

# ICU

## Management Protocols



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**Disclaimer:** The content of this book has been produced in good faith to guide medical practitioners. However practitioners are advised to keep abreast the current evidence-based practices that are constantly evolving and to take into account the local issues and limitations.



## Foreword

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There are many aspects in the care and management of the critically ill patient. As clinicians we need to keep abreast with the most current evidence-based practices to ensure optimal patient care and safety.

This is an update of the management protocol book written in 2012, to facilitate clinicians in the management of the critically ill. Each protocol was developed with careful consideration of current evidence as well as the practical application and cost containment within our institutions. The algorithms in the protocols are simple to use and can be easily implemented.

There are great concerns on the rise of multi-drug resistant organisms. We know that critically ill patients are at high risk of acquiring infections. To address this, a protocol on prevention and control of multi-drug organisms is included.

This protocol materialised due to the many hours of discussion and exchange of opinions. I hope the protocol will serve as a guide to ICU management that will enhance the quality of patient care.

I like to express my gratitude to the writing committee for their effort in publishing this excellent management protocol book.

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# Admission, Discharge and Triage

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## Introduction

Appropriate utilisation of ICU bed is essential as intensive care resources are limited and expensive. Demand for intensive care will continue to exceed supply, hence clear and rationale decision-making regarding admission and discharge is required.

## Principles

1. The decision to admit a patient to ICU should be based on the concept of potential benefit.
2. Critically ill patients with a reversible medical condition, having a reasonable prospect of meaningful recovery should be admitted.
3. A combination of criteria should be used to determine ICU admission or discharge.
4. ICU triaging is necessary to ensure optimal and equitable use of limited intensive care resources.

## Admission policy

1. It is the responsibility of the patient's attending clinician to request for ICU admission.
2. It is the responsibility of the ICU specialist to decide on admission based on his/her clinical judgement guided by the admission criteria.
3. The decision to admit or deny admission shall not be made at the level of a medical officer.
4. Admission from the Emergency and Trauma Department or from another hospital shall have a primary unit.
5. Admission from other hospitals shall be discussed with the ICU specialist prior to transfer.
6. It is the responsibility of the primary team to continue resuscitation of patients while awaiting ICU admission.

7. Patients in ICU remain under the responsibility of the primary unit. Transfer of care to a different unit shall be arranged by the primary unit.
8. Family shall be informed of patient's admission to ICU as soon as possible, with further updates when required.

## ICU admission criteria

To optimise ICU resources and improve outcomes, ICU admissions should be guided on the basis of a combination of factors:

- a. Prioritisation according to the patient's severity of illness
- b. Specific patient needs such as life-supportive therapies
- c. Diagnosis
- d. Prognosis
- e. Potential benefit from interventions
- f. Objective parameters at the time of referral
- g. Available clinical expertise
- h. Bed availability

## ICU admission based on priority

In evaluating the appropriateness of ICU admission, the priority should be based on the needs of the patient and the likelihood of benefitting from admission. This prioritisation defines those who will benefit most from ICU (Priority 1) to those who will not benefit at all (Priority 3).

### 1. Priority 1

- a. Critically ill, unstable
- b. Require life support for organ failure, intensive monitoring and therapies that cannot be provided elsewhere. This includes invasive ventilation, renal replacement therapy, invasive haemodynamic monitoring and other interventions
- c. Do not have limitations of treatment
- d. High likelihood of benefit

### 2. Priority 2

#### *Priority 2A*

- a. Acutely ill, relatively stable
- b. Requires intensive monitoring and/or therapies for organ dysfunction, that can be managed in an intermediate care facility (high dependency unit or post anaesthetic care unit)

- c. Admit to ICU, if early management fails to prevent deterioration or there is no intermediate care facility in the hospital
- d. Examples include:
  - i. post-operative patients who require close monitoring
  - ii. respiratory insufficiency on intermittent non-invasive ventilation

