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CLINICAL GUIDELINE

Physical activity and movement: A guideline for critically ill adults

Intensive Care NSW

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Disclaimer

- This clinical practice guideline (CPG) is aimed at providing the clinicians of NSW hospitals' intensive care units (ICU) with recommendations to frame the development of a physical activity and movement program for critically ill adult patients in acute care facilities.
- This CPG is not intended to replace the critical evaluation processes that underpin the development of local policy and procedure nor does it replace a clinician's judgment in an individual case.
- Users of this CPG must critically evaluate this CPG as it relates to local circumstances and any changes in the literature that may have occurred since the dates of the literature review conducted. In addition, NSW Health clinicians must review NSW State Government policy documents to identify any directives that may relate to this clinical practice.
- These guidelines are intended for use in NSW acute care facilities.
- These guidelines are intended for use in adults only.
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TABLE 1 – GUIDELINE UPDATE MEMBERS			
Name/position	**Role**	**Organisation**	**Hospital**
Lauren Thomas, Physiotherapist	Member – Physiotherapy	Hunter New England Local Health District	John Hunter
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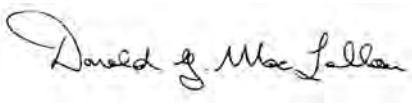
Foreword

Many survivors of a critical illness experience significant physical, psychological and cognitive deficits. Emerging research supports the inclusion of physical activity and movement programs into the care routines of Intensive Care patients.

The purpose of this guideline is to provide intensive care clinicians with evidence and best practice recommendations to guide the development of local physical activity and movement (PAM) programs for critically ill adult ICU patients.

Developed under the auspices of the Intensive Care Best Practice Manual Project, this guideline highlights the ability of the NSW Agency for Clinical Innovation (ACI) to facilitate strong working relationships with clinicians as well other executive branches of the NSW Ministry of Health.

On behalf of the ACI, I would like to thank Susan Pearce, Chief Nursing and Midwifery Officer for providing state executive sponsorship for the project and funds for the Project Officer. I would also like to extend my appreciation to the LHD executives for facilitating the participation of LHD staff in developing these guidelines, which I commend to you the clinicians of NSW.



Prof Donald MacLellan
Acting Chief Executive, Agency for Clinical Innovation

Glossary

ABHR	Alcohol-based hand rub
ACI	Agency for Clinical Innovation
ADL	Activity of daily living
AGREE Tool	The Appraisal of Guidelines for Research and Evaluation (AGREE) Instrument evaluates the process of practice guideline development and the quality of reporting
AM	Ambulating monitoring
AROM	Active range of motion
Arrhythmia	An irregular heartbeat or abnormal rhythm
Barotrauma	Pulmonary barotrauma refers to alveolar rupture due to elevated transalveolar pressure
BIS	Bioelectrical Impedence Spectroscopy
BMI	Body mass index
BSA	Body surface area
Critical illness polymyopathy	Critical illness polymyopathy is a syndrome of widespread muscle weakness which can develop in critically ill patients receiving intensive care
Critical illness polyneuropathy	Defined as a predominantly motor axonal dysfunction in critically ill patients
CNC	Clinical Nurse Consultant
CPAx	Chelsea Critical Care Physical Assessment Tool
CPP	Cerebral perfusion pressure
DC	Data collector
Deconditioning	Muscle weakness that occurs in critically ill patients
DVT	Deep vein thrombosis
DF	Dorsiflexion
Dx	Diagnosis
Dyspnoea	Shortness of breath, breathlessness, laboured breathing to the point of discomfort or distress
ETT	Endotracheal tube
FiO_2	Fraction of inspired oxygen
FSS-ICU	Functional Staus Score –Intensive Care Unit
GDN	Guideline development network
HDU	High dependency unit
HHD	Hand Held Dynamometry
HGD	Hand Grip Dynamometry
HR	Heart rate
Hypoxaemia	Subnormal oxygenation of arterial blood
IABP	Intra aortic balloon pump
ICCMU	Intensive care coordination and monitoring unit
ICP	Intracranial pressure

ICU	Intensive care unit
IMS	Intensive Care Mobility Scale
IDC	Indwelling urinary catheter
IRR	Inter-rater reliability
MAP	Mean arterial pressure
MICU	Medical intensive care unit
MRC	Medical Research Council
MRO	Multi resistant organism
MV	Mechanical ventilation
NGT	Nasogastric tube
NHMRC	National Health and Medical Research Council
PAM	Physical activity and movement
PF	Plantar flexion
P-FIT	Physical Function ICU Test
P/F Ratio	The PF ratio is PaO2/FiO2 and is a means of describing the severity of pulmonary dysfunction of ventilated patients in ICU.
PPE	Personal protective equipment
Range of motion **Range of movement**	Range of motion (ROM) is a term commonly used to refer to the movement of a joint from full flexion to full extension i.e. total amount of motion possible in a joint.
RR	Respiratory rate
RN	Registered Nurse
RROM	Resisted range of motion exercises
SBP	Systolic blood pressure
SOEOB	Sitting on the edge of the bed
SOOB	Sitting out of bed
SOMS	Surgical Intensive Care Unit Optimal Mobilisation Score
SpO_2	Peripheral oxygen saturations
Sx	Surgery
Tachypnoea	Rapid breathing
Taxonomy	The branch of science concerned with classification, especially of organisms; systematics.
Tracheostomy	A surgical procedure to create an opening through the neck into the trachea. A tracheostomy tube can be placed through this opening to create an airway and avenue to suction the patient's secretions.
US	Ultra Sound
VAP	Ventilator associated pneumonia
Vasopressor	A class of drugs that cause vasoconstriction as a means of elevating mean arterial pressure (MAP).

Executive summary

As survival rates following critical illness continue to improve [1] more information is becoming available about the significant physical, psychological and cognitive deficits experienced by many survivors during their recovery and subsequent hospital discharge. Some of these deficits can be attributed to muscle wasting as a result of critical illness, treatment and immobility while in the intensive care (ICU). Studies have demonstrated that early physical activity and movement programs are feasible, safe and effective at reducing some of the adverse effects of surviving a critical illness.[2, 3]

This guideline is based on three clinical health questions: How can critically ill adult patients in ICU be safely mobilised? What are the strategies for safely mobilising a patient within an adult ICU? What are the barriers to safe mobilisation of patients in an adult ICU?

This guideline offers 16 recommendations to guide the development of a physical activity and movement (PAM) program for critically ill adult ICU patients from the time of admission until discharge. It is recommended that when developing individual patient PAM programs local resources be taken into consideration to ensure successful implementation and maintenance of the program. Finally, it is important that clinicians evaluate the effectiveness of locally developed PAM programs to ensure that patients' recovery from their experience of critical illness has been optimised.

Section	Recommendation	GOR
Assessment and clinical practice		
1.	A dedicated physical activity and movement program should be implemented to aid in the recovery of critically ill patients.[8, 9, 56, 57]	Grade A
2.	Early physical activity and movement is feasible and safe for critically ill patients and should be incorporated into usual practice.[2-5, 23, 37, 38, 40, 56-58]	Grade A
3.	All patients admitted to the ICU should be screened on a daily basis for inclusion in a PAM program. This assessment should be documented in the patient's medical record. Where feasible this screening should occur within 24 hours of admission.[5, 6, 27]	Grade C
4.	The program, based on the patient's current activity level, should be developed in consultation with a multidisciplinary team.[6, 7]	Grade C
5.	In addition to the physical benefits PAM should be implemented to support patients' psychosocial needs and reduce concerns such as anxiety, depression and sleep disorders/disturbances that may impact the patient after discharge from the ICU.[5]	Grade C
6.	The minimum human resources for safely ambulating the ventilated patient must be three staff members, one of whom is experienced and will act as team leader. The actual number of staff will be based on pre-mobility assessment. A Medical Officer with accreditation in advanced airway skills must be available on site.[2, 3, 5, 7]	Grade C
7.	The equipment that may be required includes a portable ventilator and/or manual resuscitator bag, portable suction and oxygen, IV pole, monitoring equipment, a walking frame and a wheelchair to follow.[2, 3, 5, 7]	Grade C
8.	The development of a dedicated multidisciplinary team is essential for the successful implementation and maintenance of a patient physical activity and movement plan.[11, 35, 50]	Grade C

Infection prevention		
9.	Clinicians are to undertake a risk assessment to identify the risk of contamination and mucosal or conjunctival splash injuries during PAM activities. PPE (including goggles/ face shield/gloves and gown/apron) as per NSW 2007 Infection Control Policy are to be worn according to this risk assessment.	PD2007_036 Australian Guidelines for Prevention & Control of Infection in Healthcare.
10.	Clinicians must adhere to the Five Moments of Hand Hygiene.	PD2010_058
11.	To reduce the risk of microbial transmission, equipment utilised for each patient must be cleaned as per the NSW Infection Control Policy and ASA Standard 4187 prior to and following use.[12, 13]	PD2007_036 AS 4187 2003
Work, health and safety		
12.	Clinical staff undertaking patient physical activity and movement must undertake a risk assessment of the intended activity/ies to protect the health and safety of the patient and all staff involved.	Consensus
Governance		
13.	Education and training should be given to key stakeholders regarding the benefits/ importance of physical activities and movement in the ICU patient.	Consensus
14.	Medical, nursing or physiotherapy ownership of a patient physical activity and movement plan should be determined.[11]	Grade C
15.	Hospital executive support, in terms of management/budgetary maintenance of a patient physical activity and movement program, should be available.	Consensus
16.	Evaluation of a patient physical activity and movement program should occur following implementation, with regular audits for compliance conducted as a component of the ICU's routine quality improvement program. A number of valid and reliable ICU specific outcome measures are available to assist evaluation process.[44, 45, 47, 48, 59, 61, 62]	Consensus

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Section 1

Introduction

Health question/s at focus of clinical practice

Mobilisation of critically ill patients, particularly those receiving mechanical ventilation, presents challenges to healthcare professionals. Current evidence suggests that lack of mobilisation poses a risk to patients.[12] Physical inactivity in critically ill patients may result in the development of neuromuscular weakness and delayed weaning from mechanical ventilation.[7] Critically ill patients often experience long-term sequelae including depression, anxiety and impaired mobility.[6, 7, 13] These complications can significantly impact the quality of life of both the survivor and their family.[13] To reduce the physical deficits and muscle weakness present as a consequence of a patient's treatment and bed rest with critical illness,[14] recent attention has focused on early physical activity and movement while a patient is still in the ICU. Although further clinical trials are required to validate the benefits of physical rehabilitation programs,[15, 16] there is sufficient evidence to demonstrate the feasibility and safety of physical activity and movement interventions. The aim of this guideline is to use current evidence to guide implementation of routine and systematic physical activity and movement interventions for patients in intensive care and high dependency units.

