29% respectively) limits generalizability & external validity; study randomization sequence and allocation concealment adequate
Single vs. double sided printing	No	• Single sided to reduce missed responses if someone forgets to flip the page	• Brehaut JC et al. *J Clin Epid* 2006; 59: 635-641. → Small observational study, lack of adjustment of confounding variables
Survey Administration			
Postal vs. electronic administration	Yes	• Postal surveys reported higher response rates but at higher costs and more slower response times than electronic surveys	• Jones R, Pitt N. *Occupational Medicine* 1999; 49: 556-558. → Large nested cohort study, methods not well reported • Raziano DB, et al. *The Gerontologist* 2001; 41: 799-804. → Small RCT, allocation concealment not reported • Leece P et al. *J Med Internet Res* 2004; 6: e30. → Adequate randomization, concealment, Intention to treat analysis
Multiple mailings/reminders vs. single mailing	Yes	• Helps remind interested clinicians to fill out survey	• Dillman DA. Mail and telephone surveys: the total design method. New York: John Wiley & Sons, 1978. → Although Dillman's original paper "guarantees" a high response rate, this varies in subsequent cited surveys
Pre-contact letter	Yes	• Increase awareness of the study • Help identify ineligible participants	• Edwards P et al. *BMJ* 2002; 324: 1183-91 → Randomization method and allocation concealment not reported in most RCTs included in this meta-analysis; publication bias likely (pre-contact letters)
Use of registered mail	No	• Too expensive	
Use of Stamped return envelopes	Yes	• Facilitate easy of return and reduce costs to participants	
Other Methods			
University sponsorship	Yes	• Required by Research Ethics Board and local funding agencies	• Edwards P et al. *BMJ* 2002; 324: 1183-91 → Randomization method and allocation concealment not reported in most RCTs included in this meta-analysis • Thomson MA et al. *Cochrane Database of Syst Rev* 2000; 2: CD000125. → Randomization method and allocation concealment not reported in most RCTs included in this meta-analysis
Personalization & Hand written signatures	Yes	• The names of potential respondents were written on each cover letter & the letter was hand signed by principle investigator	• Scott P et al. *BMC Health Services Research* 2006; 6: 1-4. → RCTs of different target population
Use of incentives	Yes	• Small token of gratuity for participants	• Edwards P et al. *BMJ* 2002; 324: 1183-91 → Randomization method and allocation concealment not reported in most RCTs

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Chapter 4
Statistical Considerations & Analytic Plan of the Mobility Survey

4.0 Sample size estimations for surveys

Determining the necessary sample size is important to ensure there is adequate precision to provide reliable answers to study questions that are asked. Sample sizes that are too small lack precision while ones that are too large provide little added benefit in exchange for valuable resources. The study objectives and design guide the sample size computations.

4.1 Approaches to Descriptive Survey Questions

The mobility questionnaire was primarily a descriptive survey that was designed to understand the knowledge, perspectives and stated practice of academic physicians and physiotherapists. We decided to sample all individuals in the population of interest to maximize precision and reported descriptive statistics as proportions (percentage) and either means (+/- SD) or mode, as appropriate.

Most of the survey items were designed to evaluate the proportion of clinicians who responded to a particular response option. An example of descriptive question that was included in the knowledge domain was "*what was the proportion of clinicians who selected the response option that best reflects the incidence of ICU acquired weakness in general medical and surgical ICUs in keeping with current evidence?"* An example of a descriptive question that included the barriers to early mobilization domain was, "*what was the proportion of clinicians who perceive excessive sedation as a barrier to mobilization in their ICU*?"

We reported mean values when the response options were numerical such as the mean number of hospital patients seen in a shift.

We used descriptive analysis to summarize what the most frequently selected permissible level of activity was for each of the various diagnostic and physiological conditions. Because the response options were categorical variables (i.e. bed rest, passive range of motion, active range of motion, sitting/dangle, standing, transfers to a chair, ambulation), we used the mode (i.e. the most frequently selected category) to summarize our findings.

We calculated both the preliminary and final response rates. The preliminary response rate equalled the total number of returned surveys divided by the total number of surveys sent. The final response rate equals the total number of returned surveys divided by the true sampling frame. The true sampling frame is the total number of surveys sent minus excluded counts. The counts excluded were duplicate administrative errors and clinicians who were no longer practicing in critical care medicine, clinicians no longer practicing at an affiliated university hospital or clinicians who were deceased or retired from practice.

4.2 Approaches to Analytical Survey Questions

While the purpose of descriptive surveys is to determine *what* the attributes of a population are, analytical designs seek to explain *why* there are observed outcomes in some situations but not in others. The main purpose of an analytic design is to evaluate if there is a statistical association between variables or if there are significant differences between groups being compared to on a particular attribute of interest. We used the *chi-squared statistic* to compare proportions.

We hypothesized that the proportion of respondent physiotherapists who selected the correct incidence of ICU acquired weakness in general medical and surgical ICUs would be statistically different from the proportion of respondent physicians who selected the correct response.

The null hypothesis was there was no significant difference between the expected and observed result. The *chi-square* is the sum of the squared differences between observed and the expected data, divided by the expected data in all possible categories. The degrees of freedom is the number of categories minus 1. The *p value* is the probability that the deviation of the observed from that expected is due to chance alone.

The statistical bases for these assumptions involve a *null hypothesis* (Ho) and an *alternative hypothesis* (Ha). The null hypothesis states there is no statistically significant association between variables or differences between groups of interest. The alternative hypothesis states there is a statistically significant association between variables or differences between groups of interest. When the p value calculated for chi-squared is > 0.05, we can accept the null hypothesis. When the p value calculated for chi-squared is $p < 0.05$, we can reject the null hypothesis.

A type I error is falsely rejecting the null hypothesis when the hypothesis is actually true. Type I error is set by the level of significance (α) and is reflected in the confidence interval ($1- \alpha$). A type II error is falsely accepting the null hypothesis when the hypothesis is actually false. The lower the likelihood of a type II error (β), the greater the power ($1- \beta$) of the test. Larger samples are more reliable because there is less random sampling variation than smaller samples. Consequently, as the sample sizes increase, the probability of type I and type II errors decreases.

Survey investigators may wish to test if there is a statistical difference in response options between the proportions of individuals in one group compared to another (i.e. the proportion of physicians versus the proportion of physiotherapists who perceived they are familiar with current clinical trials in early mobilization). The null hypothesis would be the estimated proportion of

physicians (P_1) minus the estimated proportion of physiotherapists (P_2) who perceived they are familiar current literature in early mobilization equals zero (i.e. Ho: $P_1 - P_2 = 0$). The alternative hypothesis would be Ha: $P_1 - P_2 \neq 0$). The equation to calculate the required sample size to conduct this analysis is[1]:

$$n = \frac{\left[z_{1-\alpha/2} \sqrt{2\bar{P}(1-\bar{P})} + z_{1-\beta} \sqrt{P_1(1-P_1) + P_2(1-P_2)} \right]^2}{(P_1 - P_2)^2}$$

Where $\bar{P}$ = average proportion = $(P_1 + P_2)/2$; P_1 = estimated proportion$_1$ (larger); P_2 = estimated proportion$_2$ (smaller); σ = estimated standard deviation; z = standard errors associated with confidence intervals. Assuming a power of 80%, a level of significance of 0.05, $P_1 = 0.7$, $P_2 = 0.5$, 93 cases would be required in each group.

Alternatively, survey investigators may wish to determine if there is a statistical difference in the mean number of years of clinical experience in physicians versus physiotherapists. The null hypothesis would be there is no statistical difference in the estimated mean years of physicians compared to the estimated mean years of physiotherapists (i.e. Ho: $\mu_1 = \mu_2$). The alternative hypothesis would be Ha: $\mu_1 \neq \mu_2$). The equation to calculate the required sample size to conduct this analysis is[1]:

$$n = \frac{2\sigma^2 [z_{1-\alpha/2} + z_{1-\beta}]^2}{(\mu_1 - \mu_2)^2}$$

Where μ_1 = estimated mean$_1$ (larger); μ_2 = estimated mean$_2$ (smaller); σ = estimated standard deviation; z = standard errors associated with confidence intervals.

4.3 Analytical Designs using Multivariate Regression Models

Regression analysis is a statistical method used to describe and quantify the relationship between an outcome of interest and one or more other variables.[2] *Linear regressions* assume that a linear relationship exists between the dependent and independent variables. The outcome of interest must be a continuous variable. *Simple linear regressions* evaluate if a single "predictor" variable is associated with a continuous outcome variable while *multiple linear*

regressions evaluate whether two or more variables are associated with a continuous outcome. In contrast, the outcome variable for logistic regressions must be categorical and is usually *dichotomous*. If the outcome for a logistic regression is not dichotomous, the regression is a *polychotomous*. The purpose of a *multiple logistic regression* is to evaluate if two or more 'predictor' variables are associated with the outcome variable and the measure of association is reported as an *odds ratio*. The predictor variables in logistic regression do not need to be linearly related, normally distributed or have equal variance since the relationship between the predictor and outcome variable is not presumed to be linear. The magnitude of the odds ratios specifies the variables of greatest importance while confidence intervals indicate their statistical significance.

Four separate multivariate logistic regression analyses were performed to evaluate: (1) factors associated with clinician's knowledge of ICU-acquired weakness, (2) factors associated with clinicians who felt well trained and well informed to mobilize mechanically ventilated patients, (3) factors associated with clinician's perception that early mobilization is very important or critical, and (4) factors associated with clinician's perception that early mobilization is critical. For each regression analyses, the dependent variable was dichotomized. The independent variables were entered into a multivariable regression model to determine the association with the dependent variable. Variables were simultaneously entered into the model. The independent factors included the discipline of the clinician (i.e. physician or physiotherapist), the years of clinical experience i.e. less than 5 years, 5 to 20 years or greater than 20 years), the type of ICU (i.e. cardiovascular surgery, medical-surgical, mixed or specialty based), the presence of an early mobility champion within the ICU as reported by respondents, the number of beds in the ICU (i.e. less than 15 beds, 15 to 20 beds, and greater than 20 beds), and the corresponding region in Canada (i.e. Eastern, Central, Prairies and Western). The nominal level of statistical significance was set at $p < 0.05$.

We did not test for collinearity of variables. The independent variables selected for the regression analysis were drawn from different domains and we did not anticipate any collinearity. Multicollinearity does not decrease the predictive power or reliability of the model as a whole but could reduce the validity of any individual predictor variable or about which predictor variables are redundant with respect to each other.[3]

However if we suspected two variables to be from similar domains (i.e. the use of dialysis and the presence of renal failure), we could use a *correlation coefficient analysis* to access for multicollinearity. When the correlation between two variables exceeds 0.75, one variable may be removed from the analysis. By evaluating for potentially correlated independent variables, we could avoid data

redundancy, which in turn, may lead to over-fitting of the regression model and large standard errors in the related independent variables.

The referent terms for independent categorical variables were selected by using: (a) the highest or lowest ordinal variables (i.e. most years of experience greater than 20 years in clinical practice, large ICU size with more than 20 beds, (b) well-defined categories rather than 'other' (i.e. medical-surgical for type of ICU), or (c) the category with the largest sample size (i.e. physician for discipline, central for region, and the presence of mobility champion).

Peduzzi et al. recommend that there must be at least 10 dependent events per independent variables entered into a linear or logistic regression.[4] The notion that a minimum of 10 events per predictor variable (EPV) for logistical models is based on simulation studies with fixed sample sizes, a constant number of predictor variables and different number of events.[5,6] In these studies, investigators noted increasing bias, unreliable confidence interval coverage, and problems with model convergence as EPV fell below 10.

We adopted a conservative approach to ensure there were (a) 15 dependent events per dichotomous variable, (b) 10 dependent events per continuous variable and (c) 10 dependent events per strata of a categorical variable.[4] The total minimum EPV would be the sum of required events based on each additional independent variable. For example, in one multi-variable logistic regression analysis with 6 independent factors (i.e. 2 dichotomous variables and 4 categorical variables with 3 strata each), we calculated the minimum EPV for the regression was 150 dependent events.

4.4 Missing data

4.4.1 Nature & Types of Missing data

Data from a survey can be missing for a variety of reasons.[7] It is important to understand *why* it is missing and if there is any systematic reason for the incomplete information. Data can be missing completely at random (MCAR) where the probability that an observation is missing is unrelated to the value of that observation or to any other variables. This could occur as a result of respondent oversight or data entry errors. The implication of MCAR data is a loss of power to answer the study question but the estimated parameters and analysis are not biased by the lack of this type of data. When data are missing at random (MAR), the probability of an observation missing is unrelated to the value of the observation only *after* controlling for another variable. Data can also be missing not at random (MNAR). Examples of this would include non-response to highly sensitive questions, to poorly worded questions that are not clear to the respondent, or when there is no suitable option response for a participant to select. This can also occur when the questionnaire is excessively long and the respondent ends the survey prematurely leaving one or several questions

unanswered.

4.4.2 Methods to Address Missing Data

Although there are several ways to handle missing data, any method of estimating missing values likely leads to new potential sources of error. At times, when only a small amount of data is missing, a conservative approach would be to explicitly acknowledge the amount of missing data and analyze the data that is available. The definition of "small" is subjective but less than 5% of the values for any given variable is generally accepted.[8]

Partial deletion is one technique to handle missing data. It involves removing missing data variables until no missing values remain. In ***listwise deletion*** *or* ***casewise data deletion****,* cases are eliminated if they are missing data on any of the variables. It is the simplest approach, but can result in the loss of a large number of subjects. In one study, when 2% of the data were missing at random, over 18% of the subjects were removed; when 10% of the data were missing, almost 60% of the subjects were eliminated.[9] In ***pairwise deletion*** of data, subjects are removed from the analysis only for those variables where no data is available. This method makes the maximum use of existing data and makes no assumptions about why the data is missing. However, correlations between variables would then be based on different groups of subjects and it would be very challenging to compare such correlations in a meaningful way.

The second method to handle missing data is by ***imputing*** what it should be. Techniques include ***deduction***, ***replacing with the mean***, using ***multiple regressions***, and using ***multiple imputations***. Simple *deduction* of a missing data value can sometimes be possible. For instance, a patient's age entered as "6.3" is likely to be 63 from a data entry error. Replacing the missing data value with the calculated mean of known values captured for a variable is another strategy. Here, the imputed value doesn't change the overall mean of the variable but does reduce the variance. If the amount of missing data for a variable is less than 5%, the effect on variance is likely insignificant. However, once the amount of missing data replaced by the mean surpasses 5-10%, the actual variance is greatly under-estimated.[6]

Imputation of the missing value by *multiple regressions* involves using other variables as predictors. The underlying basis of this imputation is the assumption that is it possible to predict the missing value from other existing variables. The ability of the estimate this value depends on R^2 and if the predictive ability of the equation is low (i.e. R^2 is low), then the estimate can be very poor. Multiple regressions tend to involve *casewise deletions* when there are several variables with missing data. In this situation, much of the data can be removed leaving the regression based on a few cases.

The generation of missing values based on existing data, termed *multiple imputations*, is another strategy to handle missing data. *Multiple imputations* involves imputing the missing values several times using various estimates on what's missing based on the existing data. *Partial imputation* or *expectation-maximization algorithm* evaluate patterns in the missing data and imputes into the data set rather than the individual missing data.

Regardless of the method used to handle missing data, the ultimate goal is to select a data analysis method that is robust to missingness - that has mild to moderate violations of the technique's key assumptions and will have as minimal bias as possible.