*Priority 2B*

- a. Critically ill, unstable
- b. Require life support for organ failure
- c. With significantly lower probability of recovery because of advanced underlying disease
- d. May have specific limitations of care e.g. no cardiopulmonary resuscitation
- e. Lower likelihood of potential benefit
- f. Examples include:
  - i. metastatic cancer in septic shock secondary to hospital acquired pneumonia but with some limitations of therapy e.g. no CPR
  - ii. decompensated heart failure with deteriorating functional status and multiple hospital admissions

**3. Priority 3**

- a. Terminally ill or moribund patients with no possibility of recovery
- b. Not appropriate for ICU admission
- c. May benefit from palliative care rather than intensive care
- d. Examples include:
  - i. severe irreversible brain pathology impairing cognition and consciousness or in a persistent vegetative state
  - ii. metastatic cancer unresponsive to chemotherapy and/or radiotherapy
  - iii. end-stage cardiac, respiratory or liver disease with no options for transplant
  - iv. severe disability with poor quality of life
  - v. advanced disease of a progressive life-limiting condition e.g.
    - motor neuron disease with rapid decline in physical status,
    - severe Parkinson's disease with reduced independence and needs assistance for activities of daily living
  - vi. poor response to current treatment e.g.
    - bowel leak despite multiple laparotomies,
    - recurrent soft tissue or musculoskeletal infections despite multiple surgical intervention,
    - chronic medical conditions that fail to respond to treatment such as SLE or HIV

- vii. end-stage renal disease with no option or refusal for renal replacement therapy
- viii. those who have explicitly stated their wish not to receive life-support therapy

## **Triage**

Triage is the process of placing patients at their most appropriate level of care. It is often needed as the number of potential ICU patients exceeds the availability of ICU beds. Appropriate triaging allows effective bed utilisation and resource management.

Factors to consider when triaging include:

- a. Likelihood of benefit
- b. Prognosis
- c. Life expectancy due to disease
- d. Anticipated quality of life

## **Discharge policy**

1. The decision to discharge a patient shall be made by the ICU specialist.
2. Prior to discharge:
  - a. The primary team shall be informed of the management plan including any limitation of treatment.
  - b. A discharge summary shall be completed.
  - c. Any limitation of treatment shall be clearly documented including why and amongst whom these decisions are made.
  - d. Family shall be informed.
  - e. It is the responsibility of the primary team to receive and review patients promptly in the ward.
  - f. Patients who require a higher level of nursing care may benefit from admission to a step down unit, if available.

## **ICU discharge criteria**

In order to maximise the efficient use of ICU resources, patients should be assessed continuously to identify those who may no longer need ICU care. This includes patient with:

- a. Stable physiological status and no longer needing ICU monitoring and treatment.
- b. Stable haemodynamic parameters on low dose inotropic support.

- c. Stable respiratory status with oxygen requirement not more than 60%.
- d. Neurological stability.
- e. Tracheostomy, not requiring frequent suctioning.
- f. Chronic mechanical ventilation (e.g. motor neuron disease, cervical spine injury) and the acute critical problem is resolved.
- g. Deteriorating or irreversible physiological status where active interventions are no longer beneficial. Withdrawal of therapy should be initiated, however, patient may be discharged to the ward if ICU bed is required.

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# Vasoactive Agents in Acute Circulatory Failure \_\_\_\_\_

## Introduction

The aim of treatment in acute circulatory failure is to maintain adequate perfusion pressure for tissue oxygenation. Vasopressors and inotropes are cornerstones in the management of shock syndromes. It is important to identify the type of shock for the choice of vasoactive agent is determined by its mechanism of action targeting the underlying pathophysiology.