The guideline is based on three clinical health questions:

- How can critically ill adult patients in intensive care units (ICU) be safely mobilised?
- What are the strategies for safely mobilising a patient within an adult ICU?
- What are the barriers to safe mobilisation of patients in an adult ICU?

Scope

This guideline is provided so that acute care facilities can develop local practices to support the development of a culture of early physical activity and movement for critically ill adults (individuals aged older than 14). For the purposes of this guideline mobilisation encompasses the full spectrum of physical activity from limb movement through to walking.

Target clinicians

The guideline concerns all members of the multi-disciplinary team including nurses, physiotherapists, doctors, occupational therapists, therapy assistants, wardspersons/orderlies and biomedical staff.

Consumer involvement

We were unable to recruit any consumers to participate in guideline development or review.

How the guideline was developed – 2014 version

Guideline development methods were based on earlier similar work[17] and revised to reflect updates from NHMRC[18] and the AGREE tool.[19] A guideline development network (GDN) was formed, involving practising intensive care nurses and physiotherapists from a range of ICUs throughout NSW. This network developed the guideline template that outlined the clinical question and specific areas to be addressed within the guideline. Following this, a systematic literature review was undertaken (for more details see below). A practice review was also conducted to determine a practice baseline. A technical report was developed from the systematic literature review and this document was used to inform discussions and recommendation development at the consensus meeting. NHMRC evidence statement forms were created and formed the evidence audit trail. Following the meeting the guideline document was written and circulated among group members. Consensus development and organisational consultation was undertaken over three stages:

1. Guideline group consensus - the guideline group reviewed the guideline and technical report. Agreement on recommendations was undertaken using an online survey platform (Survey Monkey) and a 1-9 Likert scale. Consensus was set as a median of ≥ 7.
2. External validation consensus – an additional clinician group was recruited from NSW and their agreement with the recommendation statements was sought using the processes outlined above.

(See Appendix 1).

3. Organisational consultation was undertaken by distribution via Intensive Care Services Network.

The guideline was revised to reflect feedback received at each stage of the process.

Guideline group – 2014 version

The guideline development network (GDN) comprised senior nurses and physiotherapists working in NSW ICUs and a nursing academic (See Table 1). This group undertook the majority of development work for the guideline.

Evidence review – 2014 version

A systematic literature review was undertaken using the following clinical questions:

- How can critically ill adult patients in ICU be safely mobilised?
- What are the strategies for safely mobilising a patient within an adult ICU?
- What are the barriers to safe mobilisation of patients in an adult ICU?

The systematic literature review (see Appendix 1) considered studies that included patients in ICUs including those who were intubated and receiving mechanical ventilation. The interventions of interest were those designed to benefit critically ill patients in terms of physical activity and movement. The types of outcome measures considered were general and specific indicators of activities that promoted patients' ability with regards to specific activities and movement. Articles published from 2005 to 2013 in English and indexed in the following databases were searched: CINAHL, MEDLINE, Joanna Briggs Institute, Cochrane Library, EMBASE, DARE and Google. Key search terms used in the review were *mobilisation, exercise, rehabilitation, mechanically ventilated, intensive care, critically ill* and *critical care*. Full copies of articles considered to meet the inclusion criteria (on the basis of their title, abstract, and subject descriptors) were obtained for data synthesis. Articles identified through reference lists and bibliographic searches were also considered. Articles were excluded if the study sample consisted of healthy participants or the study was conducted in a setting other than a critical care environment. Articles were independently reviewed, using specific data extraction tools, by two reviewers who then formed a consensus on suitability for inclusion in the review. A third reviewer resolved discrepancies in reviewers' selections. NHMRC levels of evidence were used (see Appendix 3).

Guideline update methods

A systematic review using the original methods was undertaken to cover years 2013–December 2015. The new evidence has been added to the summary tables in the Appendix.

Level of evidence taxonomy

NHMRC procedures and taxonomy were used in the development of this guideline. Where research evidence could not be identified participants' expert opinions were used with agreement methods applied.

Table 2 below lists NHMRC grading of recommendation used in this guideline.

TABLE 2 – NHMRC GRADING OF RECOMMENDATIONS [20]

Grade of recommendation	Description
A	Body of evidence can be trusted to guide evidence
B	Body of evidence can be trusted to guide practice in most situations
C	Body of evidence provides some support for recommendations but care should be taken in its application
D	Body of evidence is weak and recommendation must be applied with caution
Consensus	Consensus was set as a median of ≥ 7

Background

Immobility and bed rest of the critically ill patient is an ongoing problem that challenges the healthcare team. Critically ill patients may develop muscle weakness leading to impaired mobility as a result of high acuity, mechanical ventilation (MV), sedation and decreased level of consciousness. Specific physical complications of critical illness, recently labelled ICU-acquired weakness (ICU-AW) [21] including critical illness polymyopathy and critical illness polyneuropathy, contribute significantly to impaired mobility in ICU patients. The issue is heightened by extended periods of bed rest and inactivity. [22, 23] Impaired physical mobility and loss of muscular function from critical illness and periods of MV have ramifications for the patient, the patient's family and the healthcare system more broadly.

The impact on the patient may encompass functional decline and associated neuromuscular and musculoskeletal weakness, impaired coordination, prolonged hospital stay and delayed physical recovery after hospital discharge. The invasive treatment of MV can lead to a variety of other complications such as ventilator associated pneumonia, barotrauma and other ventilator induced injury, thromboses from circulatory issues and impaired skin integrity such as pressure injuries. Once the patient has left the ICU, ongoing complications can persist. These include a decline in activities of daily living and decreased independence, psychosocial concerns such as anxiety, depression and sleep disturbance.[10, 24] The impact to the healthcare system of the critically ill patient who is exposed to a prolonged ICU stay and MV include increased length of hospital stay and subsequent high cost of healthcare.[22]

A growing body of evidence suggests that the implementation of early mobility practices by providing physical activity and movement guidelines and programs in the ICU can have long-term benefits for the patient and the healthcare system. Managing this group of patients to improve mobility needs a focus on increasing muscular strength; treating de-conditioning and maintaining muscular mass and function. The key to effecting change is to improve patient mobility through the implementation of dedicated physical activity and movement programs. This will require a collaborative approach from a multidisciplinary team based on established best practice. Physical training programs may include focusing on limb muscle training using passive and active range of movement and a progressive mobilisation plan. Research to date has shown this approach to be effective and economical. [6, 7, 25]

Physical activity and movement (PAM) is a program to optimise functional outcome of the critically ill adult. It comprises a range of strategies that include patient assessment followed by a series of activities designed to optimise muscle strength and functional mobility. It can be summarised as a specific range of patient activities (Table 3).

A series of studies have demonstrated the feasibility and safety of mobilising ICU patients, including those who are mechanically ventilated via endotracheal tube or tracheostomy. [3, 7, 23, 26] Table 4 documents the results of a systematic review undertaken by Nydahl et al., in 2014 looking at complications associated with mobilisation of critically ill patients. A small proportion of actual adverse events were observed when compared to the overall number of activities. From a combined total of 3613 activity sessions, there was a less than 4% incidence of a clinically important change in cardio-respiratory parameters or an adverse safety event for patients. It is important that staff members are aware of potential adverse events, to ensure that appropriate staffing levels, monitoring equipment and safety precautions are incorporated into the patient's PAM program. Table 5 shows an example of a safety checklist which may be utilised by staff in the ICU to ensure safe mobilisation of critically ill patients.