4.4.3 Missing Data in the Mobility Survey

Most (28/29) of the survey items in the questionnaire had categorical response options. We reported the frequency and proportion (%) of missing data per item. When there was more than 10% of the data missing, we explored the dataset for the particular survey item to consider reasons for why it was missing. For each survey item, we reported the range of per item missing in tables using superscript or footnote per item (e.g., 3 people did not report years of experience).

For the logistic regression, we specified that if there were less than 5% missing data per variable, we would assume data to be missing at random. For the regression analysis, when data from a respondent survey was missing for a specific question, this respondent was excluded from the analysis of the *specific* regression (i.e. we excluded the patients for questions in which data was missing).

4.5 Conclusion

We reported the descriptive statistics of survey respondents as proportions, means or mode as an estimate of the true attributes of the target population. Although a purely descriptive approach can simplify the statistical analysis and provide useful measures of central tendency and dispersion, analytical designs are necessary to determine if there are statistical associations between variables or if there are significant differences between groups being compared on a particular attribute of interest. We used the *chi-squared statistic* to compare proportions and used regression models to test for association.

One particular challenge was that we did not anticipate to test for association between variables during the initial design of the survey questions. Because we generated hypotheses about relationships between specific independent variables and dictomous outcomes after survey administration, we were only able to include factors that were present in the survey database. We were also limited by the number of independent factors that could be included in the regression models given the sample size of the survey participants. Tests of

association should be anticipated early in survey design and respective a prori hyotheses would help investigators select the most relevant and important predictor variables.

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Chapter 5
Challenges in Survey Administration

5.0 Administrative Methods

Questionnaires can be self administered or conducted by research personnel. A recent systematic review demonstrated a significant decrease in the use of self-administered postal surveys over time.[1] With the expansion of email communication over the years, electronically administered surveys have become more widely used. Depending on the targeted sampling frame and available research infrastructure (i.e. time and money), other methods of survey administration including face to face and telephone surveys may be preferred. This chapter explores the methods and challenges of survey administration including those used in the mobility survey.

5.1 Self-administered Questionnaires

5.1.1 Postal Surveys

Mailed questionnaires are a cost effective method of administering a large number of surveys to individuals in a sampling frame. We used this method of survey administration in conjunction with evidence-based strategies to encourage participation.[2]

Nonetheless, we experienced several drawbacks to this method. The first challenge was obtaining reliable addresses of all individuals in the sampling frame. Originally, we assumed physician and physiotherapist registries and hospital websites would contain up to date mailing addresses. However, a quick search of individuals in the principle investigators local group revealed that national registries of physicians (i.e. Royal College of Physicians and Surgeons of Canada) often did not accurately reflect current practice location. The comprehensiveness of provincial registries for physiotherapists varied considerably. Most physiotherapists were not listed, nor were their active practice locations. Hospital websites also lacked up to date information. To verify the mailing addresses of all individuals in the sampling frame, we telephoned a local contact, usually an ICU physiotherapist or manager, at each academic hospital to obtain a departmental mailing address. Physician mailing addresses were obtained through provincial college of physician and surgeon websites. When the office address was not listed, we telephoned the administrative offices of the physicians to obtain the current practice location. We underestimated the time and effort required to obtain accurate mailing lists reflective of the current practice locations of survey participants. Although this was a challenging task, it was an important task. Another drawback to mailed surveys is the need for multiple mailings to increase response rates. We mailed up to 3 reminders (including full copies of the survey) to non-responders. The cost and time to print and assemble surveys would not be required in electronic surveys. Once surveys are mailed, it is not possible to know if an individual actually receives the survey or not. We

also noted additional challenges with incomplete surveys, delays in survey return and lost surveys. In addition, it was very difficult to obtain any demographic information on non-responders. As a result, comparisons between responders and non-responders were not possible in the mobility survey.

5.1.2 Internet-based Surveys

In recent years, web-based surveys have become very popular. The main cost of this option includes the creation and maintenance of an electronic domain that must be designed, programmed, and secured properly. Once the site is completed, investigators can email invitations to all individuals in the sampling frame simultaneously. This is an environmentally friendly option that reduces paper waste and allows researchers to send reminders to non-responders quickly. Programmers can create prompts that remind individuals to complete all questions before moving onto another section and add program features that guide responders to answer questions correctly (i.e. to select one response when only one is required). Information can be directly entered by respondents rather than by research assistants. This eliminates the possibility of transmission errors. It is also a cost effective method for national or international studies when there are many individuals in the sampling. Surveys can be sent out simultaneously and completed surveys are returned instantly.

We did not select this method of survey administration because of the theoretical challenges to the internet-based questionnaires. Like self-administered postal surveys, there is no way of telling if individuals within the sampling frame have received the survey invitations. Individuals often have multiple email addresses and leave emails unopened, emails may get flagged as trash or individuals may not even read the invitation before deleting the email if they do receive it in their inbox. We were particularly concerned about these possibilities as there was no reliable method to obtain up to date email addresses from all individuals in the sampling frame. There is limited research comparing email to postal surveys however it appears that response rates are generally lower in web-based surveys and have higher non-responder bias.[3,4,5,6] Individuals also have higher tendency to perceive that their responses are linked to answers with reduced anonymity compared to postal surveys. Some research has found that respondents more frequently answer with “I prefer not to answer”[7,8] and give more socially acceptable responses[9] than in paper surveys. Another drawback is that this method of administration assumes all individuals have access to computers. Although this is likely true for the participants in the mobility survey, electronically administration may be less desirable to use in groups of individuals who are less likely to use the internet (i.e. seniors, disabled persons, lower social economic status)

5.2 Surveys administered by research personnel

5.2.1 Face-to-face Interviews

When the sampling frame is limited to a few individuals and trained research assistants are available, face-to-face interviews can be very effective. Contrary to self-administered methods, interviews allow for direct confirmation that an individual within a sampling frame has received a survey invitation. A well trained and motivated research assistant can encourage participation in a survey by articulating the objectives, rational and importance in a clear and convincing manner. Such individuals increase compliance by putting participants at ease and can quickly clarify any confusing wording or note if there are issues with language, concentration, or comprehension. Interviewers have an added flexibility and can gather more open-ended questions if desired.

We did not use face-to-face interview to administer the mobility survey because this method is too difficult to conduct nationally in many locations. Each interview is time consuming and expensive. Administrators must be trained so that they ask questions in a standardized manner and handle unusual circumstances in a consistent fashion. Additional expenses may include time required to coordinate meetings (i.e. especially for longer interview sessions) or organize for appropriate translators when necessary. The interaction between the interviewer and the respondents can also lead to social desirability bias. The effect of an interviewer's age,[10,11] sex[10,12,13] and race[14] can also affect participant's responses. An interviewer may also unknowingly sway responses by communicating subtly answers they want to hear.[15] Although, the latter may be reduced with training.[12]

5.2.2 Telephone Interviews

Telephone interviews are less expensive than face-to-face interviewers. They have similar benefits including the ability to confirm receipt of a survey invitation, the ability to be able to provide explicit information and the ability to trouble-shoot around any immediate language or comprehension difficulties.

However, telephone interviews systematically under-represent those individuals who do not have or routinely use telephones. Historically, individuals with lower social economic status would be under-represented in such surveys. In the US, the proportion of the general population who own home telephones increased from 80% in 1963 to over 95% in 2000.[16] Among young, single adults who rent their accommodations, home phone use has diminished while cell phones have become more popular.[17] The high cell phone charges may dissuade participation in surveys and may introduce bias in this group of users. Another disadvantage of telephone interviewers is that it is more difficult to conduct longer or more complicated surveys over the phone than in person when the response options maybe handed to a participant to see.

5.3 Conclusion

Postal and electronic surveys remain the most popular methods to administer national and international surveys. We chose the postal method for the national mobility survey because we assumed it would be easier to obtain accurate mailing addresses and predicted that response rates would be higher than electronic surveys. However, we learned that significant time and money is required to conduct such surveys.

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Chapter 6
Ethical Considerations in the Mobility Survey

6.0 Core Principles of Research Ethics

The fundamental core principles in medical ethics are described in the Belmont Report by the National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research[1] and the Tri-Council Policy Statement,[2] and involve *patient autonomy*, *beneficence* and *justice*. We sought a balance between finding data to answer questions while protecting the rights of the participants. We valued the autonomy of participants, took precautions to prevent harm and aimed to prevent injustice.[3]

6.1 Principle of Autonomy

This principle of *autonomy* considers what the participant wants. As researchers, we had a duty to obtain *free and informed consent* either by a cover letter or verbally by an administrator. In a cover letter delivered along with the survey, clear and comprehensive information was provided to inform potential participants a) that they were being invited to participate in a research study about acute rehabilitation in Canadian ICUs, b) about the study objectives, rational and importance of the survey, and c) that they were being invited to complete a self administered survey so that we could better understand their knowledge, perceptions and practice of acute rehabilitation.

We stated in the cover letter that participation in the survey was *voluntary*. Potential participants have the *freedom to not participate in* or to *withdraw from* the study. They may be told that if they decline to participate, their refusal has no consequences. Participants may refuse to continue in the study at any point without penalty. Sometimes individuals may feel pressured to participate because they fear if they do not they will receive inferior care or treatment. Sometimes individuals may want to participate to express gratitude for the care they have received from clinicians. Under these circumstances, coercion can be minimized when consent is obtained by a research assistant who is not part of the potential participants care. Although not required by the University of Western Ontario Research Ethics Board (REB) when the mobility survey protocol was approved, some REBs may also mandate information documents to clearly state that the decision to participate or not will not affect the person's medical care (for patients), evaluation (for trainees), or job (for clinicians).

We also informed participant that their *confidentiality* was protected and maintained during the research study. The privacy of Canadians is protected under the *Canadian Charter of Rights and Freedoms* and provision s.8 stipulates that, "everyone has the right to be secure against unreasonable search or seizure."[4] Canadian Privacy Legislation also protects the collection, use, disclosure, and retention of personal information through the *Privacy Act*[5] for

federal government institutions and the *Personal Information Protection and Electronics Documentation Act*[6] for private organizations. Information collected from survey respondents were kept confidential and reported as group summaries only. It was implied, though not explicitly stated, that their decision to participate (or not) would remain confidential and will not be disclosed to anyone else (including their employers, supervisors or any authorities). All information provided to the research team was kept in a secure and locked area with restricted access only to research personal involved in conducting or analyzing the study. The surveys did not contain any *personal identifying information* and were labeled with a unique code to facilitate administration of the survey. Personal identifying information stored in the database was kept in a separate location from the unique codes. The unique coding was kept in a separate and secure location as well. Information that was provided to the study team was be analyzed and published in summaries only. No specific individual information will be shared publically.

It is the duty of our research team to ensure that participants understood their rights and that consent was obtained freely and without coercion. We respected the autonomous choice of participants.

6.2 Principle of Beneficence

Participants in research should understand their various options and the burdens and benefits of each alternative. We disclosed that the main benefit would be that information obtained would constitute a foundation to help further educational and research initiatives around the rehabilitation and recovery of critically ill patients. There were no risks to participation in the survey and the main cost was the participant's time. Based on pilot work of the survey, we disclosed that it would take approximately 15 minutes to complete the survey. Participation in the survey was therefore associated with favorable benefits and no risk. It was not possible to know if participants fully understood the risk and benefits of the research for themselves, as the survey was self-administered. However, pilot testing did not suggest any concerns related to this. We included a gift card incentive as a token of thanks to compensate participants for time taken to participate in the study.

6.3 Principle of Justice

The principle of justice reflects on what is fair to the participants and society. Will there be any burden to participate in the research? Researchers cannot exploit vulnerable individuals (e.g. incarcerated persons, children) or exclude same without sound reason (including logistic or financial barriers) if these are eligible participants who may benefit from the study.

To avoid disadvantaging French-speaking persons by precluding their participation or impairing their full understanding the survey questions, we translated the mobility survey into French and administered the survey in this

language to potential participants in Quebec. This also ensured the inclusion of opinions and perspectives of French speaking individuals.

6.4 Research questions, design and reporting

We obtained institutional REB (i.e. the University of Western Ontario REB and the Lawson Health Institute of Research REB) before we designed, tested and conducted the survey research.

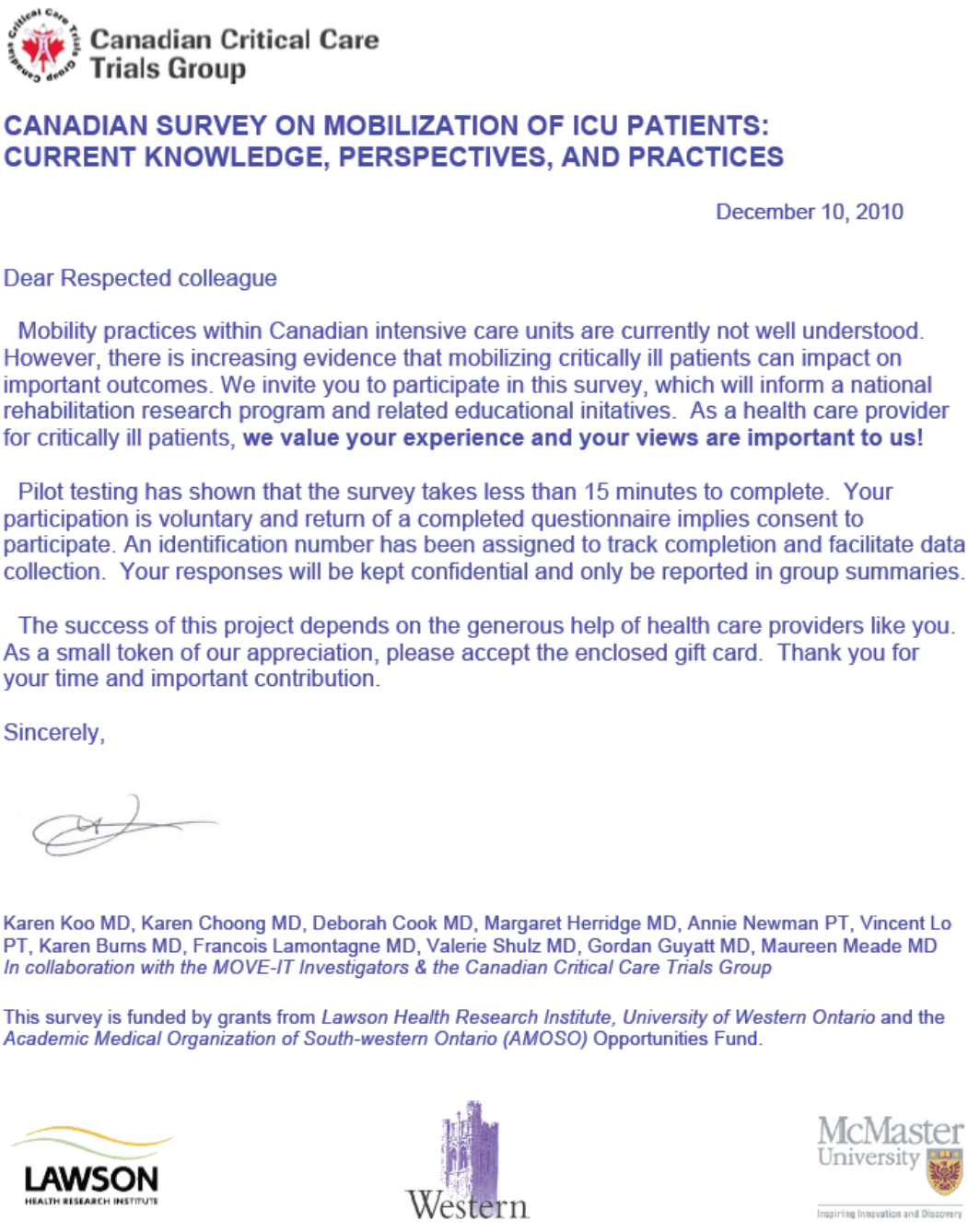
REB review of the research protocol is necessary to determine if the study employs a scientifically valid design to answer the research question and if the methods are ethical.[7] The research question should have clinical equipoise and have sufficient clinical importance to justify the risk posed to participants.[3] The study should be conducted faithfully as reported in the protocol approved by the REB and REB have a duty to ensure this is the case.[8] The findings of the study should be reported promptly and accurately with exaggeration.