## Principles

1. Initiate vasopressors promptly in severe hypotension especially in undifferentiated shock, after excluding obstructive shock.
2. It is appropriate to initiate vasoactive agents while ensuring optimal fluid resuscitation in severe hypotension.
3. Titrate the dose of vasoactive agent to achieve adequate tissue perfusion.
4. Aim for MAP 60 - 65 mmHg (or > 70 mmHg in chronic hypertension) if there is evidence of inadequate tissue perfusion.
5. The main route of administration of vasoactive drugs is via a central venous catheter, however, peripheral administration may be considered in low doses.
6. Invasive blood pressure monitoring is preferred to allow immediate recognition of change in blood pressure and precise titration of vasoactive agents.
7. Monitor regularly for potential complications e.g. arrhythmias and peripheral ischaemia.
8. Echocardiography is useful in the diagnosis and management of shock.
9. Consider advanced haemodynamic studies e.g. cardiac output monitoring in patients with refractory shock.

## Vasoactive agents in distributive shock

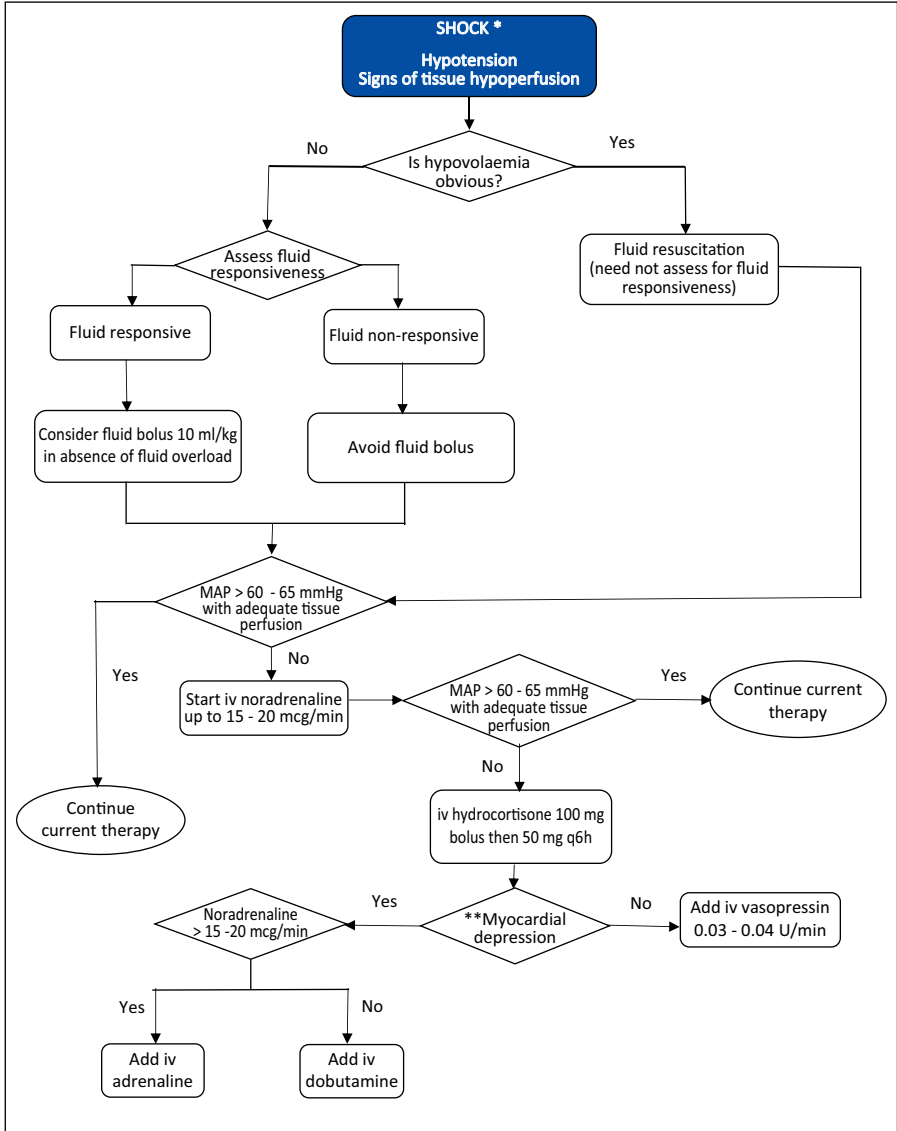
### **Septic shock**

1. Septic shock is predominantly caused by vasodilatation and relative hypovolaemia. Myocardial depression is often present although cardiac output is elevated.
2. Noradrenaline is the vasoactive agent of choice with its effects of venoconstriction (increase preload), arterial vasoconstriction, positive inotropy, improved cardiac output and improved renal perfusion.
3. Consider adding a second vasoactive agent (e.g. vasopressin or adrenaline) when noradrenaline dose of > 15 - 20 mcg/min does not achieve targets.
4. Consider adding iv hydrocortisone 50 mg q6h following a bolus of 100 mg when noradrenaline dose reaches 15 - 20 mcg/min.
5. Consider adding iv dobutamine (2 - 5 mcg/kg/min) in presence of myocardial depression, and if noradrenaline dose is < 15 - 20 mcg/min.
6. Wean vasoactive agents once targeted goals are optimised. Consider weaning noradrenaline first before vasopressin.

### **Anaphylactic shock**

1. Anaphylactic shock is an acute, multi-system disorder (predominantly heart, lung and vasculature) resulting from the sudden release of mediators from mast cells, basophils and macrophages into the circulation.
2. Stop the suspected offending agent.
3. Administer iv adrenaline in boluses of 0.05 - 0.1 mg. If no response, administer infusion adrenaline at 0.1 mcg/kg/min. Adrenaline is preferred as it reverses peripheral vasodilatation and reduces oedema.