TABLE 3 – TYPES OF PHYSICAL ACTIVITY AND MOVEMENT			
Activity	**Description**	**Examples**	**Resources**
Active range of motion exercises (AROM)	A range of movement where a patient can actively (without assistance) move a joint using the adjacent muscles	Shoulder abduction, elbow flexion, hip flexion knee extension, ankle DF/PF	Staff as required
Resisted range of motion exercises (RROM)	Strength training by AROM against an opposing force	Exercises as AROM above	Staff as required Therabands Free weights Manual resistance Ergometer
Bed exercises	A series of bed exercises to promote and preserve the patient's general bed mobility required to relieve pressure and to get up from the bed	Rolling Bridging Ankle pumps	Staff as required
Sitting on the edge of the bed (SOEOB)	The patient sits on the edge of the bed to build up trunk strength and control	a) Supported SOEOB b) Unsupported SOEOB	Staff as required depending on patient's stage of mobility and attachments. Sling/hoist Pat slide Hover mat Chair Walking frame Walk belt
Sit out of bed (SOOB)	Sitting the patient out of bed may be done in two ways; a) Passive such as sling/hoist, Hovermat or Pat slide b) Active assisted- standing transfer	Sitting out in a chair Sitting out in a water chair Transfer to a commode	Staff as required depending on patient's stage of mobility and attachments Sling/hoist Pat slide Hover mat Chair Walking frame Walk belt
Standing	Patient moves into a standing position It can be done assisted or unassisted	Active at the bed side Active assisted using tilt table	Staff as required depending on patient's stage of mobility and attachments Walking frame Tilt table Walk belt Sling
Sit to stand	Patient is able to stand from a sitting position	Active at the bed side	Staff as required depending on patient's stage of mobility and attachments Chair Standing lifter Walking frame Walk belt
Marching on the spot	If the patient cannot be mobilised for some reason then marching on the spot is done where the patient remains in the same place and performs marching for certain repetitions or duration	Distance progression	
Walking/ ambulation	Patient walks with assistance or supervision		Staff as required depending on patient's stage of mobility and attachments. Portable O2 and suction equipment Portable monitoring i.e. SpO2, HR etc. Portable/mobile ventilator or manual resuscitator bag Walking frame or stick Walk belt Chair

TABLE 4 – COMPLICATIONS (ACTUAL ADVERSE EVENTS) AS DESCRIBED BY NYDAHL ET AL., 2014		
Safety Event	**Criteria**	**Complication Rate Patients (*n*) =453 Mobilisations (n) s=3613**
Clinical Symptoms	Loss of consciousness Distress Agitation or physical combativeness Fatigue Feeling unwell or discomfort Sweat Flushing Pain Clamminess Cyanosis Decreased muscle tonus Falling to knees Fall overall	15.3% (*n*=22) of all reported complications 0.6% of all mobilisations
Respiration	Decrease SpO_2 (80%-90%) Decrease SpO_2 <85% for >3 mins; <88% for > 1 min RR > 35-40 Dyssynchrony with ventilator	49.3% (*n*=72) of all reported complications 2% of all mobilisations
Haemodynamic	MAP < 60-65mmHg SBP < 80-90 mmHg SBP > 180-200mmHg Decreased of DBP >20% HR < 40 HR > 130 > 70% of predicated HR Signs of myocardial ischaemia Cardiac arrest Disturbances in heart rhythm	26.4 (*n*= 38) of all reported complications 1.1% of all mobilisations
Tubes/lines	Removal of: - ETT/tracheostomy - Feeding tube - Central or peripheral line - Arterial line - Bladder/rectal tube - Chest tube Disconnection	6.9% (*n*=10) of all reported complications 0.3% of all mobilisations
Other	Rupture of achilles tendon Hypotension requiring volume therapy or vasopressors	2.1% (*n*=3) of all reported complications 0.1% of all mobilisations

Adverse Events: additional considerations

- Any adverse event should be documented in mobilisation evaluation
- Falls require mandatory reporting via the Incident Information Management System
- Inadvertent removal of lines or tubes during a mobilisation moment should be considered in each facility as an incident for clinical review and/or IIMS

Physical activity and movement practices

Staff from all ICUs in NSW were surveyed to establish a baseline of current patient physical activity and movement practices. Participants completed questions on unit demographics and current practices regarding mobilisation of mechanically ventilated and/or non-ventilated patients. If the usual practice was to mobilise patients, the questions were then designed to determine whether the unit had a formalised protocol in place, what equipment they used and whether there were any barriers to mobilising patients.

Once the survey was checked for clarity and relevance an email invitation to participate was sent to 56 potential participants including nursing and medical staff within NSW. From the initial email 14 participants responded to the survey. A second invitation to participate extended generally through ICUConnect (a mailing list coordinated by ICCMU) resulted in a further four participants who completed the online survey.

Of the 18 online participants, two ICUs mobilised patients within 72 hours of intubation. A total of six ICUs mobilised intubated patients after the first 72 hours and all 18 participants stated they mobilised non-ventilated patients. Only one ICU had a formalised protocol in use for walking a stable ventilated patient.

While the other participants didn't have formalised protocols in place within their units, they did respond that inclusion criteria for patients to commence mobilisation include: the patient must be conscious, have well managed pain and anxiety and be haemodynamically stable. Barriers reported included level of sedation, staffing levels and time constraints.

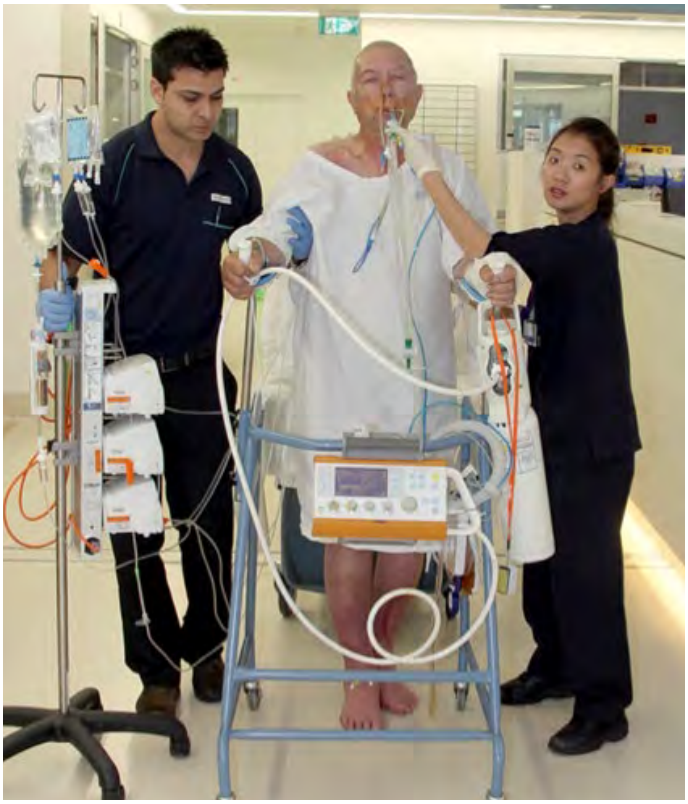


Figure 1 – Image shows a ventilated patient walking with assistance from three clinicians (staff member following patient is obscured)

Section 2

Recommendations for practice

Assessment and clinical practice

Section	Recommendation	GOR
1.	A dedicated physical activity and movement program should be implemented to aid in the recovery of critically ill patients.[8, 9, 56, 57]	Grade A
2.	Early physical activity and movement is feasible and safe for critically ill patients and should be incorporated into usual practice.[2-5, 23, 37, 38, 40, 56-58]	Grade A
3.	All patients admitted to the ICU should be screened on a daily basis for inclusion in a PAM program. This assessment should be documented in the patient's medical record. Where feasible this screening should occur within 24 hours of admission.[5, 6, 27]	Grade C
4.	The program, based on the patient's current activity level, should be developed in consultation with a multidisciplinary team.[6, 7]	Grade C
5.	In addition to the physical benefits PAM should be implemented to support patients' psychosocial needs and reduce concerns such as anxiety, depression and sleep disorders/disturbances that may impact the patient after discharge from the ICU.[5]	Grade C
6.	The minimum human resources for safely ambulating the ventilated patient must be three staff members, one of whom is experienced and will act as team leader. The actual number of staff will be based on pre-mobility assessment. A Medical Officer with accreditation in advanced airway skills must be available on site.[2, 3, 5, 7]	Grade C
7.	The equipment that may be required includes a portable ventilator and/or manual resuscitator bag, portable suction and oxygen, IV pole, monitoring equipment, a walking frame and a wheelchair to follow.[2, 3, 5, 7]	Grade C
8.	The development of a dedicated multidisciplinary team is essential for the successful implementation and maintenance of a patient physical activity and movement plan.[11, 35, 50]	Grade C

It is important that a PAM protocol identifies the healthcare worker in charge of initiating individual patient protocols. This may be the registered nurse or physiotherapist within the unit. Confusion as to the extent of a planned patient program and delayed initiation of the PAM protocol may occur if no clear guidelines exist for PAM protocol responsibility.

It has been shown that patients receive physical activity and movement interventions earlier when assessed as part of a protocol within a multidisciplinary team.[8] A rigorous screening process for inclusion in a PAM program should be performed by a designated staff member (Nurse/Physiotherapist) and based on individual assessment findings. See Figure 2 Algorithm for PAM assessment for an example of an assessment tool.

Exclusion criteria for PAM may include some absolutes at the time of assessment; for example raised intracranial pressure, where the principal aim of treatment is to minimise stimulation of the patient. It is therefore important that assessment of the patient incorporates input from all members of the healthcare team.