REB committees are comprised of at least five members[9] who have sufficient knowledge to determine if each research study meets the highest ethical standards and if the appropriate safeguards have been put in place for research subjects. The REB is usually a diverse group of men and women with at least one scientist, one non-scientist and one member who is not affiliated with the institution (i.e. community member). Members of the REB maybe selected to provide legal, lay, clinical and or scientific perspectives on the ethics of the study.

6.5 Conclusion

Surveys, like other studies, require informed consent and usually require approval of institutional REBs. We used rigorous methods to design the mobility survey to address clinically important questions. The principles of autonomy, beneficence and justice formed the pillars of our ethical research endeavors.

Figure 6.1 Cover Letter of the Mobility Survey



Canadian Critical Care Trials Group

CANADIAN SURVEY ON MOBILIZATION OF ICU PATIENTS: CURRENT KNOWLEDGE, PERSPECTIVES, AND PRACTICES

December 10, 2010

Dear Respected colleague

Mobility practices within Canadian intensive care units are currently not well understood. However, there is increasing evidence that mobilizing critically ill patients can impact on important outcomes. We invite you to participate in this survey, which will inform a national rehabilitation research program and related educational initatives. As a health care provider for critically ill patients, **we value your experience and your views are important to us!**

Pilot testing has shown that the survey takes less than 15 minutes to complete. Your participation is voluntary and return of a completed questionnaire implies consent to participate. An identification number has been assigned to track completion and facilitate data collection. Your responses will be kept confidential and only be reported in group summaries.

The success of this project depends on the generous help of health care providers like you. As a small token of our appreciation, please accept the enclosed gift card. Thank you for your time and important contribution.

Sincerely,

Karen Koo MD, Karen Choong MD, Deborah Cook MD, Margaret Herridge MD, Annie Newman PT, Vincent Lo PT, Karen Burns MD, Francois Lamontagne MD, Valerie Shulz MD, Gordan Guyatt MD, Maureen Meade MD
In collaboration with the MOVE-IT Investigators & the Canadian Critical Care Trials Group

This survey is funded by grants from *Lawson Health Research Institute, University of Western Ontario* and the *Academic Medical Organization of South-western Ontario (AMOSO)* Opportunities Fund.

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Chapter 7
Results & Interpretation of the Mobilization Survey Results

7.0 Survey Instrument Domains

After a rigorous item generation and reduction phases, the final survey domains included were (a) perceived view of and barriers to early mobilization (EM), (b) perceived permissible levels of rehabilitation by physiological, diagnostic, and therapeutic criteria, (c) perceived initiation criteria for EM, (d) knowledge of ICU acquired weakness and EM, (e) perceived technical skills, (f) stated practice of acute rehabilitation assessments, (g) stated practice of types, intensity and frequency of acute rehabilitation, (h) stated staffing workloads, (i) stated sedation use, and (j) perceived long term rehabilitation practices.

7.1 Instrument Evaluation

7.1.1 Pre-pilot evaluation

70 survey questions were generated after a literature review and discussion with 26 content experts. The items were reduced to 10 domains and 29 questions. 10 researchers with formal training in clinical epidemiology assessed the consistency and interpretation of each survey item prior to pilot testing.

7.1.2 Pilot Testing

10 clinicians comprised of critical care fellows, nurses, physiotherapists and respiratory therapists assessed the administrative ease of the survey. They were asked to comment on the flow, arrangement, relevance, and length of the questionnaire. Pilot testing showed the survey takes approximately 15 minutes to complete.

7.1.3 Validity Testing

We used a modified version of a previously validated clinical sensibility tool to evaluate the comprehensiveness, clarity and face validity among 12 content experts. There was excellent agreement among content experts that the survey contained important issues, was clearly worded, and very likely to elicit experiences, beliefs and practices pertaining to mobilization of ICU patients.

7.1.4 Reliability Testing

After administering the survey to 20 respondants on 2 separate occations, 2 weeks apart, we estimated the intra-rater reliability using Cohen's kappa. All survey items were found to be reliable (Cohen's kappa > 0.4, representing moderate to good agreement).

Table 7.1 Intra-rater Reliability of the Mobility Survey Items

Domain	Description	# Survey Items	Cohen's Kappa (Weighted Kappa*)
Perception	Institutional barriers	9	0.70
	Provider barriers – Staffing	6	0.65
	Provider barriers – EM supported but not priority	6	0.57
	Provider barriers – EM priority but not supported	6	0.45
	Provider barriers – Poor communication handover	6	0.48
	Provider barriers – Poor communication general	6	0.83
	Provider barriers – Lack of coordination	6	0.53
	Provider barriers – Slow to recognize	6	0.58
	Provider barriers – Lack of decision making power	6	0.56
	Provider barriers – Conflicting perceptions	6	0.67
	Provider barriers – Safety concerns	6	0.56
	Provider barriers – Inadequate training	6	0.61
	Provider barriers – Other	1	1
	Patient barriers	12	0.63
	Level of activity by diagnosis, device or drug	28	0.30 (0.40)
	When to initiate mobilization	1	0.63
	Level of activity by physiological parameters	12	0.40 (0.53)
Knowledge	Incidence of ICU-acquired weakness	1	0.27 (0.48)
	Familiarity with literature on EM	1	0.87
	Current understanding of Evidence	6	0.66
Practice	Automatic PT consultation with admission	1	0.53
	First clinician to identify need for EM	1	0.53
	MD order required prior to PT assessment	1	0.78
	Written protocols	1	0.61
	Clinician champion for EM	1	0.77
	Champion that promotes	1	1
	Daily duration of mobilization	4	0.47
	Frequency of mobilization	4	0.68
	Participants of mobilization	7	0.74
	PT work hours	3	1
	PT techniques used	13	0.81
	Daily interruption of sedation	1	0.36 (0.58)
	Use of standardized sedation scales	1	0.51 (0.57)
	Routine referral for patients with ICU-acquired weakness	1	0.49
	Consultant to follow patients with ICU-acquired weakness	1	0.64

*Weighted Kappa reported when response options were ordinal

7.2 Clinician Demographics

Respondents included 117 physiotherapists (87.6% of total respondents) and 194 critical care physicians (62.4% of total respondents). All clinicians worked in tertiary hospitals with academic responsibilities including the education of critical care fellows, residents, and students from allied health disciplines.

Most clinicians worked in multiple types of ICUs. Most clinicians (86.5%) worked in medical and surgical ICUs. 43.2% of clinicians practiced in cardiac and vascular surgery recovery units. 40.7% of clinicians worked in trauma centers while 39.3% of clinicians worked in neurological critical care units. 19.4% of respondents spent clinical time in specialized ICUs caring for burn patients.

7.3 Response Rates

A total of 455 surveys were mailed to 315 critical care physicians and 140 physiotherapists. The preliminary response rates (total number of surveys returned/total number of surveys mailed) after the first mailing, electronic email reminder, second mailing and final mailing among physicians were 111 (35.2%), 148 (46.9%), 177 (56.2%), and 194 (61.6%) respectively. The preliminary response rates among physiotherapists after the first mailing, electronic email reminder, second mailing and final mailing among physicians were 53 (37.9%), 71 (50.7%), 114 (81.4%), and 117 (83.6%) respectively.

The final response rates among clinicians was 311/436 (71.3%) including 194/302 (64.2%) physicians and 117/134 (87.3%) physiotherapists. The final response rate was equal to the total number of surveys returned/(total number of survey sent – excluded counts). Eight uncompleted surveys were returned from individuals who were either no longer practicing in critical care medicine; working at a university affiliated hospital or deceased. Two surveys were sent as "test entries" to the administrative center and 9 surveys were sent as duplicates. Therefore, 19 surveys mailed in error to clinicians (i.e. 13 surveys addressed to physicians and 6 surveys addressed to physiotherapists) were taken into account to calculate the final response rate.

Table 7.2 Final Survey Response Rates* by Canadian Province

Province	All Clinicians	MDs	PTs
Alberta	27/44 (61.4%)	21/37 (56.8%)	6/7 (85.7%)
British Columbia	17/24 (70.8%)	12/19 (63.2%)	5/5 (100%)
Manitoba	19/28 (67.9%)	15/24 (62.5%)	4/4 (100%)
New Brunswick	3/3 (100%)	1/1 (100%)	2/2 (100%)
New Foundland	4/6 (66.7%)	3/5 (60.0%)	1/1 (100%)
Nova Scotia	12/17 (60.0%)	7/12 (58.3%)	5/5 (100%)
Ontario	130/170 (76.5%)	82/116 (70.7%)	48/54 (88.8%)
Quebec	85/123 (69.1%)	49/79 (62.0%)	36/44 (81.8%)
Saskatchewan	14/21 (66.7%)	4/9 (44.4%)	10/12 (83.3%)
Total	**311/436 (71.3%)**	**194/302 (64.2%)**	**117/134 (87.3%)**

***Final Response Rate** = total number of surveys returned/(total number of survey sent – individuals no longer practicing in critical care, no longer practicing in academic critical care, deceased, administrative test entry, duplicate or triplicate entry). **PTs**, physiotherapists; **MDs**, physicians

7.4 Results of the Survey

7.4.1 Perceived View of and Barriers to Early Mobilization

17% of respondents believe EM is crucial while 51.8% believe it is very important in the care of the critically ill. 22.8% of respondents believe EM is important. 8.3% of clinicians selected other categories (i.e. somewhat important, not of great importance, minimal or no importance or no response).

Table 7.3 Importance of Early Mobilization in the care of the critically ill as perceived by Canadian Critical Care Clinicians [Frequency (% of all respondents)]

Level of Importance	All Clinicians	MDs	PTs
1 Crucial	53 (17.0%)	28(14.4%)	25 (21.4%)
2 Very Important	161 (51.8%)	90 (46.4%)	71 (60.6%)
3 Important	71 (22.8%)	55 (28.3%)	16 (13.7%)
4 Somewhat important	20 (6.4%)	17 (8.8%)	3 (2.6%)
5 Not of great importance	2 (0.6%)	2 (1.0%)	0 (0%)
6 Of minimal importance	0 (0%)	0 (0%)	0 (0%)
7 Of no importance	0 (0%)	0 (0%)	0 (0%)
8 No response	4 (1.3%)	2 (1.0%)	2 (1.7%)

PTs, physiotherapists; **MDs**, physicians

Barriers to EM were categorized as either institutional, clinician or patient specific. Institutional barriers were defined as customs and behavior patterns in the clinicians own local work environment. The top three perceived institutional barriers were a lack of written guidelines or protocols (177 [57% of respondents]), insufficient equipment for early mobilization (160 [51.4% of respondents]), and physician orders required prior to mobilization (126 [40.5% of respondents]). 88 (28.3% of) respondents believed that the absence of a clinician champion or advocate for early mobilization in their ICU was an important institutional barrier. Less frequently selected but also notable important institutional barriers included insufficient physical space, routine bed rest orders on admission protocols or order sheets, and perceived high costs by administrative or unit leaders. 25 (8% of) respondents selected other institutional barriers and some described in free text that the lack of human resources/staffing schedules, ICU culture and lack of ICU support in general for EM were additional important institutional barriers. 128 (41.2% of) clinicians felt there were no institutional barriers in their local ICU.

Table 7.4 Most Important Institutional Barriers[§] to Early Mobilization in ICUs as perceived by Canadian Critical Care Clinicians [Frequency (% of all respondents)]

Institutional Barrier	All Clinicians	MDs	PTs
No written guidelines or protocols	177 (57%)	134 (69.1%)	43 (36.8%)
Insufficient equipment for early mobilization	160 (51.4%)	109 (56.2%)	51 (43.6%)
Physician orders required prior to mobilization	126 (40.5%)	72 (37.1%)	54 (46.2%)
No clinician champion/advocate	88 (28.3%)	71 (36.6%)	17 (14.5%)
Not enough physical space	63 (20.2%)	48 (24.7%)	15 (12.8%)
Routine bed rest orders on ICU admission	50 (16.1%)	29 (14.9%)	21 (18.0%)
Perceived to be an expensive intervention by administrators or unit leaders	25 (8%)	21 (10.8%)	4 (3.4%)
Other institutional barriers*	25 (8%)	9 (4.6%)	16 (13.7%)
No institutional barriers	128 (41.2%)	70 (36.1%)	58 (49.5%)

[§] *By Institutional* barriers we mean customs and behavior patterns in your work environment.

*Other institutional barriers reported included insufficient staffing, ICU culture, lack of support for mobilization

No response 1 (0.003%) clinician; **PTs, physiotherapists; **MDs**, physicians

Providers were defined as critical care physicians (MD), physiotherapists (PT), registered nurses (RN), respiratory therapists (RT), and referring consultants/primary surgeons (CS). Survey participants were asked about important provider barriers in their local ICU and if the listed barrier was important, they were asked to identify discipline specific groups who contributed to the existence of the barrier. If the survey respondent did not believe the listed barrier is was an important barrier, they were asked to select “None”.

The most frequently selected perceived provider barriers were limited physiotherapists (77.5% of all respondents) and nurses (58.5% of all respondents) to routinely mobilize ICU patients, safety concerns about EM by nurses (64.3% of all respondents), delays in recognition on when ICU patients should begin mobilization by physicians (63% of all respondents) and nurses (58.5% of all respondents), and conflicting perceptions on the suitability of mobilization by nurses (58.2% of all respondents). More than half of respondents also believed that EM in the ICU is generally supported but not perceived as priority in the care of the critically ill by nurses (54% of all respondents), and physicians (50.2% of all respondents), there is a lack of communication about rehabilitation strategies at shift change among nurses (53.7% of all respondents), a lack of coordination among nurses to facilitate rehabilitation (53.4% of all respondents), and inadequate technical training among nurses to facilitate acute rehabilitation.