4. Administer iv crystalloid of 20 ml/kg rapidly. Avoid colloids.
5. May consider H1 anti-histamine, iv chlorpheniramine 10 mg to counter histamine-mediated vasodilatation and bronchoconstriction. There is no evidence on the use of H2 anti-histamine.
6. May consider iv hydrocortisone 200 mg stat to shorten the protracted reaction.

# Management of septic shock



\* ±Echocardiography

\*\* Echocardiography or cardiac output monitoring

## Neurogenic Shock

1. Neurogenic shock secondary to spinal cord injury or disease results in lack of sympathetic tone of peripheral nerves causing vasogenic and cardiogenic instability.
2. Fluid resuscitation is required to restore intravascular volume.
3. Noradrenaline is recommended as initial agent for its alpha and beta activity.
4. Add adrenaline if a second vasopressor is needed.

## Vasoactive Agents in Cardiogenic Shock

1. Cardiogenic shock is characterised by a syndrome of inadequate tissue perfusion due to myocardial depression or structural abnormality.
2. Causes of cardiogenic shock:
  - a. Left ventricular failure is the most common, with 3 pathophysiological states.

		Volume Status	
		Wet	Dry
Peripheral circulation	Cold	Classic cardiogenic shock <ul style="list-style-type: none"> <li>• Low cardiac output</li> <li>• High SVR</li> <li>• High LV filling pressure</li> <li>• Systolic and diastolic dysfunction</li> </ul>	Euvolemic cardiogenic shock <ul style="list-style-type: none"> <li>• Low cardiac output</li> <li>• High SVR</li> <li>• Normal filling pressure</li> <li>• Systolic dysfunction</li> </ul>
	Warm	Vasodilatory cardiogenic shock or mixed shock <ul style="list-style-type: none"> <li>• Low cardiac output</li> <li>• Low or normal SVR</li> <li>• High filling pressure</li> </ul>	Vasodilatory shock ( <b>not cardiogenic shock</b> ) <ul style="list-style-type: none"> <li>• High cardiac output</li> <li>• Low SVR</li> <li>• Low filling pressure</li> </ul>

SVR: Systemic vascular resistance    LV: Left ventricle

- b. Right ventricular failure
  - c. Structural heart disease
  - d. Arrhythmias
3. Early echocardiography is recommended for diagnostic and monitoring of therapy.
  4. Early cardiology consult is recommended if there is an indication for rescue revascularisation.
  5. Perform test for fluid responsiveness and correct hypovolaemia in those who are fluid responsive.