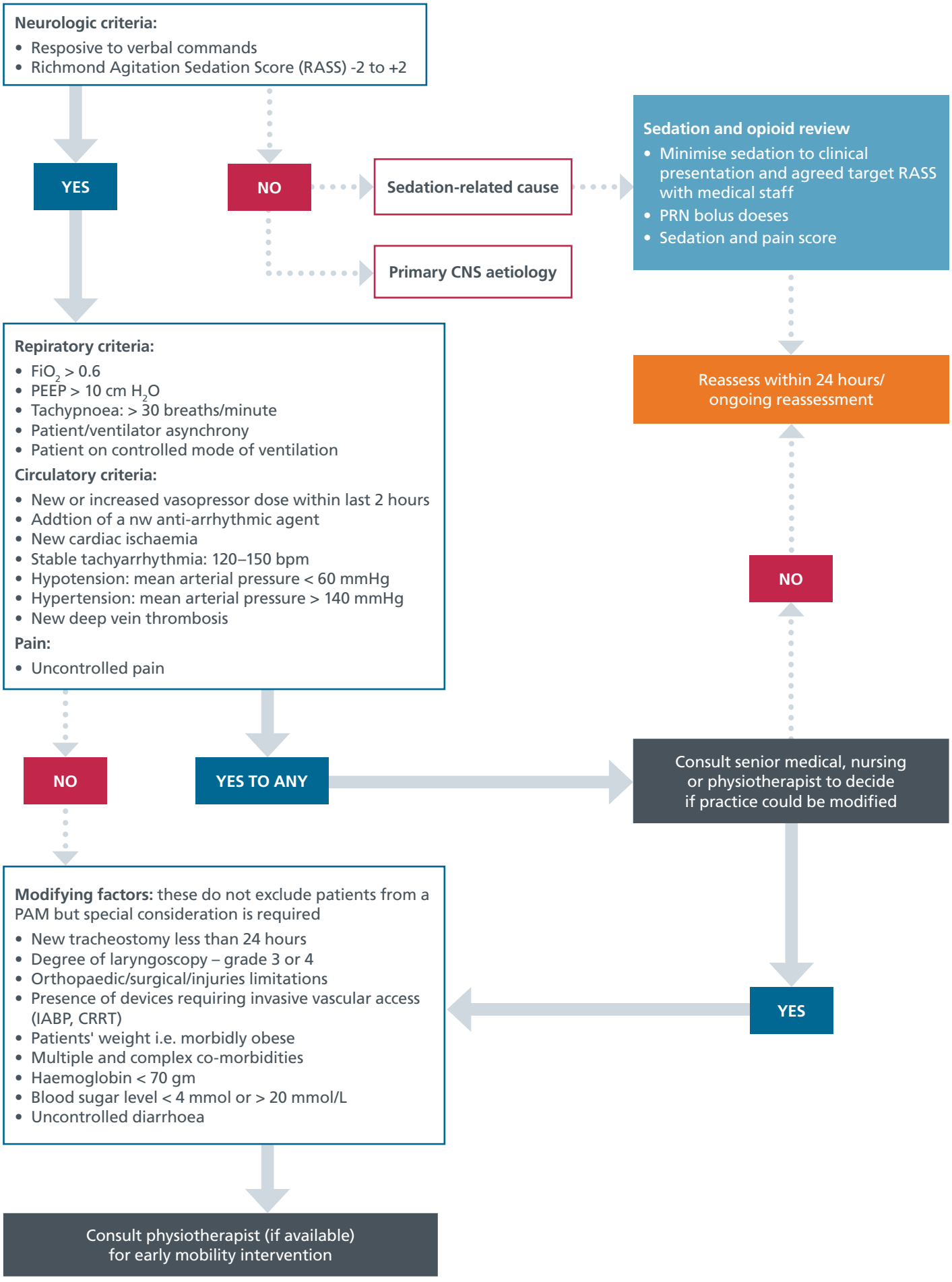


Figure 2 – Algorithm for PAM assessment

Nurses refer to haemodynamic and respiratory variables as barriers to mobility, whereas physiotherapists refer to neurological function as the main barrier to mobility.[11] Strict criteria should be set to give confidence to the whole team that PAM will be well tolerated and is safe for their patient. A group of international experts has developed consensus and recommendations regarding the safety criteria for mobilisation of the ventilated adult patient.[27] Emphasis should also be placed on the continuum of activities possible for the patient. That is, there may be contraindications for the patient walking or standing but which allow for active or resisted exercises in bed.

If a patient is deemed suitable for PAM through the use of a screening tool, then each patient should be individually commenced at the level of activity considered suitable based on assessment. An example of assessment for treatment progression is provided in Figure 3 below. Patients are generally assessed as being more capable, when the assessment is performed by a Physiotherapist when compared to an assessment performed by a Nurse.[11] Therefore, routine involvement of physiotherapists as part of a multidisciplinary team in directing physical activity and movement programs is highly desirable to promote early mobilisation of critically ill patients.[11] An individual activity plan should be developed for each suitable patient in consultation with the multidisciplinary team and should include documentation of activities to be undertaken.

STAGE 1: ACTIVE, RESISTED AND BED EXERCISES ONCE PATIENT AWAKE AND OBEYING COMMANDS

If able to do stage 1 and able to lift both arms > 90 degrees (shoulder flexion) against gravity then progress to stage 2.

STAGE 2: SIT ON THE EDGE OF THE BED (SOEOB) SUPPORTED OR UNSUPPORTED

If able to do stage 2 but cannot do straight leg raise, try tilt table and/or SOOB passively.

If able to do stage 2 (SOEOB) unsupported and can perform straight leg raise then progress to stage 3.

STAGE 3: STAND TRANSFER TO SOOB

If able to stand, transfer wih minimal assistance. Progress to stage 4.

STAGE 4: STAND UP AND MARCHING ON THE SPOT

If able to tolerate stage 4, progress to stage 5.

STAGE 5: AMBULATION WITH OR WITHOUT ASSISTANCE

Figure 3: Treatment progressions for PAM

TABLE 5 – SAFETY CHECKLIST

		Activities by the bed	Activities away from the bed

PREPARATION	**Patient**	• Explain procedure, including plan if patient unable to complete planned mobilisation episode
		• Gain consent from patient
		• Assessments:
		  ○ Pain relief
		  ○ Current Falls risk assessment
		  ○ Physiotherapy assessment(if available), including need for airway clearance prior to mobilisation
		• Non-slip socks/enclosed footwear
		• Minimise attachments
		• Ensure all invasive lines are well secured	

	Staff	• Number of staff required as per assessment • Designation of roles for duration of mobility, including team leader and "airway" clinician • Duration required discussed • Agreed criteria with MDT for assessing individualised patient tolerance and ceasing activity (see "Potential Complications Table") • Clinician within unit/facility able to manage airway if airway becomes dislodged/ compromised	+ Consider additional staff to assist safe mobilisation

	Equipment Environment	• Check safe weight limit of all equipment
		• Chair to transfer to
		• Lifter and sized sling
		• Standing lifter
		• Walking Frame
		• Emergency equipment, including equipment required to retrieve patient from floor within pod/unit (e.g. Hovermatt, sling lifter, airway trolley)
			• Mobile equipment as required:
			  ○ Ventilator or Ambubag
			  ○ Portable oxygen
			  ○ Portable suction
			  ○ Monitor
			  ○ IV pole
			  ○ Portable chair
			• Is walking route clear?

DURING	**Patient**	• Ongoing communication with patient • Patient to be involved in assessment of tolerance/decision to cease	
	Staff	• Ongoing communication – graded assertiveness • Assessment of patient tolerance	
	Equipment Environment	• Monitor for strain on invasive lines/monitoring equipment	
AFTER	**Patient**	• Settle back to preferred rest position (comfort, pain) – ideally SOOB • Evaluate tolerance and response and provide feedback including plan • Ensure invasive lines/monitoring equipment are secure and reconnected for bedside monitoring purposes	
	Staff	• Mobility status communicated to be included in handovers	

	Documentation	• Document activity level (including equipment used) in patient record
		• Update patient care board with current mobility status
		• If adverse event occurs (see "Potential Complications Table"):
		  ○ Report to senior medical officer regarding response and adverse event/complications
		  ○ Record and report adverse events to NUM and LHD system as required.	

Infection prevention

Section	Recommendation	GOR
9.	Clinicians are to undertake a risk assessment to identify the risk of contamination and mucosal or conjunctival splash injuries during PAM activities. PPE (including goggles/ face shield/gloves and gown/apron) as per NSW 2007 Infection Control Policy are to be worn according to this risk assessment.	PD2007_036 Australian Guidelines for Prevention & Control of Infection in Healthcare.
10.	Clinicians must adhere to the Five Moments of Hand Hygiene.	PD2010_058
11.	To reduce the risk of microbial transmission, equipment utilised for each patient must be cleaned as per the NSW Infection Control Policy and ASA Standard 4187 prior to and following use.[12, 13]	PD2007_036 AS 4187 2003

NSW Ministry of Health policies

Prevention of infection is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering infection control. Local policy must also be consulted.

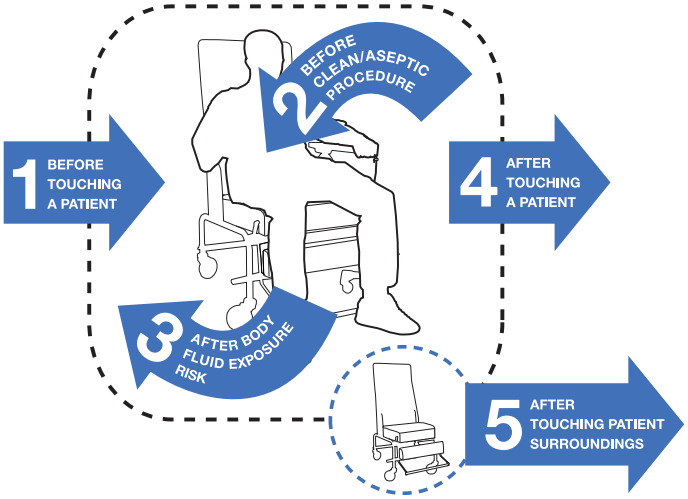
1. Infection Control Policy
2. Infection Control Policy: Prevention & Management of Multi-Resistant Organisms (MRO)
3. Hand Hygiene Policy

Other relevant policies and standards

1. Australian Guidelines for the Prevention and Control of Infection in Health Care
2. Cleaning, disinfecting and sterilizing reusable medical and surgical instruments and equipment, and maintenance of associated environments in healthcare facilities. ASA 4187:2003.