Table 7.5 Most Important Provider barriers[§] to Early Mobilization in ICU as perceived by Canadian Critical Care Clinicians [Frequency (% of all clinicians)]

Potential Provider Barrier	MD	PT	RN	RT	CS	None
Limited staffing	5 (1.6%)	241 (77.5%)	182 (58.5%)	92 (29.6%)	7 (2.3%)	36 (11.6%)
EM is supported but not priority	156 (50.2%)	30 (9.7%)	168 (54%)	71 (22.8%)	62 (19.9%)	85 (27.3%)
EM perceived as important but it is not supported by some individuals	55 (17.7%)	15 (4.8%)	117 (37.6%)	31 (10.0%)	31 (10%)	141 (45.3%)
Lack of communication among clinician groups at bedside	141 (45.3%)	99 (31.8%)	134 (43.1%)	66 (21.2%)	36 (11.6%)	108 (34.7%)
Lack of communication during hand-over at shift change	75 (24.1%)	45 (14.5%)	167 (53.7%)	41 (13.2%)	12 (3.9%)	96 (30.9%)
Lack of coordination among providers to facilitate EM	83 (26.7%)	143 (46.0%)	166 (53.4%)	113 (36.3%)	29 (9.3%)	99 (31.8%)
Slow to recognize when patients should begin EM	196 (63.0%)	54 (17.4%)	182 (58.5%)	59 (18.9%)	48(15.4%)	63 (20.3%)
Lack of specific decision-making authority to initiate EM	83 (26.7%)	96 (30.8%)	82 (26.3%)	35 (11.3%)	24 (7.7%)	126 (40.5%)
Conflicting perceptions about suitability of EM in some patients	138 (44.4%)	93 (29.9%)	181 (58.2%)	64 (20.5%)	45 (14.5%)	86 (27.6%)
Safety concerns about EM	95 (30.5%)	89 (28.6%)	200 (64.3%)	87 (28.0%)	37 (11.9%)	75 (24.1%)
Inadequate training to facilitate EM	93 (29.9%)	83 (27.0%)	161 (51.7%)	97 (31.2%)	37 (11.9%)	114 (36.7%)
Other provider level barrier	3 (1.0%)	5 (1.6%)	3 (1%)	2 (1%)	1 (0.3%)	297 (95.4%)

[§]*Providers* are critical care physicians (MD), physiotherapists (PT), registered nurses (RN), respiratory therapists (RT), and referring consultants/primary service (CS). **The following are frequency of respondents who did not respond to the statement (i.e. missing): 4 (1.3%) for limited staffing, 12 (3.9%) for EM is supported but not prioritized, 23 (7.4%) for lack of communication at bedside rounds, 29 (9.3%) for lack of communication at shift change, 34 (10.9%) for lack of co-ordination, 16 (5.1%) for slow to recognize when patients should begin EM, 29 (9.3%) for lack of decision making authority, 20 (6.4%) for conflicting perceptions about suitability, 18 (6.0%) for safety concerns, 22 (7.1%) for inadequate training.

The most important patient barriers to early mobilization in the ICU as perceived by critical care clinicians were medical instability (82.6% of respondents), excessive sedation (60.1% of respondents), and the risks of dislodgement of lines or devices (41.8% of respondents). Many survey participants also believed that obesity (33.8% of respondents), cognitive impairment (31.5% of respondents), endotracheal intubation (28.3% of respondents) and mechanical ventilation (28.3% of respondents) were important patient barriers. Less frequently selected responses included physical restraints (20.6%), inadequate analgesia (13.8%), frailty (13.2%), and nutritional status (2.6%). 25 (8% of) clinicians described other patient barriers such as extracorporeal membrane oxygenation, continuous renal replacement therapy, and the poor patient motivation.

Table 7.6 Most Important Patient Barriers to Early Mobilization in the ICU As perceived by Canadian Critical Care Clinicians [Frequency (% respondents)]

Patient Barrier	All Clinicians	MDs	PTs
Medical instability	257 (82.6%)	150 (77.3%)	107 (91.4%)
Excessive sedation	187 (60.1%)	112 (57.7%)	75 (64.1%)
Risk of device/line dislodgement	130 (41.8%)	106 (54.6%)	24 (20.5%)
Obesity	105 (33.8%)	75 (38.7%)	30 (25.6%)
Cognitive impairment	98 (31.5%)	72 (37.1%)	26 (22.2%)
Endotracheal intubation	88 (28.3%)	71 (36.6%)	17 (14.5%)
Physical restraints	64 (20.6%)	50 (25.8%)	14 (12.0%)
Inadequate analgesia	43 (13.8%)	23 (11.9%)	20 (17.1%)
Frailty	41 (13.2%)	39 (20.1%)	2 (1.7%)
Inadequate nutritional status	8 (2.6%)	4 (2.1%)	4 (3.4%)
No patient barriers	6 (1.9%)	3 (1.5%)	3 (2.6%)
Other patient barrier*	25 (8%)	12 (6.2%)	13 (11.1%)

*Other patient factors written: 6 delirium/anxiety, 2 ECMO, 3 IHD/CRRT, 2 lack of motivation, 2 trauma, 3 bariatric/heavy-requiring special equipment, 1 excessive length of lines, 1 culture, 1 lack of nursing buy in**,** ** complete response/

7.4.2 Initiation Criteria for Acute Rehabilitation

185 (59.5% of) respondents perceived it was most appropriate to begin acute rehabilitation as soon as possible following ICU admission. Most physiotherapists (69.2%) believed patients could be mobilized soon after ICU admission while only some physicians (33.4%) agreed with this view. Most clinicians (75.2%) believed patients had to be stable from a cardiovascular and respiratory status where there was no longer any escalating hemodynamic or mechanical ventilator support. Patient consciousness and the ability to co-operate were perceived by many clinicians (44.1%) as a necessary criterion prior to engaging in acute rehabilitation. 72 (23.2% of) respondents believed patients should be off all vasoactive drug infusions while 48 (15.4% of) respondents believed sedative infusions should be discontinued prior to mobilization. Only 13 (4.2% of) survey participants thought acute rehabilitation should begin once a patient is ready to be transferred out of the ICU.

Table 7.7 Criteria on When to Initiate Mobilization in ICUs as perceived by Canadian Critical Care Clinicians by Discipline (Frequency (% respondents)]

Criteria	All Clinicians	MDs	PTs
Admission to ICU	185 (59.5%)	104 (33.4%)	81 (69.2%)
Cardio-respiratory status stabilization*	234 (75.2%)	143 (73.7%)	91 (77.8%)
Just after extubation	57 (18.3%)	27 (13.9%)	30 (25.6%)
Off all vasoactive infusions	72 (23.2%)	43 (22.2%)	29 (24.8%)
Patient is conscious & can co-operate	137 (44.1%)	82 (42.3%)	55 (47.0%)
Sedative infusions are discontinued	48 (15.4%)	24 (12.4%)	24 (20.5%)
Ready to be transferred out of the ICU	13 (4.2%)	7 (3.6%)	6 (5.1%)
Other Self-reported criteria	16 (5.1%)	3 (1.6%)	13 (4.2%)

*Cardio-respiratory status stabilization refers the point when to a patient's cardio-respiratory status is not longer requiring escalation in hemodynamic or ventilator support; **Complete response/no missing

7.4.3 Perceived Permissible Levels of Acute Rehabilitation by Physiological, Diagnostic & Therapeutic criteria

Clinical scenarios with various patient diagnoses were provided to survey participants and they were instructed to assume all patients were previously ambulatory and physiologically stable on mechanical ventilation, without inotropes/vasopressors and on minimal sedating infusions. These patients had purposeful motor response and could obey verbal commands.

The majority of clinicians (84%) believed patients affected by head trauma with increased intracranial pressures should remain on bed rest restrictions. There was greater heterogeneity of maximal activity levels for patients with head trauma without increased intracranial pressures from bed rest (4%) to full ambulation (38.6%). The most frequently perceived maximal level of activity for patients with cervical and thoracic-lumbar spinal injuries was active range of motion (26.1%, 28.0% respectively). There was a wide range of perceived maximal permissible level of activities for patient with spinal cord injuries and 17% of clinicians were not sure at what level these such patients could safely engage. Most clinicians believed there should be no activity restrictions and patients within 24 hours of myocardial infarctions with decreasing enzymes (30.1%), with coagulopathy, thrombocytopenia, deep vein thrombosis, obesity or frailty. Patients within 24 hours of a treated myocardial infarction with persistently elevated enzymes were thought to perform at most active range of motion. One-third (115, 36.9%) respondents believed patients within 24 hours of uncomplicated coronary bypass surgery should be restricted to transfers to chairs while 109 (35.1%) believed that these patients should be permitted to ambulate freely. Patients diagnosed with delirium were permitted at most to participate in active range of motion according to 73 (23.5%) of respondents. However, 97 (31.2%) believed these patients could at most transfer to a chair and 89 (28.6%) believed in no activity restrictions.

Table 7.8 Maximal Permissible Level of Activity for a Patient with a given Diagnosis or Condition as perceived by Canadian Critical Care Clinicians.

Diagnosis or Condition	Bed Rest	Passive Range of Motion	Active Range motion	Standing	Transfers to Chair	Ambulation	Not Sure
a) Head trauma *without* increased intracranial pressure	1 (4%)	23(7.4%)	55(17.6%)	23(7.4%)	54(17.6%)	120(38.6%)	23(7.4%)
b) Head trauma *with* increased intracranial pressure	121(84%)	84(27%)	62(19.9%)	2(0.6%)	5(1.6%)	4(1.3%)	26(8.6%)
c) Cervical spinal injury	40(12.9%)	45(14.8%)	81(26.1%)	1(0.9%)	20(6.4%)	49(15.7%)	54(17.4%)
d) Thoracio-lumbar spinal injury	30(10.0%)	44(14.2%)	87(28.0%)	0(0%)	24(7.7%)	51(16.4%)	55(17.7%)
e) Within 24 h of treated myocardial infarction (*cardiac enzymes persistently elevated)*	53 (17.0%)	50(15.1%)	86(27.7%)	10(3.2%)	64(20.6%)	26(8.4%)	10(3.2%)
f) Within 24 h of treated myocardial infarction *(cardiac enzymes decreasing)*	12 (3.9%)	17 (5.7%)	61 (19.6%)	20(6.4%)	89(28.6%)	95(30.1%)	8(2.6%)
g) Coagulopathy (INR > 3)	7(2.3%)	7(2.3%)	31(10.0%)	14(4.5%)	58(18.7%)	170(54.8%)	12(3.9%)
h) Thrombocytopenia (platelet count < 20 x10^9/L)	11(3.5%)	8(2.6%)	44(14.2%)	16(5.2%)	61(19.6%)	147(47.3%)	16(5.1%)
i) Delirium (fluctuating level of consciousness at times inattentive or agitated)	9(3.0%)	9(3.0%)	73(23.5%)	19(6.1%)	97(31.2%)	89(28.6%)	7(2.3%)
j) Within 24 h of uncomplicated coronary bypass surgery	3(1.0%)	10(3.2%)	31(10%)	22(7.1%)	115(37.0%)	109(35.1%)	14(4.5%)
k) Deep vein thrombosis (on therapeutic anti-coagulation)	2(0.6%)	3(0.9%)	15(4.8%)	8(2.6%)	31(10.0%)	236(75.9%)	9(2.9%)
l) Obesity	0(0%)	0(0%)	7(2.3%)	10(3.2%)	24(7.7%)	258(83.2%)	4(1.3%)
m) Frailty	0(0%)	1(0.3%)	8(2.6%)	8(2.6%)	38(12.2%)	243(78.2%)	5(1.6%)

*No response/Missing: 9(2.8%) for a, 10(3.2%) for b, 20(6.4%) for c, 20(6.4%) for d, 12(3.6%) for e, 9(2.9%) for f, 11(3.6%) for g, 8(2.6%) for h, 8(2.6%) for i,7(2.5%) for j, 7(2.3%) for k, 7(2.2%) for l, 8(2.6%) for m, ;[Frequency (% respondents); Mode highlighted]

Clinical scenarios with various devices or drugs were provided to survey participants and they were instructed to assume all patients were previously ambulatory and physiologically stable on mechanical ventilation, without inotropes and on minimal sedating infusions. These patients had purposeful motor response and could obey verbal commands.

There was a wide range of permissible level of activities noted for many of the drugs and devices. More restricted activity was thought to be necessary for patients with invasive devices providing ongoing monitoring (i.e. pulmonary artery catheters) and ongoing therapies (i.e. intra-aortic balloon pumps, continuous renal replacement therapy, extra corporeal membrane oxygenation, and high frequency oscillation). The most frequently selected maximal level of activity for the pulmonary artery catheter (28.9%) and continuous renal replacement therapies (54%) was restricted to active range of motion. Most clinicians believed that patients requiring the assistance of an intra-aortic balloon pump (35.7%),

extra corporeal membrane oxygenation (27.7%), and high frequency oscillation (37%) should remain on bed rest.

The location of a line affected the level of activity. Most clinicians (61.4%) were comfortable allowing patients with arterial lines inserted at the radial site to ambulate freely. Most respondents believed that during non-dialysis periods, patients with dialysis lines inserted at subclavian sites (78.1%) could be permitted to fully ambulate. Some clinicians believed lines inserted at the femoral site, including central venous catheters (33.4%) and dialysis lines (29.2%), should be restricted to active range of motion while others did not feel any restriction in level of activity to be necessary.

Most survey participants believed that patients on conventional mechanical ventilation should be permitted to ambulate. More clinicians permitted full ambulation when patients were being ventilated though a tracheostomy (61.4%) rather than an endotracheal tube (45.3%). 132 (42.4% of) clinicians believed patients receiving non-invasive positive pressure ventilation should be restricted to transfers to chairs while 95 (30.1% of) respondents believed that such patients could be allowed to ambulate if able to.

The uses of chest tubes (78.4%), Foley urine catheters (85.2%), or full dose therapeutic anticoagulation therapy (79.7%) were not perceived by most clinicians to require any restrictions in activity levels.

Table 7.9 Maximal Permissible Level of Activity for a Patient with a given Device or Drug as perceived by Canadian Critical Care Clinicians

Device or Drug	Bed Rest	Passive Range of Motion	Active Range of Motion	Standing	Transfers to Chair	Ambulation	Not Sure
a) Pulmonary artery catheter	33(10.6%)	19(6.1%)	90(28.9%)	16(5.1%)	78(25.1%)	28(9.0%)	26(8.3%)
b) Intra-aortic balloon pump	111(35.7%)	43(13.8%)	107(34.4%)	0 (0%)	3(10.0%)	4(1.3%)	36(11.6%)
c) Femoral central venous catheter	18(5.8%)	22(7.1%)	104(33.4%)	26(8.6%)	38(12.2%)	78(25.1%)	15(4.8%)
d) Radial arterial catheter	2(0.6%)	1(0.64%)	17(5.5%)	10(3.2%)	73(23.5%)	191(61.4%)	7(2.3%)
e) Dialysis line inserted at the subclavian site (during non-dialysis periods)	1(0.3%)	2(0.6%)	10(3.2%)	8(2.5%)	32(10.3%)	243(78.1%)	10(3.2%)
f) Dialysis line inserted at the femoral site (during non-dialysis periods)	11(3.5%)	11(3.5%)	91(29.2%)	47(15.1%)	42(13.5%)	81(26.1%)	19(6.1%)
g) Continuous renal replacement therapy (during dialysis such as PRISMA)	36 (11.6%)	27 (8.7%)	168(54.0%)	10 (3.2%)	34(11.0%)	8(2.6%)	17(5.5%)
h) Extra Corporeal Membrane Oxygenation	86(27.7%)	76(24.4%)	57(18.3%)	1(0.3%)	1(0.3%)	3(0.9%)	72(23.2%)
i) High Frequency Oscillation	115(37.0%)	115(37%)	29(9.3%)	0 (0%)	2(0.6%)	9(2.9%)	31(10.0%)
j) Conventional Mechanical Ventilation *with an Endotracheal tube*	2(6.0%)	5(1.6%)	58(18.7%)	14(4.5%)	77(24.8%)	141(45.3%)	5(1.6%)
k) Conventional Mechanical Ventilation *with a Tracheostomy*	0 (0%)	1(0.3%)	23(7.4%)	6(1.9%)	75(24.2%)	191(61.4%)	6(1.9%)
l) Non-invasive Positive Pressure Ventilation (e.g. BiPAP)	5(1.6%)	10(3.2%)	44(14.2%)	11(3.5%)	132(42.4%)	95(30.1%)	5(1.6%)
m) Chest Tube	0 (0%)	0 (0%)	6(2.0%)	5(1.6%)	45(14.5%)	243(78.4%)	4(1.3%)
n) Foley Catheter	0 (0%)	0 (0%)	1(0.3%)	6(1.9%)	12(3.6%)	265(85.2%)	19(6.1%)
o) Full Anti-Coagulation (i.e. heparin infusion, warfarin)	3 (0.9%)	0 (0%)	9 (2.9%)	5 (1.6%)	22 (7.1%)	248(79.7%)	8 (2.6%)

*No response/Missing: 21(6.6%) for a, 7(2.3%) for b, 10(3.2%) for c, 10(3.2%) for d, 5(1.6%) for e, 9(2.8%) for f, 15(4.8%) for h, 10(3.2%) for i, 9(3.0%) for j, 9(3.0%) for k, 11(3.5%) for g, 16(5.1%) for o, 7(2.2%) for m, 8(2.6%) for n, 9(3.0%) for l

Survey participants were given scenarios with various physiological parameters and asked what the maximal permissible level of activity would be for patients who were intubated and mechanically ventilated.