6. The vasoactive agent of choice in cardiogenic shock remains unclear as there is little evidence to guide the use of one agent over another.
7. The initial vasoactive agent based on the type of cardiogenic shock is shown below:

Type of cardiogenic shock	Vasoactive/management considerations	Haemodynamic rationale
Cold and wet (low cardiac output & high SVR)	<ul style="list-style-type: none"> <li>Noradrenaline or dopamine</li> <li>Inotrope</li> </ul>	<ul style="list-style-type: none"> <li>Noradrenaline is preferred in hypotensive and presence of arrhythmias</li> <li>Dopamine is preferred in bradycardia</li> <li>Consider addition of inotrope when stabilised and after revascularisation (MI only)</li> </ul>
Cold and dry (low cardiac output & normal filling pressure)	<ul style="list-style-type: none"> <li>Noradrenaline or dopamine</li> <li>Inotrope</li> <li>Small fluid boluses</li> </ul>	<ul style="list-style-type: none"> <li>Noradrenaline is preferred in hypotensive and presence of arrhythmias</li> <li>Dopamine is preferred in bradycardia</li> <li>Consider addition of inotropic agent when stabilised and after revascularisation (MI only)</li> <li>Small fluid bolus may be given if patient is fluid responsive</li> </ul>
Vasodilatory warm and wet or mixed cardiogenic and vasodilatory	<ul style="list-style-type: none"> <li>Noradrenaline</li> </ul>	<ul style="list-style-type: none"> <li>This subtype has low SVR</li> <li>Consider haemodynamic-guided therapy</li> </ul>
Right ventricular failure in shock	<ul style="list-style-type: none"> <li>Fluid boluses</li> <li>Noradrenaline, dopamine, vasopressin</li> <li>Inotrope</li> </ul>	<ul style="list-style-type: none"> <li>Haemodynamic goals include: optimise preload, reduce PVR (RV afterload)</li> <li>Dopamine for bradycardia</li> <li>Vasopressin may raise SVR but has no effect on PVR</li> <li>Inhaled pulmonary vasodilators may be considered</li> </ul>
Normotensive shock (symptomatic)	<ul style="list-style-type: none"> <li>Dobutamine, milrinone, or levosimendan</li> </ul>	<ul style="list-style-type: none"> <li>Initial inotrope may be appropriate given that this subtype has SBP &gt; 90 mm Hg and relatively high SVR</li> <li>Dobutamine is preferred in isolated LV dysfunction</li> <li>Levosimendan or milrinone is preferred in presence of increased PVR and RV dysfunction, or on beta-blockers as their action is independent on beta-adrenergic receptors</li> </ul>

PVR: Pulmonary vascular resistance    RV: Right ventricle

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## Appendix 1: Fluid responsiveness

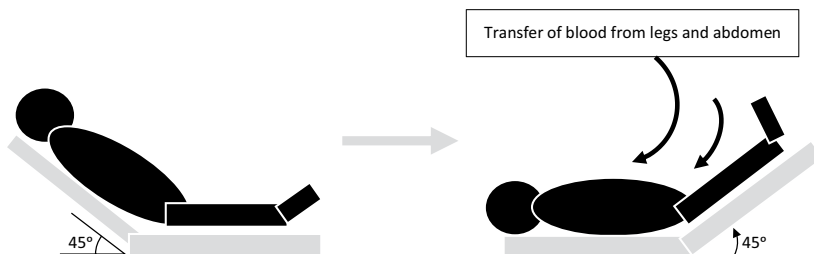
Test for fluid responsiveness is performed to identify patients who may need volume expansion.