Hand hygiene

The NSW Health Hand Hygiene Policy (PD2010_058) states that all staff must perform hand hygiene as per the Five Moments for Hand Hygiene. Hand hygiene must occur before touching the patient; prior to a procedure; after a procedure or body fluid exposure risk; after touching a patient; after touching a patient's surroundings. Hand hygiene can be performed using appropriate soap solutions and water or alcohol-based hand rub (ABHR). Soap and water must be used when hands are visibly soiled.



Based on the 'My 5 moments for Hand Hygiene', URL: http://www.who.int/gpsc/5may/background/5moments/en/index.html

Cleaning of equipment

All equipment used during PAM is to be cleaned prior to and following use as per PD2007_036.

Workplace health and safety

Section	Recommendation	GOR
12.	Clinical staff undertaking patient physical activity and movement must undertake a risk assessment of the intended activity/ies to protect the health and safety of the patient and all staff involved.	Consensus

Risk assessment

Prevention of work injury is an important aspect of any clinical practice guideline. Users are directed to the following policy directives covering work health and safety. Local policy must also be consulted.

- NSW Work Health and Safety Act 2011

The NSW Work Health and Safety Act 2011 states that organisations must eliminate the health and safety risks to workers where at all possible. When it is not possible to eliminate risks, the risk must be minimised as far as reasonably practicable. Organisations must provide appropriate PPE for use by staff. Staff have a responsibility to use PPE according to policy.

The worker has an obligation under the NSW Work Health and Safety Act 2011 to:

i. Take all reasonable care for their own safety.

ii. Take care that their acts or omissions do not adversely affect the health and safety of other persons.

iii. Comply with any reasonable instruction that they are given.

Governance

Section	Recommendation	GOR
13.	Education and training should be given to key stakeholders regarding the benefits/ importance of physical activities and movement in the ICU patient.	Consensus
14.	Medical, nursing or physiotherapy ownership of a patient physical activity and movement plan should be determined.[11]	Grade C
15.	Hospital executive support, in terms of management/budgetary maintenance of a patient physical activity and movement program, should be available.	Consensus
16.	Evaluation of a patient physical activity and movement program should occur following implementation, with regular audits for compliance conducted as a component of the ICU's routine quality improvement program. A number of valid and reliable ICU specific outcome measures are available to assist evaluation process.[44, 45, 47, 48, 59, 61, 62]	Consensus

While there is reported support for physical activity and movement programs to improve patient outcomes,[9] nurses and physiotherapists need to identify potential local barriers associated with these interventions and develop strategies to achieve optimal patient outcomes.

Section 3

Implementation of PAM

PAM resources

The major factor in ensuring a successful PAM program is that it is tailored to the availability of local resources (both human and equipment) and the needs of the specific patient diagnostic group together with all associated patient medical devices.

The resources necessary for safe physical activity and movement can be divided into human and mechanical resources. Human resources include a trained multidisciplinary team that may, depending on the patient's strength and the current activity, include some or all of the following healthcare workers: nurses, physiotherapists, medical staff, occupational therapists, therapy aides and wards-persons/orderlies. The roles adopted by these staff would include a dedicated staff member (nurse/medical officer/physiotherapist) to hold the airway; care must be taken with all other medical devices attached to the patient. In addition, a medical officer with accredited advance airway skills should be readily available. Biomedical personnel may also be required to adapt equipment to meet the demands of the intended patient activity. An example of this is the modification of ventilators and monitoring equipment to facilitate patient mobilisation.

Mechanical resources can be divided into simple and complex devices. Simple devices include those which promote strength training by resisted exercises, including squeeze balls, Therabands, weights, support frames, step and cycle ergometer. More complex devices range from mobile monitoring equipment, ventilators and other support equipment. Table 6 summarises the recommended resources identified in the systematic literature review. The resources required will also be dependent on patient needs and risk assessment.

The minimum resources utilised in the study protocols were three to four staff members, a portable ventilator and manual resuscitator bag, monitoring equipment, a walking frame and either a wheelchair or static chair to follow behind in case the patient becomes fatigued. One study used a purpose-built frame that combined the mobile ventilator, intravenous lines and monitoring equipment, and an emergency seat.[28]

TABLE 6 – SUMMARY OF HUMAN AND PHYSICAL RESOURCES REQUIRED FOR PATIENT MOBILISATION

PERSONNEL	NUMBER
Nurse [2, 3, 5, 7]	1
Physiotherapist [2, 3, 5, 7]	2
Physiotherapy Assistant [3, 5, 7]	1
Occupational Therapist [2, 5, 7]	1
Doctor [2, 5]	1
EQUIPMENT	
Portable ventilator and manual resuscitator bag with medical gas supply and suction [2, 3, 5, 7]	Yes
Wheeled pole for IV lines [2, 5, 7]	Yes
Portable haemodynamic monitor [2, 3, 5, 7]	Yes
Portable pulse oximetry [2, 3, 5, 7]	Yes
Upright static chair [2, 3, 29, 30]	Yes
Walking frame [3, 7, 30]	Yes
Wheelchair to follow [3, 7, 30]	Yes

Education and training

Creating an ICU culture that embraces a PAM protocol is dependent on a rigorous and comprehensive educational program for all staff involved. As with implementation of most new models of care, success is more likely to occur and be maintained if a staff member supported by an enthusiastic team is identified to drive the change. This staff member could be a Nurse or Physiotherapist.

It is recommended that medical, nursing and allied health staff be educated in the PAM protocol for their ICU. Staff should be educated regarding all aspects of the protocol including:

- the benefits of PAM
- the types of PAM
- the equipment and staffing required for PAM
- the inclusion/exclusion of screening tools and processes, including who is responsible for the performance of screening

- the assessment and treatment progression, including utilisation of a Physiotherapist as part of the multidisciplinary team
- the potential for adverse events, particularly falls and the removal of medical devices
- the potential for barriers to mobilisation.

The introduction of a specific patient mobility program can reportedly increase nursing compliance from 22% to 80%.[31]

In summary, education programs to ensure successful implementation and maintenance of a PAM program must address all aspects of the protocol for early patient physical activity and movement and provide comprehensive training of the multi-disciplinary team. The team must perceive that the benefits of early mobilisation outweigh the risks of adverse events.

PAM implementation tools

There are a number of factors to consider prior to implementation of the PAM guideline. These include, but are not limited to, a determination of a need for a PAM program based on a comparison between current practice and the guideline recommendations; an understanding of the barriers to successful implementation and how these might be overcome; strategies to sustain a PAM program; and finally, a sound evaluation method to review the degree of success of the PAM program and its continued use.

In conjunction with this guideline there are a number of internet-based tools available from the ACI Vimeo channel and other sites, to assist in the safe implementation of a PAM program.

Addressing barriers to PAM

There have been a number of quality improvement projects which aimed to introduce a physical rehabilitation program with some using a structured approach including a PDSA cycle [32-34] or the 4Es.[35, 36] A number of barriers and interventions to address them were identified across several projects, these are summarised in Table 7.

TABLE 7 – BARRIERS TO PAM PROGRAM

BARRIER	INTERVENTION
Lack of leadership	Recruited interdisciplinary team +/- medical lead Designated clinical leader with high visibility and engagement Discipline clinical champions Project leader
Lack of staffing and equipment	QI funding Use of student physical therapist Obtain additional staff
Lack of knowledge and training	MDT education of all aspects including evidence, some cross training of PTS to recognise adverse events Literature review Development of Inter professional standard protocol Site visit to early adopter
Lack of referral to PT	Automated referral Rounds by PT and ICU nurse practitioner
Over sedation	Change from continuous to as needed PAD guidelines Inter-disciplinary Education and reinforcement of new sedation guidelines Use of RASS 1 on 1 discussion where patients were over-sedated
Delirium	Screening, PAD, Mobilize
Patient haemodynamic tolerance of activity	Specific protocol Exclusion criteria PT daily screening
Safety	Prospective set of adverse events Emphasis on detangling of lines Retrospective analysis of incident reports
Physiological instability	Screening guidelines (algorithm) Review of mechanical ventilation settings
Lack of physician referrals	Project coordinator screened patients

Outcome measures

Lack of outcome assessment tools with robust clinimetric properties (reliability, measurement error, validity, responsiveness) make it difficult to compare results between studies.[57] Objective measures which aimed to measure muscle mass, strength or physical function are recommended in the literature.

Ultrasound, dynamometry, PFIT and CPAx performed the best in terms of clinometric properties.[59] It may be appropriate to use a combination of outcome measures [44, 45, 47, 48, 59, 61, 62] including the Quality of Life (SF 36), as numerical scores may not translate into an understanding of functional activity.[61] Parry et al [59] states there is a need to identify a core set of standardised measures which can be utilised across the continuum of critical illness recovery.