Overall, most clinicians believed patients on minimal cardiovascular and respiratory support or the ability to follow motor and verbal command could ambulate freely. 227 (73% of) clinicians believed patients who were not on any vasopressor or inotropic medications should be permitted to walk. Similarly, minimal pressure support on conventional mode of mechanical ventilation was parameter 175 (56.3% of) respondents believed should not restrict the level of activity. 168 (54% of) respondents thought patients who had purposeful motor response and who could obey verbal commands should be allowed to ambulate.

As the level of cardiovascular support increased, fewer clinicians were comfortable with allowing patients to ambulate and more frequently restricted the maximal level of activity. The most frequently selected permissible level of activity by clinicians for patients on one low dose vasopressor or inotropic medication was transfers to chair. The most frequently selected permissible level of activity for patients who were on one medium or high dose or multiple vasoactive agents, was active range of motion.

A similar trend of greater restriction in level of activity was observed as the amount of respiratory support increased. 116 (37.3% of) respondents believed patients on moderate pressure support on conventional mechanical ventilation parameters should be restricted to transfers in chairs. If patients were on non-conventional or advanced modes of mechanical ventilation, more clinicians preferred to have patients remain engaged, at most, in passive ranges of motion.

Most clinicians thought patients with impairment in cognitive status resulting in inability to follow verbal commands should be restricted to passive ranges of motion

Table 7.10 Maximal Permissible Level of Activity in Mechanically Ventilated Patients by Physiologic Criteria as perceived by Canadian Critical Care Clinicians [Frequency (% of all clinicians); Mode highlighted]

Physiological Status	Bed Rest	Passive Range of Motion	Active Range of Motion	Standing	Transfers to Chair	Ambulation	Not Sure
Cardiovascular a) three or more vasopressors or inotropic infusions	75(24.2%)	87(30.0%)	99(31.8%)	5(1.6%)	8(2.5%)	7(2.2%)	25(8.1%)
b) two vasopressors or inotropic infusions	47(15.1%)	81(26.0%)	116(37.3%)	9(2.9%)	14(4.5%)	9(2.9%)	30(9.7%)
c) one high dose vasopressor or inotropic infusion	41(13.2%)	70(22.5%)	119(38.3%)	15(4.8%)	20(6.4%)	9(3.0%)	31(10.0%)
d) one medium dose vasopressor or inotropic infusion	18(5.8%)	48(15.4%)	117(37.6%)	18(5.7%)	54(17.4%)	23(7.4)	29(9.3%)
e) one low dose vasopressor or inotropic infusion	10(3.2%)	16(5.2%)	86(27.6%)	14(4.5%)	89(28.6%)	67(21.5%)	24(7.7%)
f) no vasopressor or inotropes	1(0.3%)	0 (0%)	21(6.8%)	6(1.9%)	39(12.5%)	227(73.0%)	17(4.5%)
Respiratory g) minimal pressure support on conventional mode of mechanical ventilation	0 (0%)	1(0.3%)	37(11.9%)	12(3.8%)	79(25.4%)	175(56.3%)	3(1.0%)
h) moderate pressure support on conventional mode of mechanical ventilation (e.g., FiO_2 0.5, PEEP 10)	2(0.6%)	13(4.2%)	82(26.4%)	26(8.4%)	116(37.3%)	64(20.6%)	6(1.9%)
i) advanced mode of mechanical ventilation (e.g., high frequency oscillation)	95(30.5%)	118(37.9%)	74(23.8%)	3 (1.0%)	0(0%)	5 (1.6%)	14 (4.5%)
Neurologic j) unresponsive to verbal and motor stimulation	15(4.8%)	241(77.5%)	25(8.0%)	2(0.6%)	20(6.4%)	2(6.4%)	3(1.0%)
k) purposeful motor response, not obeying verbal commands	5(1.6%)	116(37.3%)	109(35.1%)	13(4.2%)	50(16.1%)	10(3.2%)	2(0.6%)
l) purposeful motor response, obeys verbal commands	2(0.6%)	5(1.6%)	70(22.5%)	12(3.9%)	47(15.1%)	168(54.0%)	3(1.0%)

*No response/Missing: 5(1.6%) for a, 5(1.6%) for b, 6(1.9%) for c, 4(1.2%) for d, 5(1.6%) for e, 3(1.0%) for f, 4(1.2%) for g, 2(0.6%) for h, 2(0.6%) for i, 3(0.9%) for j, 6(1.9%) for k, 4(1.3%) for l

7.4.4 Knowledge of ICU acquired weakness & Trials in Early Mobilization

The majority of respondents (68.8%) under-estimated the incidence of ICU-acquired weakness found in the general medical and surgical ICUs based on clinical research. The proportion of physicians (31.2%) who answered correctly (i.e. responding that the incidence was at least 40% or more) was similar to the proportion of physiotherapists (33.3%) who answered correctly.

Most clinicians (67.4%) reported that they are familiar with the current literature on early mobilization in the ICU. Based on a series of 5 true and false questions of clinical trials on early mobilization in the ICU, the actual clinician knowledge was lower than the perceived knowledge. The mean % of correct responses for all clinicians was 58.4%. Physicians answered correctly more often than physiotherapists. The mean % of correct responses to 5 questions among physicians was 64.4% and 57.7% among physiotherapists.

Table 7.11 Summary of Knowledge evaluated in the Mobility Survey

Knowledge Domain	Response	% Clinicians
Incidence of ICUAW in MS- ICU ❖	% Correct	31%
Self-report familiarity of EM literature	Yes	67%
Knowledge of Clinical Trials - EM in ICU ✪	% Correct	58%

❖Answers based on results from:
Stevens RD et al. *Intensive Care Med* 2007, 33: 1876-1891.
De Jonghe B et al. *JAMA* 2002: 288; 2859-2867.
Leijten FS et al. *Intensive Care Med* 1996; 22: 856-861.
Berek Ket al. *Intensive Care Med* 1996; 22:849-855.

✪ Answers based on results from:
Schweickert WD et al. Lancet 2009; 373:1874-82.
Bailey P et al. Crit Care Med 2007; 35: 139-145.
Nava, S. Arch of physical medicine & Rehab 1998: 79: 849-854.
Morris PE et al. Crit Care Med 2008; 36: 2238-2243

Table 7.12 Perceived Incidence of ICU-Acquired Weakness by Canadian Critical Care Clinicians [Frequency (% of all clinicians)]

Incidence	All Clinicians	Physicians	Physiotherapists
< 5%	4 (1.3%)	2 (1.0%)	2 (1.8%)
5-10%	30 (9.7%)	13 (6.9%)	17 (14.9%)
11-20%	59 (19.0%)	43 (22.8%)	16 (14.0%)
21-40%	100 (32.2%)	68 (35.9%)	32 (28.1%)
> 40%*	97 (31.2%)	59 (31.2%)	38 (33.3%)
Don't know	13 (4.8)	4 (2.1%)	9 (7.9%)
No Response	8 (2.6%)	5 (2.6%)	3 (2.6%)

*correct incidence of ICUAW in general medical-surgical ICU population

Table 7.13 Knowledge of Incidence of ICU-Acquired Weakness by Canadian Critical Care Clinicians [Frequency (% of all clinicians)]

Answer	All Clinicians	Physicians	Physiotherapists
% Correct	97 (31.2%)	59 (31.2%)	38 (33.3%)
% Incorrect	214 (68.8%)	135 (68.8%)	79 (67.5%)

Table 7.14 Familiarity of Current Literature* on Early Mobilization as Perceived by Canadian Critical Care Clinicians [Frequency (% of all clinicians)]

Answer	All Clinicians	Physicians	Physiotherapists
Yes	207 (67.4%)	131 (69.0%)	76 (65.0%)
No	59 (32.6%)	41 (31.0%)	41 (35.0%)

* Current literature refers to clinical trials or literature, ** No response: 4 physicians only (1.3% all clinicians)

Table 7.15 Knowledge of Clinical Studies about Early Mobilization (EM) in General Medical-Surgical ICUs as Perceived by Canadian Critical Care Clinicians [Frequency (% of all clinicians)]

Respondents were asked to select all TRUE responses to the following statements:

a) "*I am not sufficiently familiar with the current literature/clinical studies on EM in the ICU*".

Answer	All Clinicians	Physicians	Physiotherapists
Yes	86 (28.1%)	60 (31.4%)	26 (22.6%)
No	220 (71.9%)	131 (68.6%)	89 (77.4%)

b) "*EM of critically ill patients can improve their functional independence (i.e., activities of daily living) at hospital discharge*."

Answer	All Clinicians	Physicians	Physiotherapists
Yes - % correct	203 (66.3%)	114 (59.7%)	89 (77.4%)
No - % incorrect	103 (33.7%)	77 (40.3%)	26 (22.6%)

c) "*EM of critically ill patients is associated with reduced mortality at hospital discharge*."

Answer	All Clinicians	Physicians	Physiotherapists
Yes - % incorrect	82 (26.8%)	34 (17.8%)	48 (41.7%)
No - % correct	224 (73.2%)	157 (82.2%)	67 (58.3%)

d) "*EM of critically ill patients is associated with a reduced incidence of delirium*."

Answer	All Clinicians	Physicians	Physiotherapists
Yes - % correct	144 (47.1%)	93 (48.7%)	51 (44.3%)
No - % incorrect	162 (52.9%)	98 (51.3%)	64 (55.7%)

e) "*EM of critically ill patients reduces the incidence of deep vein thrombosis."*

Answer	All Clinicians	Physicians	Physiotherapists
Yes - % incorrect	97 (31.7%)	41 (21.5%)	56 (48.7%)
No - % correct	162 (52.9%)	150 (78.5%)	59 (51.3%)

f) "*EM of critically ill patients reduces their time requiring mechanical ventilation*."

Answer	All Clinicians	Physicians	Physiotherapists
Yes - % correct	161 (52.6%)	95 (49.7%)	66 (57.4%)
No - % incorrect	145 (47.4%)	96 (50.3%)	49 (42.6%)

g) **Summary of Knowledge of Clinical Studies about Early Mobilization in ICUs**

Answer	All Clinicians	Physicians	Physiotherapists
% correct	58.4%	64.4%	57.7%
% incorrect	41.6%	35.6%	42.3%

No response: 5 physicians only (1.6% all clinicians)

7.4.5 Perceived Technical Skills

Most clinicians reported that they were not well trained or well informed to mobilize mechanically ventilated patients. 42.1% of respondents reported they were somewhat trained and informed while 17.7% of respondents reported they were not sufficiently trained or informed at all. A higher proportion of physiotherapists (60.7%) than physicians (25.5%) felt well trained and informed to mobilize mechanically ventilated patients.

Table 7.16 Clinician's Perception of Practical Skills & Training

Response	All Clinicians	Physicians	Physiotherapists
Feels well trained & informed	119 (38.3%)	48 (25.5%)	71 (60.7%)
Feels somewhat trained & informed	131 (42.1%)	91 (48.4%)	40 (34.2%)
Does not feel sufficiently trained or informed	55 (17.7%)	49 (26.1%)	6 (5.1%)

No response: 6 physicians only (1.9% all clinicians)

7.4.6 Stated Practice of Acute Rehabilitation in the ICU

7.4.6.1 Assessments & Guidelines for Acute Rehabilitation

Respondents were asked "*Are all patients automatically assessed for appropriateness to begin mobilization by the physiotherapist in your ICU without prompting or requests by other clinician groups*?" Only 43.7% of respondents believed that all critically ill patients were screened automatically, including 49.6% of respondent physiotherapists and 40.1% of respondent physicians. Most clinicians (73.2%) agreed that the initial physiotherapist assessment on each patient required a written medical order by a physician.

According to most physiotherapists (47.9%), the first critical care providers to identify when patients are ready for acute rehabilitation in the ICU are usually physiotherapists. Physicians believed either nurses (32.5%), physicians (32.5%) or physiotherapist (31.4%) were providers who usually first determine when a patient is suitable for rehabilitation. Occupational therapists and respiratory therapists are infrequently the first to identify readiness for rehabilitation. Most respondents (66.6%) stated that there were no written protocols or policies that provide guidelines on when a patient should begin mobilization in the ICU in which they work.

Table 7.17 Assessment of Rehabilitation Requirements by Physiotherapists

Response	All Clinicians	Physicians	Physiotherapists
Yes	135 (43.7%)	77 (40.1%)	58 (49.6%)
No	149 (48.2%)	93 (48.4%)	56 (47.9%)
Unsure	25 (8.1%)	22 (11.5%)	3 (2.6%)

No response: 2 physicians only (0.6% all clinicians)

Table 7.18 First Clinician to Identify When an ICU Patient can begin Mobilization

Critical Care Provider	All Clinicians	Physicians	Physiotherapists
Registered Nurse	92 (29.6%)	63 (32.5%)	29 (24.8%)
Physician	94 (30.2%)	63 (32.5%)	31 (26.5%)
Physiotherapist	116 (37.3%)	61 (31.4%)	55 (47.0%)
Occupational Therapist	0 (0%)	0 (0%)	0 (0%)
Respiratory Therapist	1 (0.3%)	1 (0.5%)	0 (0%)
Other Provider*	6 (1.9%)	4 (2.0%)	2 (1.7%)

*Other providers included: 1 intensivist, 2 depends on who the attending staff is, 2 anyone, 1 unsure
**No response

Table 7.19 Physiotherapy consult requirements in ICUs

Response	All Clinicians	Physicians	Physiotherapists
Technically, yes	225 (72.3%)	146 (76.4%)	79 (67.5%)
No	80 (25.7%)	42 (22.0%)	38 (32.4%)
Unsure	3 (1.0%)	3 (1.6%)	0 (0%)

No response: 3 physicians only (1.0% all clinicians)

Table 7.20 Availability of Rehabilitation Protocols in ICUs

Response	All Clinicians	Physicians	Physiotherapists
Yes	54 (17.4%)	19 (9.9%)	35 (30.2%)
No	207 (66.6%)	138 (72.3%)	69 (59.5%)
Unsure	46 (14.8%)	34 (17.8%)	10.3%)

No response: 3(1.5%) physicians, 1(0.6%) physiotherapist

7.4.6.2 Champions and Participants of Early Mobilization

A *mobility champion* was defined as a health care clinician who promotes acute rehabilitation and/or physiotherapy in the ICU through patient advocacy or quality improvement initiatives. 54.3% of respondents believed that there was at least one champion for early mobilization in their ICU. Most respondents reported that the champions were commonly physiotherapists (46.1%) or physicians (38.5%).