1. Fluid responsiveness is defined as ability of the left ventricle to increase stroke volume by 10 - 15% after rapid bolus fluid administration.
2. Cardiac output or its indicators during test for fluid responsiveness should be assessed accurately.
3. Common indicators of fluid responsiveness are pulse pressure change measured by arterial blood pressure, LV outflow tract (LVOT) velocity time integral (VTI) on echocardiography, carotid Doppler flow on transoesophageal echocardiography or cardiac output on pulse contour analysis.
4. Transthoracic echocardiography measurement of LVOT VTI for the estimation of stroke volume requires expertise.
5. The different methods to test for fluid responsiveness and their limitations.

Methods	Main limitations
Pulse pressure/stroke volume variations	Cannot be used in cases of spontaneous breathing, cardiac arrhythmias, low tidal volume/low lung compliance
Inferior vena cava diameter variation	Cannot be used in cases of spontaneous breathing, low tidal volume/low lung compliance
Passive leg raising (PLR)	Requires continuous and real-time cardiac output measurement e.g. echocardiography, pulse contour analysis, oesophageal Doppler or changes in end-tidal carbon dioxide
Mini fluid challenge (100 ml)	Requires a precise technique for measuring cardiac output e.g. pulse contour analysis
End-expiratory occlusion test	Cannot be used in non-intubated patients

## Appendix 2: Passive leg raising test

Passive leg raising test (PLR) is the preferred method as it does not involve additional fluid administration.



- PLR test consists of measuring haemodynamic effects (stroke volume or cardiac output) following leg elevation up to 45 degrees.
- Position patient at 45° head up semi-recumbent position.
- Lower patient's upper body to horizontal and passively raise legs to 45° up using the automatic motion of the bed. Avoid touching the patient.
- Assess haemodynamic effect of PLR within 30 - 90s after the onset of test.

## Appendix 3: Dose and haemodynamic effects of vasoactive agents

Drug	Infusion dose	Receptor binding				Haemodynamic effects
		$\alpha_1$	$\beta_1$	$\beta_2$	Dopamine	
<b>Vasopressor or inotrope</b>						
Noradrenaline	0.01 - 1.5 $\mu\text{g}/\text{kg}/\text{min}$	++++	++	+	-	$\uparrow\uparrow\text{SVR}$ , $\uparrow\text{CO}$
Vasopressin	0.03 - 0.04 U/min	stimulates $V_1$ receptors in vascular smooth muscle				$\uparrow\uparrow\text{SVR}$ , $\leftrightarrow\text{PVR}$
Adrenaline	0.01 - 1.5 $\mu\text{g}/\text{kg}/\text{min}$	++++	++++	+++	-	$\uparrow\uparrow\text{CO}$ , $\uparrow\uparrow\text{SVR}$
Dopamine	0.5 - 2 $\mu\text{g}/\text{kg}/\text{min}$	-	+	-	+++	$\uparrow\text{CO}$
	5 - 10 $\mu\text{g}/\text{kg}/\text{min}$	+	+++	+	++	$\uparrow\uparrow\text{CO}$ , $\uparrow\text{SVR}$
	10 - 20 $\mu\text{g}/\text{kg}/\text{min}$	+++	++	-	++	$\uparrow\uparrow\text{SVR}$ , $\uparrow\text{CO}$
Phenylephrine	0.1 - 10 $\mu\text{g}/\text{kg}/\text{min}$	+++	-	-	-	$\uparrow\uparrow\text{SVR}$
<b>Inodilators</b>						
Dobutamine	2.5 - 20 $\mu\text{g}/\text{kg}/\text{min}$	+	++++	++	-	$\uparrow\uparrow\text{CO}$ , $\downarrow\text{SVR}$ , $\downarrow\text{PVR}$
Milrinone	0.125 - 0.75 $\mu\text{g}/\text{kg}/\text{min}$	PD-3 inhibitor				$\uparrow\text{CO}$ , $\downarrow\text{SVR}$ , $\downarrow\text{PVR}$
Levosimendan	0.05 - 0.2 $\mu\text{g}/\text{kg}/\text{min}$	myofilament $\text{Ca}^{2+}$ sensitiser, PD-3 inhibitor				$\uparrow\text{CO}$ , $\downarrow\text{SVR}$ , $\downarrow\text{PVR}$