A number of valid and reliable ICU specific outcome measures are available to assist evaluation process. See summary table Appendix 4.

Conclusion

Ultimately, the success of a PAM program will depend largely upon the alacrity of hospital executives to ensure sufficient resource funding and the willingness of the entire ICU clinical team to assess every patient, every day, for suitability in a physical activity and movement program.

Section 4

Appendices

Appendix 1 – Guideline update history

1. 2015 - Systematic review and practice survey undertaken.

Appendix 2 – Summary tables

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
dDamluji [37]	Case series	16 bed medical ICU (John Hopkins Hospital) N=239 patients with femoral catheters (venous, arterial, dialysis) 101 patients received PT interventions	Evaluate the feasibility and safety of physical therapy interventions in ICU patients with femoral catheters.	Highest daily activity achieved was: standing and walking (23%); sitting (27%); supine cycle ergometry (12%); in bed exercises (38%) No physical activity stopped due to femoral catheter related concerns. No catheter related adverse events.	Safe and feasible to perform PT interventions with femoral catheter in situ. Clinicians should develop appropriate clinical judgement to evaluate risk/benefit of providing rehabilitation therapy.
Perme [38]	Case series	Single centre 40 bed CVICU N=30 cardiovascular and thoracic surgery patients > 18 years with femoral arterial catheter for haemodynamic monitoring	Mobilisation of patients with femoral arterial catheter for HD monitoring.	No adverse events related to femoral catheter.	Early mobility appears to be safe and do not affect femoral arterial catheters used for HD monitoring.
Wang [39]	Case series	2 Australian tertiary ICUs (Victoria) N=34 Patients admitted to ICU with the insertion of vascath for CRRT	3 levels of physical interventions: – Passive – Low-level – High-level. Measures of adverse events during or after interventions as defined.	Level of activity achieved: – Passive: 11 patients – Low level: 16 patients – High level: 6 patients. No episodes of filter occlusion or failure No adverse events Intervention filters lasted longer than non-intervention filters.	Activity in ICU patients on CRRT was found to be safe, with no adverse events Increase in filter life in femoral catheter group.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Abrams [40]	Cohort	Medical ICU – 100 consecutive patients receiving ECMO for refractory respiratory or cardiac failure	Evaluated daily for suitability to participate in PT/OT by MDT. Highest level of mobilization recorded.	35/100 participated in PT. Patients received 7.2 ± 6.5 PT sessions whilst on ECMO 15 (51%) of patients ambulated.	Active PT & OT can be performed in patients receiving ECMO. MDT approach assisted in the safety and success of mobilising ECMO patients.
Bailey [3]	Cohort	Respiratory ICU – 103 subjects	Early activity protocol with twice daily activity. Range from sit on edge of bed without back support; sit in chair, ambulate with or without assistance.	A majority of survivors (69%) were able to ambulate >100 feet at RICU discharge.	Early activity is feasible and safe in respiratory failure patients.
Chang [8]	Cohort	Adult ICU – 15 subjects	Investigate the effect of passive tilt table standing on short-term ventilation parameters and gas exchange in chronic critically ill population and to determine whether any changes are maintained after the intervention.	Standing in the tilted position for 5 minutes produced significant increases in tidal volume, minute volume and respiratory rate. Gas exchange was not enhanced post tilt table.	Short-term gains in ventilation can be achieved by use of a tilt table.
Clini [41]	Cohort	Adult respiratory ICU – 77 subjects	Structured program targeting limb and trunk control to facilitate transfer from bed to chair, standing and walking.	A large percentage of the patients who survived had recovered in all the basic activities of daily living (BADL) domains at respiratory ICU discharge.	Patients on long-term mechanical ventilation may benefit from a comprehensive rehabilitation program.
Hildreth [31]	Cohort	Surgical adult ICU – 100 subjects	Pre and post intervention comparison of mobilising patients from bed to chair.	There were no statistically significant differences between both group in terms of ICU or hospital LOS. There were no adverse events reported.	Surgical ICU patients can be safely mobilised.
Martin [42]	Cohort	Chronic ventilator-dependent rehabilitation unit – 49 subjects	Gradual, structured increase in rehabilitation sessions aimed at improving trunk control and maintenance of body posture to standing and ambulation including staircase.	Multidisciplinary team achieved significant improvement in patient rehabilitation from confined to bed with severe limb weakness to ability to stand and ambulate.	Multidisciplinary team approach to patient rehabilitation can improve both motor strength and functional status and is an important part in the care of chronically ventilated patients.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Morris [6]	Cohort	Medical ICU Block allocation of 3 blocks with 50 subjects/block	Multidisciplinary team mobility protocol comprising 4 levels of activity.	ICU and hospital LOS reduced in the intervention group.	Early mobility therapy in respiratory ICU patients is feasible, safe and is associated with decreased ICU and hospital LOS. There is no increase in cost associated with a mobility program.
Morris [6]	Cohort	Adult medical ICU – 280 subjects	Multidisciplinary team driven 4 level protocol initiated within 48 hours of mechanical ventilation.	There was a significant difference between the usual care and protocol groups in both ICU and hospital LOS. There were no adverse events reported.	A planned early mobility regimen for critically ill ICU patients receiving mechanical ventilation is safe and can decrease ICU and hospital LOS.
Thelandersson [43]	Cohort	Neuro ICU – 12 ICU pts vs. 12 healthy controls respect to intracranial, cerebrovascular and haemodynamic parameters.	A range of PROM exercises supervised by a physiotherapist.	In the patient group CPP, BP and HR did not significantly change during and after PROM exercise, but a significantly lower ICP (p 0.01) value was found after compared with during exercise.	In terms of intracranial, cerebrovascular and haemodynamic parameters, physiotherapist-supervised critically ill NICU patients can safely undertake PROM exercises.
Thomsen [30]	Cohort	Adult respiratory ICU – 104 subjects after transfer from general ICU to respiratory ICU.	MV patients with respiratory failure. Early activity protocol with criteria: follows commands and cooperative, FiO2 < 0.6, PEEP < 10, no inotrope support, no orthostasis. Mobilised from sit on edge of bed to ambulate.	The transfer of patients to the RICU, where activity was actively promoted resulted in a statistically and clinically significant increase in ambulation.	Controlled studies are needed to evaluate the effects of immobilisation on neuromuscular dysfunction associated with critical illness.
Denehy [44]	Diagnostic	Nested cohort from previously published RCT N=144 on ICU admission/116 on ICU discharge	Further develop the original PFIT, to derive an interval score (the PFIT-s) and to test the clinimetric properties of the PFIT-s.	Removed shoulder lift component Displayed moderate convergent validity with TUG, 6MWT and MRC-SS Higher admission PFIT-s score was predictive of an MRC-SS of 48, increased likelihood of discharge home, reduced likelihood of discharge to inpatient rehab, reduced acute care hospital LOS.	PFIT-s is valid, responsive to change and predictive of key outcomes.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Hodgson [45]	Diagnostic	2 x ICUs in Melbourne, Australia Medical/Surgical/Trauma Caseload N=100 patients	Development of IMS by experience ICU clinicians based on commonly reported mobility milestones to assess highest level of mobility achieved during ICU admission Assess feasibility of ICU mobility scale for use by nursing and PT staff as well as inter-rater reliability.	Clinicians reported IMS as easy to use and take <1 min to complete Excellent inter-rater reliability between PTs Good inter-rater reliability between nursing staff and PTs.	IMS is feasible for use in ICU and has good-excellent inter-rater reliability Validity, sensitivity to change over time, and association with clinical outcome yet to be determined.
NICE [46]	Guideline	Consensus derived clinical guideline for rehabilitation after critical illness.	Comprehensive list of recommendations. The responsibility for implementation and use remains with the clinicians.	No reported evaluation of the guideline identified in the literature.	The guideline should stimulate research, and the impact of the introduction of the recommendations, along with alternative approaches, should be thoroughly evaluated.
Nordon-Craft [47]	Longitudinal observational study	4 x ICUs in USA N=51 MV via ETT > 4 days	PFIT-s, MRC sum score and hand grip strength test administered from ICU recruitment, then weekly until hospital discharge.	PFIT-s highly correlated with MRC sum score and grip strength Baseline and ICU discharge PFIT-s scores did not predict discharge home.	PFIT-s is a feasible and valid measure of function for MV patients who are alert, able to follow commands and have sufficient strength to participate.
Corner [48]	Observational proof-of-concept	General and trauma ICU N=33	Construct validity and inter-rater reliability of the Chelsea Critical Care Physical Assessment Tool (CPAx).	Positive correlation with CCU discharge scores and SF-36 Moderate to strong correlation with MRC score, GCS score, sedation score -3 to 1, peak cough flow and AusTOMs score Negative correlation with SOFA, CCU discharge score and no. of days MV Strong inter-rater reliability.	Suggests validity of the CPAx as a measure of overall physical morbidity. Has good inter-rater reliability Requires future development and testing- focus on clinician and patient perceptions, further reliability testing, expert review and predictive validity for hospital outcomes.
Garzon-Serrano [11]	Prospective observational study	Surgical ICU – 63 subjects	Mobilisation protocol developed by nurses, physical therapists, intensivists, respiratory therapists and surgeons.	Physical therapists achieved a significantly higher level of patient mobilisation than nurses. Different barriers to mobilisation were reported between the two groups.	Physical therapist involvement results in promotion of early mobilisation of critically ill patients.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Deacon [49]	QA	Study website linked to other ICU websites. N=35 subjects	Questionnaire following ICU discharge, to determine ex-ICU patients' experience of an ICU rehabilitation program.	Physiotherapy and occupational therapy identified as important.	There is a need to take a holistic approach to designing post ICU rehabilitation.