Respondents believed that nurses (99%) and physiotherapists (99%) were the primary participants in acute rehabilitation. Health care aids (62.9%) were also frequently stated to participate. Respondents felt family members or home caregivers (27.7%) were thought to contribute to acute rehabilitation, as were occupational therapists (22.5%). Physicians (16.9%) and respiratory therapists (6.3%) were thought to less likely participate. Other participants included orderlies, rehabilitation specialists or personal attendants.

Table 7.21 Champion for Early Mobilization in the ICU

Response	All Clinicians	Physicians	Physiotherapists
Yes	169 (54.3%)	85 (44.5%)	84 (71.8%)
No	114 (36.7%)	93 (48.7%)	21 (18.0%)
Unsure	25 (8.1%)	13 (6.8%)	12 (10.3%)

No response: 3 physicians only (1.0% all clinicians)

Table 7.22 Discipline of Early Mobilization Champion

Critical Care Provider	All Clinicians
Physiotherapist	78 (46.1%)
Physician	65 (38.5%)
Registered Nurse	10 (5.9%)
Respiratory Therapist	2 (1.2%)
Unsure	1 (0.6%)

No response: 13 (7.7%)

Table 7.23 Participation in Acute Rehabilitation in the ICU

[Frequency (% of all clinicians); Mode highlighted]

Participant	All Clinicians
Registered Nurse	304 (99.0%)
Physician	52 (16.9%)
Physiotherapist	303 (98.7%)
Occupational therapist	69 (22.5%)
Respiratory Therapist	185 (6.3%)
Health care aide	193 (62.9%)
Family member or home caregiver	85 (27.7%)
Other participant*	17 (5.5%)

* Other participants: 6 orderly, 2 personal attendants, 1 rehabilitation specialist, 1 legally authorized representative,
**No response: 4 (1.3%) clinicians

7.4.6.3 Modes, Duration and Frequencies of Acute Rehabilitation in the ICU

Physiotherapists were asked about their general practice of acute rehabilitation in the ICU. Most of these clinicians stated that they routinely engaged in all ranges of acute rehabilitation including chest physiotherapy, passive range of motion, active range of motion, strengthening exercises, bed mobility, transfers from bed to chair, pre-gait activities, gait training and ambulation. The use of neuromuscular electrical stimulation and active exercise equipment (including treadmills, cycle ergometer, and dynamic tilt table testing) were stated to be rarely, if ever, used.

Physiotherapists were asked about average daily duration and average weekly frequency of acute rehabilitation that they would provide to critically ill patients with different levels of wakefulness and co-operative ability. All patients in the scenarios were intubated and mechanically ventilated. Four categories of neurological status included patients who were a) deeply sedated & unconscious, b) inattentive & uncooperative, c) alert, interactive & co-operative but could not ambulate yet, and d) alert, interactive/cooperative and could ambulate (with or without assistance). 46 (39.3% of) respondents stated they would provide no physical therapy to patients who were deeply sedated and unconscious while 39 (33.3%) stated they would provide 1 to 15 minutes of physical therapy. As the level of wakefulness and the ability to co-operate of patients improved, the majority of respondents stated they would provide longer durations of physical therapy. For patients who were inattentive and uncooperative, 62 respondents (53%) stated they would deliver 1 to 15 minutes of physical therapy on average per day. 60 respondents (51.3%) stated they would provide 16 to 30 minutes of physical therapy per day in patients who were alert, interactive, and co-operative but could not ambulate yet. For patients who were alert, cooperative and could ambulate, 43 (36.8%) of respondents stated they would spend 31 to 45 minutes per day delivering physical therapy.

Respondents said they would provide more frequent physical therapy sessions as the level of wakefulness and cooperative ability improved in mechanically ventilated patients. The most frequently selected number of physical therapy sessions per week for each neurological level was no physical therapy for those patients who were deeply sedated and uncooperative (34.1% respondents), 1 to 2 sessions of physical therapy for patients who were inattentive and uncooperative (29.1%), 5 to 6 sessions of physical therapy for patients who were interactive and co-operative (29.1%), and daily sessions for patients who were alert, interactive/cooperative and could ambulate (42.7%).

Table 7.24 Types of Acute Rehabilitation in ICUs

Type of physiotherapy	Never	Infrequently	Sometimes	Frequently	Routinely	Unsure
a) Chest physiotherapy	0 (0%)	4 (3.4%)	15 (12.8%)	35 (29.9%)	62 (53.0%)	1 (0.9%)
b) Passive range of motion	0 (0%)	13 (11.1%)	31 (26.5%)	32 (27.4%)	39 (33.3%)	0 (0%)
c) Active range of motion	0 (0%)	3 (2.6%)	9 (7.7%)	41 (35.0%)	63 (53.9%)	0 (0%)
d) Strengthening exercises	0 (0%)	4 (3.4%)	18 (15.4%)	53 (45.3%)	40 (34.2%)	0 (0%)
e) Bed mobility	0 (0%)	3 (2.6%)	8 (6.8%)	35 (29.9%)	70 (59.8%)	0 (0%)
f) Transfers	0 (0%)	0 (0%)	5 (4.3%)	41 (35.0%)	70 (59.8%)	0 (0%)
g) Pre-gait activities	0 (0%)	3 (2.5%)	27 (23.1%)	35 (29.9%)	52 (44.4%)	0 (0%)
h) Gait training & ambulation	1 (0.9%)	9 (7.7%)	32 (27.4%)	32 (27.4%)	42 (35.9%)	0 (0%)
i) Treadmill	103 (88.0%)	9 (7.7%)	2 (1.7%)	1 (0.9%)	1 (0.9%)	0 (0%)
j) Neuromuscular electrical stimulation	83 (70.9%)	28 (23.9%)	3 (2.6%)	1 (0.9%)	1 (0.9%)	0 (0%)
k) Cycle ergometer	57 (48.7%)	36 (30.8%)	17 (14.5%)	2 (1.7%)	1 (0.9%)	4 (3.4%)
l) Dynamic tilt table	60 (51.3%)	29 (24.8%)	20 (17.1%)	5 (4.3%)	0 (0%)	2 (1.7%)
m) Other Physiotherapy Technique*	0 (0%)	1 (0.9%)	8 (6.9%)	4 (3.4%)	0 (0%)	0 (0%)

Table 7.25 Intensity of Mobilization* in Mechanically Ventilated Patients by Neurological Status [Frequency (% Physiotherapists); Mode highlighted]

Level of Neurological Status	none	<15 min	16-30 min	31-45 min	46-60 min	>60 Min	unsure
a) Deeply sedated & unconscious	46 (39.3%)	39 (33.3%)	14 (12.0%)	10 (8.6%)	5 (4.2%)	1 (0.9%)	1 (0.9%)
b) Inattentive & uncooperative	16 (13.7%)	62 (53.0%)	24 (20.5%)	7 (6.0%)	5 (4.2%)	0 (0%)	2 (1.7%)
c) Alert, interactive & co-operative but can't ambulate yet	1 (0.9%)	5 (4.3%)	60 (51.3%)	29 (24.8%)	8 (6.8%)	12 (10.3%)	1 (0.9%)
d) Alert, interactive/cooperative & can ambulate	2 (1.7%)	2 (1.7%)	33 (28.2%)	43 (36.8%)	17 (14.5%)	16 (13.7%)	2 (1.7%)

**Mobilization* refers to physical therapy that involves active or assisted patient mobility. This may include bed mobility, sitting, standing, ambulation or active exercise training. This does not include passive range of motion.
**No response: 1 (0.9% of physiotherapists) for a, b, c & 2 (1.7% of physiotherapists)

Table 7.26 Frequency of Mobilization in Mechanically Ventilated Patients by Neurological Status [Frequency (% Physiotherapists); Mode highlighted]

Level of Neurological Status	none	<1/wk.	1-2/wk.	3-4/wk.	5-6/wk.	once daily	twice daily	unsure
a) Deeply sedated & unconscious	40 (34.1%)	13 (11.1%)	23 (19.7%	17 (14.5%)	12 (10.3%)	8 (6.8%)	1 (0.9%)	0 (0%)
b) Inattentive & uncooperative	11 (9.4%)	8 (6.8%)	34 (29.1%)	28 (23.9%)	13 (11.1%)	15 (12.8%)	0 (0%)	0 (0%)
c) Interactive & co-operative but can't ambulate yet	1 (0.9%)	0 (0%)	3 (2.6%)	23 (20.0%)	34 (29.1%)	51 (43.6%)	2 (1.7%)	0 (0%)
d) Alert, interactive/cooperative & can ambulate	3 (2.6%)	0 (0%)	0 (0.0%)	18 (15.4%)	33 (28.2%)	50 (42.7%)	7 (6.0%)	0 (0%)

*_Mobilization_ refers to physical therapy that involves active or assisted patient mobility. This may include bed mobility, sitting, standing, ambulation or active exercise training. This does not include passive range of motion.
**No response: 3 (2.6% of physiotherapists) for a, 8 (6.8% of physiotherapists) for b, 3 (2.6% of physiotherapists) for c, 6 (5.1% of physiotherapists) for d

7.4.7 Physiotherapist Workload

Most physiotherapists (93.2%) stated that they were available for full assessments and mobilization during the regular weekday hours from 08:00 to 17:00 from Monday to Friday. After 17:00, only 20 physiotherapists (17.1%) stated they were availabilities were limited to chest physiotherapy and most (74.4%) said they were not available. On the weekends, the majority of respondents (65.8%) stated they would provide chest physiotherapy. Only 13 clinicians (11.1%) were available for full assessments and mobilization. 17 clinicians (14.5%) were available for limited assessments and mobilization.

On average, physiotherapists stated they worked for a mean duration of 7.2 hours (SD 1.5, range 0-12). Among ICU physiotherapists, 51 (46.4%) were working full time while 59 (53.6%) were working part time. Most of these clinicians had an average workload of 6 patients in the ICU (SD 3, range 0-15), and 10 patients on the ward (SD 3, range 0-20). Physiotherapists who only worked casually less than 1 day per week were not included in the sampling frame.

7.4.8 Interruption of Sedation

Many clinicians stated that daily interruption of sedation was used routinely (34.1%) or frequently (19.6). The majority of physician (55.7%) stated that use of standardized sedation scales or protocols were titrated to the activity level of patients while few physiotherapists (15.5%) agreed with this. In contrast most physiotherapists (34.5%) stated that they never used standardized sedation scales or protocols titrated to the activity level or were unsure (38.8%) if they were used at all.

7.4.9 Acute Rehabilitation beyond the ICU

Some (19.9%) respondent clinicians stated that patients with suspected ICU acquired weakness were routinely referred to outpatient clinics after ICU discharge for long term rehabilitation. Most clinicians did not agree (48.6%) or were unsure of plans for rehabilitation beyond ICU care (31.2%). Among those who clinicians who thought patients were referred for follow-up, physiotherapists (36.2%) and rehabilitation therapists (26.3%) were perceived to be the most common out patient follow-up consultants.

7.5 Regression Analysis

Four multivariate logistic regression analyses were conducted to evaluate for association between dependent and independent variables. *Calibration* is the degree of correspondence between the estimated probability produced by the model and actual observed probability. There was good fit as demonstrated by the Hosmer Lemeshow Goodness Of Fit (GOF) value of $p > 0.05$ for all analyses. The *discrimination* is the ability of the regression model to correctly separate subjects into different groups. The discrimination values can range between 0 and 1.0. The discrimination value of 0.5 is no better than chance.

The first multivariate logistic regression analysis was conducted to evaluate if independent factors were associated with the dependent variable of clinician perception that Early Mobilization is either very important or crucial. The independent factors included the discipline of the clinician (i.e. physician or physiotherapist), the years of clinical experience i.e. less than 5 years, 5 to 20 years or greater than 20 years), the type of ICU (i.e. cardiovascular surgery, medical-surgical, mixed or specialty based), the presence of an Early mobility champion within the ICU, the number of beds in the ICU i.e. less than 15 beds, 15 to 20 beds, and greater than 20 beds), and the corresponding region in Canada (i.e. Eastern, Central, Prairies and Western). 295 observations were included in the multivariate regression analysis with 16 cases excluded because of missing responses. Three factors were significantly associated with the clinician's perception that early mobilization is crucial or very important including bed size ($p=0.014$), profession ($p=0.006$), and presence of EM champion ($p<0.0001$). The odds of smaller ICUs with less than 15 beds compared to larger ICUs with greater than 20 beds was 0.4 times (OR 0.4, 95% CI 0.2, 0.8). The odds of physiotherapists compared to physicians to perceive that early mobilization is very important or crucial was 2.8 times (OR 2.8, 95% CI 1.3, 5.6). In addition, the odds of clinicians working in an ICU where there was no early mobility champion compared to those working in an ICU where there was an early mobility champion to perceive that early mobilization is very important or crucial was 0.3 times (OR 0.3 95% CI 0.2, 0.5).

Table 7.27 Factors associated with Clinician's Perception that *Early Mobilization is Very Important or Crucial* in the Care of ICU Patients

Independent Variable	OR (95% CI)	p - value
Clinician Discipline		
PT vs. MD	2.75 (1.34-5.63)	<0.01
Years of Clinical Experience		
< 5 vs. > 20	0.53 (0.23-1.21)	0.13
5 to 20 vs. > 20	0.63 (0.30-1.29)	0.21
Type of ICU		
CV ICUs only vs. Medical-Surgical ICUs	1.93 (0.613-6.06)	0.26
Mixed ICUs vs. Medical-Surgical ICUs	1.11 (0.59-2.09)	0.75
Specialty ICUs vs. Medical-Surgical ICUs	0.41 (0.08-2.03)	0.27
Local ICU Early Mobility Champion		
Absence vs. Presence	0.31 (0.18-0.54)	<0.0001
Number of ICU Beds		
< 15 vs. > 20	0.38 (0.18-0.83)	0.01
15-20 vs. > 20	0.85 (0.43-1.71)	0.65
Region in Canada		
East vs. Central	0.57 (0.18-1.76)	0.33
Prairies vs. Central	1.26 (0.55-2.86)	0.18
West vs. Central	1.26 (0.55-2.86)	0.59

The second multivariate logistic regression analysis was conducted to evaluate if independent factors were associated with the dependent variable of clinician perception that early mobilization is crucial. The independent factors included the discipline of the clinician (i.e. physician or physiotherapist), the years of clinical experience i.e. less than 5 years, 5 to 20 years or greater than 20 years), the type of ICU (i.e. cardiovascular surgery, medical-surgical, mixed or specialty based), the presence of an ICU Early mobility champion, the number of beds in the ICU i.e. less than 15 beds, 15 to 20 beds, and greater than 20 beds), and the corresponding region in Canada (i.e. Eastern, Central, Prairies and Western). Clinician discipline was the only factor significantly associated with clinician's perception that early mobilization is crucial in the management of critically ill patients (p = 0.04). The odds of physiotherapists perceiving early mobilization as crucial than compared to their physician colleagues were 2.1 times (OR 2.1, 95% 1.0, 4.4).