SVR: systemic vascular resistance PVR: pulmonary vascular resistance CO: cardiac output PD: phosphodiesterase



# Severe Hypoxaemic Respiratory Failure

## Introduction

$P_aO_2/F_iO_2$  is one of the most convenient and widely used bedside oxygenation parameter to quantify severity of hypoxaemic failure. Severe hypoxaemic respiratory failure is defined by  $P_aO_2/F_iO_2 < 100$ -150 mmHg. The primary aim of ventilatory support is to ensure adequate gas exchange while minimising the risk of ventilator-induced lung injury (VILI).

## Principles

1. Currently there is no outcome advantage of using either volume or pressure controlled ventilation.
2. Protective lung ventilation (PLV) strategy should be instituted to minimise VILI. Target a tidal volume of  $\leq 6$  ml/kg of ideal body weight with plateau pressure ( $P_{plat}$ ) of  $\leq 30$  cmH<sub>2</sub>O and accept a lower  $P_aO_2$ .
3. A lung recruitment manoeuvre should be reserved for patients who show 'PEEP responsiveness'.
4. Prolonged prone positioning ( $> 16$  hours) should be considered in early phase.
5. Muscle paralysis with neuromuscular blocking agent (NMBA) may be considered in the early phase of ventilation.
6. Extracorporeal membrane oxygenation (ECMO) may be considered as a rescue therapy. It should be based on clinician expertise on a case to case basis.
7. Non-invasive ventilation (NIV) should be avoided in patients with  $P_aO_2/F_iO_2 < 200$  as it is associated with a high failure rate.

## Ventilatory strategy and adjunctive therapies

1. Adhering to protective lung ventilation strategy
2. Optimising mean alveolar pressure
3. Performing lung recruitment manoeuvre if applicable and selecting optimal PEEP
4. Prone positioning
5. Use neuromuscular blocking agent

## I. Protective lung ventilation strategy

1. Calculate ideal body weight (IBW)  
Male =  $50 + 0.91 [\text{height (cm)} - 152.4]$  kg  
Female =  $45.5 + 0.91 [\text{height (cm)} - 152.4]$  kg
2. Mode: Pressure-controlled ventilation (PCV) or volume-controlled ventilation (VCV)
3. Target tidal volume ( $V_t$ ) of 6 ml/kg IBW with  $P_{\text{plat}} \leq 30$  cmH<sub>2</sub>O.
4. Set initial PEEP level at 10 - 15 cmH<sub>2</sub>O.
5. In PCV, aim for a driving pressure of not more than 15 cmH<sub>2</sub>O.
6. In VCV
  - a.  $P_{\text{plat}}$  should be measured every 4 hours if VCV is used in passively ventilated patients (no spontaneous breathing).
  - b. if  $P_{\text{plat}} > 30$  cmH<sub>2</sub>O, decrease  $V_t$  by 1 ml/kg till  $P_{\text{plat}}$  target achieved or a minimum 4 ml/kg  $V_t$  is reached.
7. In patients with high respiratory drive resulting in  $V_t > 6$  ml/kg and patient-ventilator dyssynchrony, muscle paralysis should be considered to prevent patient self-inflicted lung injury (P-SILI).
8. Use the lowest  $F_iO_2$  to achieve adequate oxygenation. Allow permissive hypoxaemia, accepting  $P_aO_2 \geq 55$  mmHg or  $SpO_2 \geq 88\%$ .
9. Accept permissive hypercapnia with  $pH > 7.2$ . The respiratory rate may be increased to a maximum of 35/min. Contraindications to permissive hypercapnia include intracranial hypertension, acute coronary artery disease, arrhythmias, right heart failure and worsening pulmonary hypertension.