Dinglas [50]	QA	MICU patients with ALI as defined by international criteria Early rehabilitation project (pre-post) Pre=120 Post=123	Early rehabilitation project	Higher percentage of patients received PT intervention. Decrease in time to initiate physical activity. Nil adverse safety events. Achieved higher level of mobility during ICU stay. Severity of illness and sedation were independently associated with longer time to initiate active physical therapy.	For sustained practice change, early rehabilitation programs need to incorporate culture change, frequent audits and feedback to the MDT with proactive discussion and intervention for barriers. Need to address appropriate sedation levels.
Masley [51]	QA	Three academic medical centres involving 18 physical therapists	Semi-structured interviews of critical care physical therapists to determine knowledge associated with critical care physical therapy.	Process for decision-making in providing physical therapy to critical care patients was described.	Physical therapists in the acute care setting aimed to provide optimal care in the context of their work environment.
Needham [7]	QA	MICU – 57 subjects	Multi-disciplinary team protocol with change to the ICU culture with regards to sedation, staffing and patient activity.	There was a higher level of functional mobility and a decrease in ICU and hospital LOS.	A structured and multifaceted QI process can reduce deep sedation and increase activities for mechanically ventilated patients.
Burtin [4]	RCT	Medical and surgical ICU with 90 subjects divided into 2 groups	Control group: Respiratory therapy and limb active or passive motion exercises. Intervention group: Same as control group with additional use of bedside ergometer.	At ICU discharge, functional status was not different between groups. At hospital discharge: walking distance, quadriceps force and subjective wellbeing were significantly higher in the treatment group. No adverse events were reported.	Early exercise in critically ill survivors enhances functional capacity and muscle force at time of hospital discharge.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Kayambu [52]	RCT	Single general hospital ICU in Brisbane, Australia N=50 Intervention=26 Control=24	Individualised, early targeted physical rehabilitation program, prescribed by ICU PT for 30mins, one to two times daily, until discharge from ICU within 48 hours of diagnosis of sepsis. Interventions included: EMS, PROM, AROM, SOOB, transfers, ambulation, and other mobilization as appropriate.	Improved self-reported health related QoL in the physical domains and induce anti-inflammatory effects.	Further research required to examine detailed mechanism behind effects in order to refine and tailor approaches to physical rehabilitation in critically ill.
Kho [53]	RCT	3 x medical and surgical ICUs at John Hopkins Hospital, Baltimore, USA Sham=16 (12 in primary analysis) NMES=18 (17 in primary analysis)	NMES vs sham	No significant difference in lower extremity muscle strength between NMES vs sham at hospital discharge. Greater mean increase in strength in LL muscle groups from awakening to ICU discharge and from awakening to hospital discharge.	Inconclusive. Further research required.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Langhorne [54]	RCT	32 stroke patients randomised into 4 groups	Patients recruited within 24 hours of admission. Exclusions: Patients with severe pre-stroke disability, those fully recovered, or had severe co-morbidities. Intervention groups: 1. Standard care – immediate transfer to a stroke unit and mobilised 30-60 minutes/day. 2. Early mobility (EM) – standard care plus trial-based protocol, which aimed to get patients up to sit, stand and walk within 24hrs of the stroke and continue this at least 4 times per day. 3. Ambulatory monitoring – standard care plus a protocol-driven approach. 4. Combined protocol – this incorporated both EM and AM.	The EM group was significantly more likely to mobilise very early and to achieve walking by day 5 without complications of immobility. The AM group was significantly more likely to have pre-defined physiological complication events detected. All these associations remained, but were less statistically significant, after correcting for unadjusted comparisons. There were no significant safety concerns observed.	Larger trials are required to confirm benefits of these interventions.
Pohlman et al [2]	RCT	Two tertiary adult ICUs – 49 subjects	Mobilisation protocol delivered by physical, occupational therapists and ICU nurses.	Patients achieved improved levels of mobilisation and required less assistance following discharge from ICU.	Mobilisation of MV patients is both feasible and safe.
Schweickert [5]	RCT	Medical adult ICU – 104 subjects	Control group: Daily interruption of sedation and therapy as determined by primary team. Intervention group: physical and occupational therapy led early exercise and mobilisation during periods of sedation interruption.	At hospital discharge there was a 59% return to independent functional status in the intervention group compared to 35% in the control group.	A whole-body rehabilitation program is well tolerated and can achieve better functional outcomes at hospital discharge. The program can also achieve shorter durations of delirium and ventilator days compared to standard care.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Castro-Avila [56]	SR	Randomisation was based on functional independence.	To determine the effect of early rehabilitation/mobilization on the functional status in patients admitted to the ICU or HDU: – Impact of time from ICU admission to first mobilization session – Impact of the dose of physical therapy on function – Describe current interventions available in this clinical setting which could be implemented in addition to usual care.	All studies showed an improvement in functional status from baseline to follow-up evaluation, but overall there was no significant positive effect, apart from improvement in patients walking ability at discharge. Tendency toward improved outcomes relating to ICU-AW and 6MWT. No significant difference in ICU or hospital LOS.	Recommended: – determine most appropriate outcome measures for critically ill patients – gap in knowledge relating to dosage of rehab for critically ill patients – standardised rehab of most benefit in settings that currently do not have early intervention for functional recovery. – daily interruption of sedation seems to increase effect of early rehabilitation – safety criteria for possible addition of cycle ergometry +/-EMS – further research.
Da Silva [57]	SR	Databases: Pubmed, CINAHL, Cochrane, Elsevier, LILACS, British Nursing Index and SciELO Paper format journals, reference list search Inclusion: cohort, controlled studies, randomized studies; Portuguese, English, Spanish; full text; 2003-2013 N=6 (2 x cohort, 4 x RCT)	What are the effects of early mobilization in the functional rehabilitation of critically ill patients?	Early mobilisation is feasible, safe, does not increase costs and may facilitate functional recovery including increasing muscle strength and performance of some activities. No significant difference in ICU or hospital LOS or MV time.	Lack of consistent outcome assessment tools makes it difficult to compare results between studies. Effect of drug administration on functional recovery needs to be improved. Further research to identify subpopulations of patients who might benefit most from early mobilisation.
Nydahl [58]	SR	Databases: Pubmed, CINAHL, Cochrane library, MedPilot Inclusion: MV adult patients in ICU who were mobilized and screened for complications N=16 studies	Potential complications that are associated with early mobilization of adult, mechanically ventilated ICU patients.	453 patients mobilised 3613 times Complications in trials ranged from 0-16%. Mean complication rate = 3.9% (n=144). Most complications were pulmonary, followed by haemodynamic.	Early mobilization is safe with low complication rate. There is no convincing evidence for general cut off values according to haemodynamic or pulmonary safety limits which could be applied to every population.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Parry [59]	SR	Databases: CINAHL, Cochrane Library, EMBASE, Medline, Scopus Inclusion: Quantitative study designs, >18 yrs, ICU setting or survivors of ICU N=47	1. Identify outcome measures to evaluate muscle mass, strength and function in critically ill population at any point on the trajectory of recovery 2. Evaluate, synthesise and compare the clinimetric properties of the measures identified.	33 measures identified, only 20 had published clinimetric properties.	US, dynamometry, PFIT-s and CPAx performed the best in terms of clinimetric properties. Need to identify core set of standardised measures which can be utilised across the continuum of critical illness recovery.
Parry [60]	SR	Databases: CINAHL, EMBASE, MEDLINE, Scopus, Cochrane library, Expanded Academic ASAP, PubMed, PEDRO Inclusion: quantitative study designs, >18 years, EMS to peripheral muscles N=9 (6 unique participant samples)	Effectiveness and safety of EMS in intensive care and optimal intervention variables.	Greater degree of muscle preservation with lower APACHE II scores. Long stay ICU patients showed significant increase in muscle strength. Stimulation settings varied One reported incident of superficial burn.	May be beneficial in attenuating muscle weakness in ICU patients, particularly long stay ICU patients with lower acuity. Further investigation required for most effective training regime, safety and use of suitable outcome measure.
Tipping [61]	SR	Databases: Ovid, Medline, Embase, CINAHL, Cochrane Library, PEDro Reference and citation tracking Contacting authors Inclusion: prospective RCTs, controlled clinical trials, early rehab in ICU setting, reported measure of physical function, 2002-2012 N=11 articles (2RCTS) with 19 measures of physical function	1. To identify, describe and evaluate measurements of physical function that have been used to assess early mobilization in critically ill adults 2. To evaluate the available evidence for the measurement properties and risk of bias associated with the identified end points when used with ICU patients.	WHO classification: i. mobility ii. muscle function iii. walking and moving iv. self-care v. QoL. Most common measures of physical function: – Mobility measured during Rx in ICU – Walking measured at ICU or hospital D/C. FSS-ICU only end point measure specifically designed for ICU-showed clinical responsiveness but requires further evaluation. MRC-SS, hand-held dynamometry, SF-36 have good to excellent reliability.	Lack of data on measurement properties including responsiveness, face validity, content validity, cross-cultural validity and inter-rater/intra-rater reliability of most common end points. Numerical scores may not translate into understanding of functional activity. May be appropriate to use a combination of outcome measures.