Table 7.28 Factors associated with Clinician's Perception that *Early Mobilization is Crucial* in the care of ICU patients

Independent Variable	OR (95% CI)	p - value
Clinician Discipline		
PT vs. MD	2.14 (1.03-4.44)	0.04
Years of Clinical Experience		
< 5 vs. > 20	0.42 (0.16-1.09)	0.07
5 to 20 vs. > 20	0.75 (0.36-1.56)	0.43
Type of ICU		
CV ICUs vs. Medical-Surgical ICUs	0.78 (0.25-2.48)	0.67
Mixed ICUs vs. Medical-Surgical ICUs	0.62 (0.30-1.30)	0.20
Specialty ICUs vs. Medical-Surgical ICUs	0.26 (0.03-2.53)	0.24
Local ICU Early Mobility Champion		
Absence vs. Presence	0.59 (0.30-1.16)	0.12
Number of ICU Beds		
< 15 vs. > 20	0.50 (0.19-1.33)	0.17
15-20 vs. > 20	0.98 (0.47-2.07)	0.96
Region in Canada		
East vs. Central	0.93 (0.24-3.64)	0.92
Prairies vs. Central	0.60 (0.18-2.05)	0.42
West vs. Central	0.94 (0.37-2.38)	0.89

The third multivariate logistic regression analysis was conducted to evaluate if independent factors were associated with the dependent variable of clinician's knowledge of ICU acquired weakness. The independent factors included the discipline of the clinician (i.e. physician or physiotherapist), the years of clinical experience i.e. less than 5 years, 5 to 20 years or greater than 20 years), the presence of an early mobility champion within the ICU, and the corresponding region in Canada (i.e. Eastern, Central, Prairies and Western). 280 observations were used in the regression model with 31 missing responses. None of the independent variables included in the model were significantly associated with the correct knowledge of ICU-acquired weakness.

Table 7.29 Factors Associated with Clinician's Knowledge of ICU-Acquired Weakness

Independent Variable	OR (95% CI)	p - value
Clinician Discipline		
PT vs. MD	1.26 (0.72-2.18)	0.42
Years of Clinical Experience		
< 5 vs. > 20	1.12 (0.53-2.35)	0.77
5 to 20 vs. > 20	1.03 (0.54-1.98)	0.92
Local ICU Early Mobility Champion		
Presence vs. Absence	1.10 (0.65-1.86)	0.72
Region in Canada		
East vs. Central	0.25 (0.05-1.16)	0.07
Prairies vs. Central	0.92 (0.39-2.19)	0.85
West vs. Central	0.87 (0.42-1.81)	0.71

Lastly, a multivariate logistic regression analysis was conducted to evaluate if independent factors were associated with the dependent variable of clinician's perception of adequacy of educational training to mobilize mechanically ventilated patients. The independent factors included the discipline of the clinician (i.e. physician or physiotherapist), the years of clinical experience i.e. less than 5 years, 5 to 20 years or greater than 20 years), the presence of an Early mobility champion within the ICU, and the corresponding region in Canada (i.e. Eastern, Central, Prairies and Western). 297 observations were used in the regression model with 14 missing responses.

One factor, the discipline of the clinician, was significantly associated with the perception of being well trained and informed enough to mobilize mechanically ventilated patients ($p<0.0001$). The odds of physiotherapists perceiving that they likely to feel well trained and informed than compared to physicians was 4.4 times (OR 4.4, 95% 2.5, 7.5).

Table 7.30 Factors Associated with Clinician's Perception of Practical Skills & Training

Independent Variable	OR (95% CI)	p - value
Clinician Discipline		
PT vs. MD	4.36 (2.52-7.54)	<0.0001
Years of Clinical Experience		
< 5 vs. > 20	0.72 (0.34-1.51)	0.39
5 to 20 vs. > 20	0.89 (0.47-1.67)	0.71
Local ICU Early Mobility Champion		
Presence vs. Absence	0.61 (0.36-1.04)	0.06
Region in Canada		
East vs. Central	1.81 (0.61-5.36)	0.28
Prairies vs. Central	0.80 (0.34-1.91)	0.61
West vs. Central	1.84 (0.88-3.85)	0.11

7.6 Discussion

Over the past few years, early mobilization has gained considerable attention from the international critical care community as a therapy that may expedite recovery and minimize the functional consequences associated with critical illness. Prominent editorials[12,] highlighting improvement in functional outcomes and cost savings in prospective studies have heightened global awareness and facilitated the implementation of early mobility programs in many institutions. Our survey demonstrates enthusiasm for early mobilization as most respondents perceive it to be very important or crucial in the care of the critically ill. Predictor variables independently associated with clinician support for early mobilization included the presence of an early mobility champion in the ICU, practice in a larger ICU (i.e. greater than 15 beds) and practice as a physiotherapist. However despite this support, clinicians perceive that there are numerous important institutional, provider and patient level barriers that prevent

the timely provision of such rehabilitative measures. The lack of written guidelines or protocols for early mobilization was perceived to be the most important institutional barrier to early mobilization in Canadian ICUs. This perception maybe a reflection of few published guidelines,[3,4] the paucity of evidence for accelerated rehabilitation in all critically ill patients and the uncertainty of the optimal mode, dose and intensity of rehabilitation required for recovery. The strongest evidence in support of early mobilization stems from a single center RCT in a medical ICU where patients in the intervention group began physiotherapy at a median of 1.5 days (1.0-2.1) after intubation compared to those in the control group who began physiotherapy at 7.4 days (6.0-10.9) after intubation ($p<0.0001$).[5] The role for early activity in surgical patients or those with spinal cord injury, renal failure requiring dialysis, delirium, deep vein thrombosis and pulmonary embolism remains to be elucidated. Similar to other recent national surveys,[6,7,8,9] respondents to this questionnaire reported that insufficient staffing (i.e. primarily of physiotherapists and nurses) and the lack of specialized equipment and devices hindered mobilization in their ICUs. Indeed, multiple health care providers and portable equipment (including cardiac monitors, pulse oximeters, battery powered ventilators, bag-valve mask with supplemental oxygen, suction devices, poles, and wheelchairs) are necessary to deliver physiotherapy safely[10].

Our survey highlights significant gaps in the knowledge of ICU acquired weakness among physicians and physiotherapists. The incidence of ICUAW in the general medical-surgical population was under-estimated by 69% of clinicians. Almost 75% of respondents had over 5 years of clinical experience in critical care and regression analysis showed that knowledge deficits were not associated with level of experience, region of practice or discipline of practice. In addition, over 50% of those surveyed did not feel well trained or well informed to mobilize mechanically ventilated patients. Although physiotherapists were 4 times more likely to feel well trained and informed compared to physicians, 39% of them confided that their education was inadequate. Clinician's also reported that safety concerns, delays in recognition on when ICU patients should begin mobilization, conflicting perceptions on the suitability of mobilization in candidate patients, lower prioritization, poor communication and lack of coordination were also important provider barriers of early mobilization in their ICUs.

Although most physicians believed that standardized sedation scales titrated to activity level are routinely used in their ICUs, most physiotherapists were unsure of their existence or felt they are rarely used. It is unclear from this survey what the actual use of sedation scales are in practice. It is possible that sedation scales may have be ordered by physicians but not routinely implemented in practice. It is also possible that sedation scales were routinely used, but that physiotherapists were unaware this. Regardless, most clinicians agreed that excessive sedation is a top patient level barrier to early mobilization in their ICUs.

Most clinicians believed that patients should initiate acute rehabilitation as soon as possible following ICU admission and when their cardio-respiratory status is stable, but the maximal permissible level of activity depended on physiologic, diagnostic and therapeutic measures. Activity restrictions were most frequent in scenarios of patients with head trauma (with increased intracranial pressure), spinal injuries, acute myocardial infarctions (with persistently elevated cardiac enzymes), and delirium. Patients with a central venous catheter or dialysis line in the femoral area were often restricted to range of motion exercises compared to patients with similar lines in the subclavian position. Activity restrictions were not perceived to be necessary in patients who were obese, frail, or affected by thromboembolic events. In addition, physiotherapists stated that they would provide longer durations and more frequent physiotherapy sessions to patients with increased cognitive and co-operative ability. Finally, only 20% of respondent clinicians stated that patients with suspected ICU acquired weakness were routinely referred to outpatient clinics after ICU discharge. This suggests a lack of follow-up care in deconditioned patients and a need to better facilitate such planning after ICU discharge.

The results from our survey are likely representative of Canadian critical care physicians and physiotherapists as the survey employed a number of evidence-based design and incentive based strategies to achieve a very good response rate and reduce non-responder bias. The survey was also extensively developed using a broad range of clinicians and scientific experts in rehabilitation research, physiotherapy, nursing, neurology, clinical epidemiology, and critical care. Clinical sensibility testing revealed excellent agreement among content experts, relavance, and clarity. Survey items were found to be reliable. This validated questionnaire may be a useful tool to better understand the knowledge, perspective and stated practice of acute rehabilitation in critical care in other institutions, organizations or countries. Another strength of this survey is that it is the first national survey to evaluate knowledge of ICU acquired weakness and clinical studies about early mobilization in the ICU. It is the first study to show significant gaps in knowledge and training among experienced clinicians. It also takes into account many unique barriers that had not been evaluated in previous surveys. The results highlighted that early mobilization is a complex therapy that requires the expertise of multiple disciplines of dedicated individuals. Beyond the availability of human and device specific resources, our survey showed additional barriers in the recognition of suitable candidates and communication of providers to prioritize and coordinate rehabilitation in the ICU.

There are some limitations to our survey. The sampling frame included all physicians and physiotherapists who practice in university based critical care units in Canada. The results of the survey may not reflect the perspectives of clinicians working in community-based practices, other disciplines or other

countries. However, the lack of protocols to initiate activity[6] and the limited resources and personal to mobilize patients[7,8] are perspectives that parallel other recent national surveys. Finally, the current survey provides estimates of stated but not actual practice of acute rehabilitation and physiotherapy. A prospective study would be required to better understand the acute rates and barriers to early mobilization.

7.7 Conclusion

We developed and tested a rigorous, reliable questionnaire to evaluate clinician's knowledge, perspectives and practices around mobilization of critically ill patients. Most critical care clinicians believe that early mobilization is very important, but cite numerous important institutional, provider and patient level barriers. The main challenges to the provision of timely rehabilitation in Canadian ICUs include the lack of protocols to guide therapy, limited human resources and equipment, and significant gaps in knowledge and training of providers to safely provide rehabilitation. Although the permissible level of activity depended on physiologic, diagnostic and therapeutic factors, physiotherapists stated they would provide longer and more frequent physiotherapy sessions to critically ill patients who had higher cognitive and co-operative ability. Taking into account that excessive sedation was considered to be one of the most important barriers to early mobilization, strategies improve the neurological status including, daily interruption of sedation, may be one of the most modifable interventions used to improve the activity status of patients in the ICU.

This self-administered survey of Canadian physiotherapists and intensivists will inform next steps in a program of research related to early mobililization of patients recovering from critical illness in the ICU. We plan to conduct a survey of critical care nurses and conduct observational studies on EM in Canadian ICUs.

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Chapter 8
Future Rehabilitation Research in Canada

8.0 Challenges to Acute Rehabilitation in the ICU

Although early mobilization (EM) can reduce ICUAW in critically ill patients, the extent of delay in mobilizing patients varies across ICUs.[1,2] Numerous patients, health care provider and institutional level barriers – both actual and perceived - prevent EM in the ICU. According to clinicians, medical instability, cognitive impairment, obesity, endotracheal intubation, vascular devices, excessive sedation and inadequate analgesia are all important patient barriers to timely mobilization of critically ill patients.[1-5] The lack of portable equipment and health care personnel further limit recovery and are perceived in national surveys from India,[3] Europe,[1] Canada,[4,5] and the US[2] to impede the mobilization of suitable patients. 25% of European ICUs and 20% of ICUs in India do not have designated physiotherapists.[3] In addition, health care providers may have concerns about the safety of early mobilization and perceive that they are inadequately trained to ambulate mechanically ventilated patients.[4] These concerns are compounded by a paucity of guidelines on which patients should begin ICU rehabilitation and when.[6,7] In a national survey of US hospitals, only 10% of all ICUs had established initiation criteria for activity and fewer than 1% of all ICUs had automatic physiotherapy consultations.[2] Hospital administrators may perceive the intervention of early rehabilitation in the ICU to be costly.[8] However, the potential for decreased ICU and hospital length of stay from EM programs may lead to enhanced resource utilization and improved patient satisfaction, resulting in a net cost savings on a larger scale.[8]

8.1 Uncertainty of knowledge, perspectives and practice in Nurses

The current thesis work details the design, testing and results of a national survey of ICU physiotherapists and physicians to assess clinician awareness of ICU acquired weakness, perceived barriers to EM, and perceived physiotherapy practices in 46 Canadian ICUs. This work highlights important gaps in the knowledge and perspectives of two key clinican groups who participate in early mobilization. However, this current survey does not capture the opinions and views of other important participants such as nurses, respiratory therapists, occupational therapists, health care aids and family members. As reported by clinicians in the current survey, nurses are primary participants 99% of the time in early mobilization efforts. Therefore, a survey evaluating critical care nursing knowledge, perspectives and practise may provide further insight into barriers that must be overcome before EM can be delivered.

8.2 Mobility Champions & EM Programs

In the current survey, over 50% of respondents perceived that there was at least one mobility champion in their ICU. A mobility champion was defined as a health care clinician who promotes acute rehabilitation and/or physiotherapy in

the ICU through patient advocacy or quality improvement initiatives. Seminal work by Hopkins et al. suggested that the identification of barriers by local mobility champions in multidisciplinary teams are of paramount importance in creating an environment that supports the provision of timely and effective rehabilitation in the ICU.[9] The recognition of local barriers through a review of existing practices followed by strategic discussions among health care champions across disciplines have led to the creation of guidelines and educational initiatives to promote EM.[52]

8.3 Stated practice versus actual practice: Justifying a Point Prevalence study

While recent surveys provide data about stated practice and perceived barriers, *actual* rates and barriers of mobilization in daily practice may differ considerably. The prevalence of immobility in important populations and unique patient populations including trauma, spinal cord injury patients, those with renal failure requiring dialysis, delirium, deep vein thrombosis and pulmonary embolism have yet to be elucidated. The current intensity, frequency and types of physiotherapy need to be understood before any rehabilitation interventions can be stategically developed and tested. Understanding key factors that trigger mobilization from bedside nurses and physiotherapist who are faced with daily challenges will be intrumental in helping design effective mobilization programs.

A prospective one-day point prevalence study has been designed and is currenty in progress. This study will be the first prospective study of mobilization in Canada and focus specifically on current practice in Canadian ICUs. This work will seek to understand if EM protocols, guidelines or programs exist in actual practice. Identifying the proportion of patients who are eligible to be mobilized but are otherwise not, barriers to and facilitating factors of mobilization are necessary to raise awareness of ICUAW and begin to develop specific interventional strategies Canada. The results of this prospective study will provide clinicians and researchers with a better understanding of the gap in care, which we believe is crucial in the recovery of critically ill patients.

8.4 Future Directions

Further studies are required to fully elucidate the mechanisms by which immobility and other aspects of critical illness lead to ICUAW. Currently, there are limitations in the ability to diagnose and treat ICUAW. Early prospective studies demonstrate that early mobility is safe in critically ill patients. However, well-designed randomized controlled trials are required to evaluate clinically important outcomes of early mobilization. The optimal mode and dose of acute rehabilitation and the effects of novel treatments remain unknown. Elucidating local barriers, developing guidelines to facilitate early mobilization, advocating for appropriate staffing, and nurturing a culture that prioritizes rehabilitation as an integral part of critical care are important steps in building a sustainable rehabilitation program. Evaluating the ongoing benefits of pro-active recovery

program as patient's transition from the ICU, to the ward, and to the community, would also be of interest. Finally, the potential benefits of early mobilization in other populations of critically ill patients (e.g. pediatric, surgical, trauma, neurological) need to be explored in future clinical trials.