First author	Study type	Study design (N=subjects)	Intervention	Results	Conclusions
Vanpee [62]	SR	Databases: No discussion Inclusion: >18 years, critically ill patients, included reliability of muscle strength measurements in critically ill patients or survivors N=6 observational studies	To determine the reliability of volitional and non-volitional limb muscle strength assessment in critically patients and to provide guidelines for the implementation of limb muscle strength assessment in this population	MRC (individual muscles): fair to very good inter-rater reliability MRC-SS: very good inter-rater reliability. HHD: good to very good inter-rater reliability : very good intra-rater reliability HGD: very good inter-rater and intra-rater reliability. No studies obtained on reliability of non-volitional muscle strength assessment.	To undergo volitional muscle strength assessment: – Patients should be fully awake – Use of well-defined standardised test positions: including patient position, limb position, joint angle, hand position of tester, contraction time, verbal encouragement, repetitions, learning attempts and rest periods.
Stockley [63]	Survey	Survey of 152 senior physiotherapists employed in general, neuro, trauma and cardiology ICUs.	Study of respondents' usual practice and aim of treatment in mechanically ventilated and sedated patients in terms of passive movement.	Majority stated that the aim of using passive movement (PM) was to maintain joint range of movement (ROM) in ventilated and sedated patients across all clinical areas.	There was agreement amongst the physiotherapists that PMs influence joint range and that this is at risk of being lost if PMs are not done. The author acknowledged that this opinion is not supported by evidence and that further research is required to investigate this view.
Adler [55]	SR	Search keywords, mobilisation, exercise and physical therapy, intensive care unit and critical illness. Inclusion criteria: prospective randomised trials, prospective cohort studies, retrospective analyses and case series. 2000 to 2011.	Mobilisation of the critically ill with emphasis on functional outcomes and safety.	15 papers (RCTs, cohort, quality improvement and case control studies).	Based on the limited evidence early physical therapy and mobilisation of the critically ill is achievable and safe.

Appendix 3 – NHMRC Levels of evidence

Level	Intervention	Diagnosis	Prognosis	Aetiology	Screening
I	A systematic review of Level II studies	A systematic review of Level II studies	A systematic review of Level II studies	A systematic review of Level II studies	A systematic review of Level II studies
II	A randomised controlled trial	A study of test accuracy with an independent, blinded comparison with a valid reference standard, among consecutive patients with a defined clinical presentation	A prospective cohort study	A prospective cohort study	A randomised controlled trial
III-1	A pseudo-randomised controlled trial (i.e. alternate allocation of some other method)	A study of test accuracy with an independent, blinded comparison with a valid reference standard, among consecutive patients with a defined clinical presentation	All or none	All or none	A pseudo-randomised controlled trial (i.e. alternate allocation of some other method)
III-2	A comparative study with concurrent controls: Non-randomised, experimental trial Cohort study Case-control study Interrupted time series with a control group	A comparison with reference standard that does not meet the criteria required for Level II and III-1	Analysis of prognostic factors amongst untreated control patients in a randomised controlled trial	A retrospective cohort study	A comparative study with concurrent controls: • Non-randomised, experimental trial • Cohort study • Case-control study.
III-3	A comparative study without concurrent controls: • Historical control study • Two or more single arm study • Interrupted time series without a parallel control group	Diagnostic case-control study	A retrospective cohort study	A case-control study	
IV	Case studies with either post-test or pre-test/post-test outcomes	Study of diagnostic yield (no reference standard)	Case series, or cohort study of patients at different stages of disease	A cross-sectional study	

Appendix 4 – Summary table of outcome measures

SOURCE	Parry et al., 2015			Tipping et al., 2012	Vanpee et al., 201)
Outcome Measure	**Reliability, measurement error & responsiveness**	**Construct validity**	**Criterion predictive validity**	**Reliability and clinical responsiveness**	**Reliability**
MUSCLE MASS					
Anthropometry		Mod – high	Conflicting		
BIS	Mod – high	Poor – good	Conflicting		
US	High	Correlation good	Excellent		
MUSCLE STRENGTH					
MRC score					Fair-very good
MRC-SS	Poor – excellent		Fair	Good-excellent	Very good
HHD	Good – excellent	None	–	Good-excellent	*Inter-rater* Good-excellent *Intra-rater* Very good
HGD	Good – excellent	Good	–		*Inter-rater* Good-excellent *Intra-rater* Very good
FUNCTIONAL MEASURES					
CPAx	Excellent	Excellent	Excellent ceiling effect 0.8%, floor effect 3.2%		
PFIT	Excellent	Fair – excellent	Excellent ceiling and floor effect 20%	Good reliability but not yet published in clinical trial	
FSS-ICU	Poor	–	Ceiling effects not measured	Showed clinical responsiveness but requires further evaluation	
SOMS	Excellent	Fair – good	Excellent		
IMS					
De Morton Mobility Index				Showed clinical responsiveness but requires further evaluation	
QOL					
SF-36				Good-excellent	

Functional Measure	First author	Year	Validity	Reliability	Responsiveness	Other	Comments
CPAx	Corner	2013	CONSTRUCT VALIDITY Significant positive correlation: – Pre-adm CPAx score/CCU discharge score and physical component of SF-36 Moderate to strong correlation: – MRC score – GCS score – Sedation score -3 to 1 – Peak cough flow – AusTOMs score Significant negative correlation: – SOFA CCU discharge score and number of days in MV	Strong inter-rater reliability (K-0.988; 95% confidence interval 0.791 to 1.00; P<0.01)			Shows potential for assessment tool in critically ill population within Australia with the suggestion of validity in measuring overall physical morbidity. Needs further investigation to prove generalizability, reliability and use as a predictive tool for patient outcomes/ rehabilitation requirements/ ICU-AW.
P-FIT(s)	Denehy (Australia)	2013	CONVERGENT VALIDITY The PFIT-s displayed moderate convergent validity with the Timed "Up & Go" Test (r_= -.60), the Six-Minute Walk Test (r=.41), and the Medical Research Council (MRC) sum score (rho.49).		The ESI of the PFIT-s was 0.82, and the MCID was 1.5 points (interval scale range_0–10).		It is valid, responsive to change, and predictive of key outcomes. Application to Australian clinical practice is highly suitable, however, generalisability is unclear.
	Nordon-Craft (US)	2014	CONVERGENT VALIDITY PFIT-s was strongly correlated to MRC-SS and grip strength		Baseline to ICU discharge: large responsiveness (1.14) ICU discharge to follow-up (~5.67 days): moderate responsiveness (0.59)	Higher PFIT-s at baseline and ICU discharge significantly associated with reduced likelihood of discharge to long term acute care facility MRC sum score cut off of 41.5 had a sensitivity of 85.7% and specificity of 83.3% in predicting whether an individual would be unable to perform STS and MOS on ICU discharge	Adds to the Australian study and may support recommendations from it. Different population though. Small sample.

IMS	Hodgson	2014	INTER-RATER RELIABILITY – Intraclass correlation (95% confident interval) between raters was excellent (0.8) – The inter-rater reliability between PTs was excellent agreement of the IMS scores and good between PTs and nursing and PTs			FEASIBILITY OF IMS – 90% of clinicians stated that IMS easy to use and take < 1 min to perform and appropriate length – 100% reported the scale is unambiguous – 15% surveyed reported some aspects of scale were irrelevant, superfluous or misleading – Able to be used by a range of users within the ICU without prior training on use of the scale	Ordinal scale – limited in analysis whether the distance between each of the levels of the scale in terms of functional ability is accurate. No association to outcomes – requires further study. Requires further testing to determine sensitivity to change over time and validity.

Appendix 5 – Original guideline GDN

Name/position	Role	Organisation	Hospital
Dr Angela Berry, RN, MHthSc, GradCert ICNurs, PhD CNC	Chair	Western Sydney	Westmead
Dr Doug Elliott, RN, PhD Professor of Nursing	Academic Advisor	University of Technology	
Rebecca Moore, Cardiopulmonary Rehab Physiotherapist	Co-chair Evidence	Western	Orange
Janet Scott, RN, BHlthSc(Nurs), GradCert ICNurs, GradCert CoronaryCare CNC	Co-chair Practice	Nepean Blue Mountains	Nepean
Karen Beattie, CNE RN, BN GradCert ICNurs	Member – Intensive care	Western	Bathurst
Yoni Cross, CNS	Member – Intensive care	Central Coast	Gosford
Sue Cushway, B Nurs, GradDip AdultEd CNE	Member – Intensive care	Hunter New England	Armidale
Elizabeth Longhurst, RN, MNurs, GradCert Emerg Nurs	Member – Intensive care	Sydney South West	Bowral
Danielle Phillips, RN, BNurs, ICCert, CritCareCert(Neuroscience) CNS	Member – Intensive care	Nepean Blue Mountains	Nepean
Evan Plowman, RN, GradCert ICNurs, BNurs/BParamedics	Member – Intensive care	Murrumbidgee	Wagga Wagga
Lauren Thomas, B Phty, A/L4 Physiotherapist ICU/Cardiothoracics	Member – Physiotherapy	Hunter New England	John Hunter
Jacqueline Bennett, BAppSc (Phyt), Dip Management, Senior ICU Physiotherapist	Member – Physiotherapy	South Eastern Sydney	POW
Anwarul Hassan, PT, MPhty (CP), Senior Respiratory Physiotherapist	Member – Physiotherapy	Nepean Blue Mountains	Nepean

All GDN members completed a 'declaration of interest' form based on NHMRC guidelines. The guideline development network members declared no conflicts of interest.

Section 5

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