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Addendum 1: Survey of Acute Rehabilitation in Canadian ICUs

Canadian Critical Care Trials Group

CANADIAN SURVEY OF MOBILIZATION OF ICU PATIENTS:
CURRENT KNOWLEDGE, PERSPECTIVES, AND PRACTICES

Please complete the following questions. All responses will be held in confidence.

Glossary of Terms

ICU: Intensive Care Unit

PCCU: Pediatric Critical Care Unit

ICU-acquired weakness: polyneuropathy, polyneuromyopathy or neuropathy acquired during critical illness.

Mobilization: physical therapy that involves active or assisted patient mobility. This may include bed mobility, sitting, standing, ambulation or active exercise training. This does not include passive range of motion.

Early Mobilization (EM): physical therapy and acute rehabilitation measures initiated as soon as possible following admission to the ICU. Patients who receive EM will be progressively rehabilitated through a series of exercises that may begin while they are still receiveing life support (i.e. mechanical ventilation).

Non-Mobility Physiotherapy
• **Cardio-respiratory/Chest physiotherapy:** physical therapies to improve ventilation-perfusion matching and respiratory mechanics including deep breathing exercises, airway secretion clearance, and percussion techniques • **Passive Range of Motion:** passive movement facilitated by providers
Mobility Physiotherapy
• **Active Range of Motion:** unassisted patient movement • **Strengthening exercises:** muscle strengthening (can include bedside cycle ergometer), neuro-developmental play (i.e., play activities to facilitate fine and gross motor development) for infants and developmentally delayed children. • **Bed mobility:** activities done while recumbent (e.g., active or partially assisted repositioning in bed or rolling from side to side) • **Transfers:** trunk control, unsupported sitting, sitting on edge of bed, sit to stand, from bed to chair or commode • **Pre-Gait:** weight shifting, stepping in place and sideways • **Ambulation:** walking/gait training with or without walking aid or assistance

PERCEPTIONS

1.0 Personal view of Early Mobilization in the ICU

1. Please select ONE option below that best describes your view of early mobilization:

☐ 1	☐ 2	☐ 3	☐ 4	☐ 5	☐ 6	☐ 7
crucial, should be top priority in the care of ICU patients	very important, should be a priority in the care of ICU patients	important, should be a priority in the care of ICU patients	somewhat important, should be considered in the care of ICU patients	not of great importance, but clinicians should bear it in mind	of minimal importance to the care of ICU patients	of no importance to the care of ICU patients

1.1 Barriers to Early Mobilization in the ICU

2. a) What is (are) the most important *institutional* barrier(s) to early mobilization in YOUR ICU? By *institutional* barriers we mean customs and behaviour patterns in your work environment. Please check ALL that apply or "no institutional barriers" if there are none.

- routine bed rest orders on ICU admission
- physician orders required prior to mobilization
- insufficient equipment for early mobilization (e.g. ceiling lifts, chairs, walkers etc)
- no written guidelines or protocols for early mobilization
- not enough physical space
- no clinician champion/advocate to promote early mobilization in the ICU
- perceived to be an expensive intervention by administrators or unit leaders
- no institutional barriers
- other institutional barrier(s), please specify

_____

_____

2. b) What is (are) the most important *patient* level barrier(s) to early mobilization in YOUR ICU? Please check ALL that apply or "no patient barriers" if there are none.

- medical instability
- endotracheal intubation
- physical restraints
- risk of dislodgement of devices or lines
- cognitive impairment/cognitive age
- excessive sedation
- inadequate analgesia
- obesity
- frailty
- inadequate nutritional status
- no patient barriers
- other patient barrier(s), please specify

_____

_____

3. *Providers* are critical care physicians (MD), physiotherapists (PT), registered nurses (RN), respiratory therapists (RT), and referring consultants/primary surgeons (CS). What is (are) the most important *provider* level barrier(s) to early mobilization (EM) in YOUR ICU/PCCU? If you believe that the listed barrier is important, please select ALL provider(s) who contribute to the existence of that barrier. Alternatively, if you believe the listed barrier is NOT an important barrier, select "None".

Potential Provider Barrier	MD	PT	RN	RT	CS	None
a) limited staffing to routinely mobilize patients						
b) EM in the ICU/PCCU is generally supported but it is not perceived as a priority in the care plan of a critically ill patient						
c) EM in the ICU/PCCU is generally perceived as important but it is not supported by some specific individuals						
d) lack of communication among clinician groups to facilitate EM during bedside rounds						
e) lack of communication about rehabilitation during hand-over at shift change						
f) lack of coordination among providers to facilitate EM						
g) slow to recognize when patients should begin EM						
h) lack of specific decision-making authority to initiate EM						
i) conflicting perceptions about suitability of EM in some patients						
j) safety concerns about EM						
k) inadequate training to facilitate EM						
l) other *provider* level barrier(s), please specify: _____ _____						

1.2 When to Initiate Mobilization in the ICU/PCCU

4. Generally speaking, when do YOU think mobilization should be initiated in the ICU/PCCU? Please select ALL that apply.

- ☐ as soon as possible following ICU/PCCU admission
- ☐ as soon as the patient's cardio-respiratory status has stabilized (i.e. no escalation in hemodynamic or ventilatory support)
- ☐ as soon as the patient is extubated
- ☐ as soon as the patient is off all vasoactive infusions
- ☐ as soon as the patient is conscious and can cooperate
- ☐ as soon as all sedative infusions are discontinued
- ☐ as soon as the patient is ready to be transferred out of the ICU
- ☐ other, please specify _____

1.3 Level of Activity

5. For each of the following scenarios, assume that the patients are previously ambulatory and are currently physiologically stable on mechanical ventilation, no inotropes and on minimal sedation infusion. These patients have purposeful motor response and can obey verbal commands (unless otherwise stated). In YOUR opinion, what would you consider as the *greatest permissible* level of activity for a patient with the following diagnosis, condition, device or drug. Please select ONE response for each diagnostic group.

Diagnosis, Condition, Device or Drug	bed rest	passive range of motion	active range of motion	standing	transfers to chair	ambulation	not sure
Diagnosis/Conditions							
a) head trauma without increased intracranial pressure							
b) head trauma with increased intracranial pressure							
c) cervical spinal injury							
d) thoracio-lumbar spinal injury							
e) within 24 hrs of treated myocardial infarction (cardiac enzymes persistently elevated)							
f) within 24 hrs of treated myocardial infarction (cardiac enzymes decreasing)							
g) coagulopathy (INR > 3)							
h) thrombocytopenia (platelet count < 20 $x10^9$/L)							
i) delirium (fluctuating level of consciousness, at times inattentive or agitated)							
j) within 24 hrs of uncomplicated coronary bypass surgery							
k) deep vein thrombosis (receiving therapeutic anti-coagulation)							
l) obesity							
m) frailty							
Devices							
n) pulmonary artery catheter							
o) intra-aortic balloon pump							
p) femoral central venous catheter							
q) radial arterial catheter							
r) dialysis line inserted at the subclavian site (during non-dialysis periods)							
s) dialysis line inserted at the femoral site (during non-dialysis periods)							
t) continuous renal replacement therapy (during dialysis such as PRISMA)							
u) extra corporeal membrane oxygenation							
v) high frequency oscillation							
w) conventional mechanical ventilation with an endotracheal tube							
x) conventional mechanical ventilation with a tracheostomy							
y) non-invasive positive pressure ventilation (e.g. BiPAP)							
z) chest tube							
aa) foley catheter							
Drugs							
bb) full anti-coagulation (i.v. heparin infusion, warfarin)							

6. Consider a patient admitted to the ICU/PCCU who is intubated and mechanically ventilated (unless otherwise stated). What *maximum level* of activity would you prescribe for this patient under each of the following independent circumstances? Please select ONE response for each condition.

Physiological Status	bed rest	passive range of motion	active range of motion	standing	transfers to chair	ambulation	not sure
Cardiovascular a) three or more vasopressors or inotropic infusions							
b) two vasopressors or inotropic infusions							
c) one high dose vasopressor or inotropic infusion							
d) one medium dose vasopressor or inotropic infusion							
e) one low dose vasopressor or inotropic infusion							
f) no vasopressors or inotropes							
Respiratory g) minimal pressure support on conventional mode of mechanical ventilation							
h) moderate pressure support on conventional mode of mechanical ventilation (e.g., FiO_2 0.5, PEEP 10)							
i) advanced mode of mechanical ventilation (e.g., high frequency oscillation)							
Neurologic j) unresponsive to verbal and motor stimulation							
k) purposeful motor response , not obeying verbal commands							
l) purposeful motor response, obeys verbal commands							

KNOWLEDGE

2.1 Intensive Care Unit Acquired Weakness (ICU-AW)

7. What do YOU think is the approximate incidence of ICU-AW in the population of general medical-surgical ICU patients?

- < 5%
- 5-10%
- 11-20%
- 21-40%
- > 40%
- Don't know

2.2 Current Literature

8. Are YOU familiar with any clinical trials or literature evaluating early mobilization of critically ill patients?

- yes
- no

9. What do the clinical studies about early mobilization of critically ill patients (i.e., general medical surgical ICU population) show? Select ALL TRUE responses only.

- I am not sufficiently familiar with the current literature/clinical studies on early mobilization in the ICU.
- early mobilization of critically ill patients can improve their functional independence (i.e., activities of daily living) at hospital discharge
- early mobilization of critically ill patients is associated with reduced mortality at hospital discharge
- early mobilization of critically ill patients is associated with a reduced incidence of delirium
- early mobilization of critically ill patients reduces the incidence of deep vein thrombosis
- early mobilization of critically ill patients reduces their time requiring mechanical ventilation

2.3 Practical and Technical Skills

10. How well trained and informed do you feel to mobilize mechanically ventilated patients? Please select ONE response only.

- I feel well trained and informed to mobilize mechanically ventilated patients.
- I feel somewhat trained and informed to mobilize mechanically ventilated patients.
- I do not feel sufficiently trained or informed to mobilize mechanically ventilated patients

PRACTICE

3.1 Assessment for Need of Rehabilitation

11. Are all patients automatically assessed for appropriateness to begin mobilization by the physiotherapist in YOUR ICU/PCCU without prompting or requests by other clinician groups?

- yes
- no
- unsure

12. Who is generally the first health care provider to identify if a patient is ready for mobilization? Please select ONE response only.

- registered nurse
- physician
- physiotherapist
- occupational therapist
- respiratory therapist
- other, please specify _____

13. Does the initial physiotherapist assessment on each patient require a written medical order by a physician?
- technically, yes
- no
- unsure

14. Does YOUR ICU/PCCU have written protocols or policies that provide guidelines on when a patient should begin mobilization?
- yes
- no
- unsure

15. Does YOUR ICU/PCCU have at least one clinician who serves as a champion for early mobilization?
- yes
- no
- unsure

16. If the ICU/PCCU you work in has at least one champion who promotes early mobilization, what discipline is she/he from?
- PT
- MD
- RN
- RT
- unsure

3.2 Intensity & Frequency of Mobilization

17. On average, what is the daily duration of mobilization performed by physiotherapists in YOUR ICU/PCCU on the following types of critically ill patients?

Condition	none	<15 min	16-30 min	31-45 min	46-60 min	>60 min	unsure
a) a patient who is intubated, mechanically ventilated, deeply sedated and unconscious							
b) a patient who is intubated, mechanically ventilated, inattentive and uncooperative							
c) a patient who is intubated, mechanically ventilated, alert, interactive and co-operative but can not ambulate yet							
d) a patient who is intubated, mechanically ventilated, alert, interactive/cooperative and can ambulate							

18. How frequently is mobilization performed by a physiotherapist in YOUR ICU on the following types of critically ill patients?

Condition	none	<1/wk	1-2/wk	3-4/wk	5-6/wk	once daily	twice daily	> twice daily	unsure
a) a patient who is intubated, mechanically ventilated, deeply sedated and unconscious									
b) a patient who is intubated, mechanically ventilated, inattentive and uncooperative									
c) a patient who is intubated, mechanically ventilated, alert, interactive and co-operative but can not ambulate yet									
d) a patient who is intubated, mechanically ventilated, alert, interactive/cooperative and can ambulate									

3.3 Staffing in the ICU/PCCU

19. Who participates in the mobilization of patients in YOUR ICU/PCCU? Please select ALL that apply.

- registered nurse
- physician
- physiotherapist
- occupational therapist
- respiratory therapist
- health care aide (i.e. physical therapy assistant, nurse aide etc)
- family member or home caregiver
- other, please specify _____

20. Is there a designated physiotherapist working in YOUR ICU/PCCU during the following times?

Time	available for full assessments & mobilization	available for limited assessments & mobilization	available only for cardio-respiratory/ chest physiotherapy	not available	unsure
regular weekday hours (Monday - Friday)					
weekday evenings (after 17:00, Monday-Friday)					
weekends (Saturday, Sunday) & holidays					

3.4 Types of Physiotherapy Techniques Performed

21. In general, how often are these physiotherapy techniques used in ICU/PCCU patients who are eligible/suitable for rehabilitation? Please select only ONE answer for each type of treatment.

Type of physiotherapy	never	infrequently	sometimes	frequently	routinely	unsure
a) chest physiotherapy						
b) passive range of motion						
c) active range of motion						
d) strengthening exercises						
e) bed mobility						
f) transfers						
g) pre-gait activities						
h) gait training/ambulation						
i) treadmill						
j) neuromuscular electrical stimulation						
k) cycle ergometer						
l) dynamic tilt table						
m) other, please specify _____						

3.5 Workload of the Physiotherapist

22. Please answer the following questions about YOUR workload in the ICU/PCCU:

a) On average, how many ICU/PCCU patients do you see each per day? _____

b) On average, how many hospital patients (including ICU/PCCU) do you see per day? _____

c) Do you work full time or part time in the ICU/PCCU?

- full time
- part time

d) What is the duration of your shift? _____ hours

3.6 Sedation Practices

23. Are daily interruption of sedation or sedation protocols used in YOUR ICU/PCCU?

- routinely
- frequently
- sometimes
- infrequently
- never
- unsure

24. Do YOU use standardized sedation scales to titrate sedation, according to patient activity level?

- routinely
- frequently
- sometimes
- infrequently
- never
- unsure

3.7 Rehabilitation following ICU/PCCU Discharge

25. Are patients with suspected ICU acquired weakness routinely referred to an outpatient clinic after ICU/PCCU discharge for long term rehabilitation?

- yes
- no
- unsure

26. To whom are the patients with suspected ICU acquired weakness referred?

- family physician
- general internist/paediatrician
- neurologist
- physiotherapist
- occupational therapist
- rehabilitation specialist
- intensivist
- other, please specify _____
- patients with ICU acquired weakness are not routinely referred to outpatient clinics
- unsure

4.1 Clinician Demographics

27. What type of clinician are you?

- physiotherapist
- physician
- registered nurse

28. What is your primary area of practice?

- adult
- paediatric

29. What type(s) of ICU(s) do you work in? Please select ALL that apply.

- medical-surgical ICU
- cardiovascular ICU
- neurological ICU
- trauma ICU
- burn ICU

Thank you very much for completing this survey!
Please return completed survey in the pre-addressed, pre-paid envelope provided.