## II. Mean alveolar pressure

1. Optimise mean alveolar pressure:
  - a. Increase inspiratory time ( $T_i$ ).
    - i. in VCV, decrease inspiratory flow rate or add inspiratory pause
    - ii. in PCV,  $T_i$  is directly set in seconds or adjusted as I:E ratio
    - iii. may require deep sedation as it has the potential to cause air trapping with haemodynamic consequences or barotrauma
  - b. Optimise PEEP and inspiratory pressure

### III. Lung recruitment manoeuvre and optimal PEEP selection

1. Common non-recruitable pathologies include:
  - a. Focal lung injury e.g. lung contusion, focal pneumonia
  - b. Pulmonary ARDS
2. Assess 'PEEP responsiveness' to evaluate recruitment potential of the lung.
  - a. Increase PEEP to 15 cmH<sub>2</sub>O for 30 minutes. High potential recruiters are those who demonstrate the following at the end of trial:
    - i. increase in P<sub>a</sub>O<sub>2</sub>/F<sub>i</sub>O<sub>2</sub>
    - ii. decrease in P<sub>a</sub>CO<sub>2</sub>
    - iii. increase in respiratory system compliance (C<sub>RS</sub>) by measuring dynamic compliance (C<sub>dyn</sub>)

$$C_{\text{dyn}} = \frac{V_t \text{ delivered}}{P_{\text{peak}} - \text{PEEP}}$$

C<sub>dyn</sub> is automatically measured in some ventilators.

3. Do not perform lung recruitment manoeuvre in non-recruiters. PEEP should be kept ≤ 10 in these patients. Consider prone and muscle paralysis.
4. Recruitment manoeuvre in recruiters:
  - a. Additional sedation, paralysis or both may be required during manoeuvre. Monitor for hypotension. Transient desaturation may be expected during manoeuvre.
  - b. Several types of recruitment manoeuvre has been described:
    - i. sustained high pressure inflation
      - CPAP 30 - 50 cmH<sub>2</sub>O for 20 - 40s with zero pressure support.
    - ii. extended sigh
      - Stepwise increase in PEEP and reduction in tidal volume over 2 minutes
      - Used in patients on VCV

V <sub>T</sub> (ml/kg IBW)	PEEP/CPAP	Duration (sec)
6	15	30
4	20	30
2	25	30
0	30	30

- iii. staircase recruitment manoeuvre (SRM)
    - PCV with stepwise increase in PEEP every 2 min, keeping driving pressure constant, up to a peak inspiratory pressure (PIP) of 45 - 50 cmH<sub>2</sub>O
    - PCV with driving pressure of 15 cmH<sub>2</sub>O, RR 10/min, I: E 1:1 F<sub>i</sub>O<sub>2</sub> 1.0.
    - Start with PEEP 20 cmH<sub>2</sub>O.
    - PEEP is increased by 5 cmH<sub>2</sub>O every 2 min until PIP of 45 - 50 cmH<sub>2</sub>O and PEEP 30 - 35 cmH<sub>2</sub>O.
    - An alternative method is a stepwise increase in PEEP with return to baseline between each increase.
5. Determining optimum PEEP after a recruitment manoeuvre:
    - a. Set PEEP at 20 cmH<sub>2</sub>O and reduce the PEEP in a stepwise fashion (1 cmH<sub>2</sub>O every 3 minutes) to achieve a maximal decrease in P<sub>a</sub>O<sub>2</sub> or C<sub>RS</sub>.
    - b. P<sub>a</sub>O<sub>2</sub> reduction of >10% or a reduction in C<sub>RS</sub> indicates de-recruitment and collapse pressure.
    - c. Repeat recruitment with sustained high pressure inflation. (CPAP 30 - 50 cmH<sub>2</sub>O for 20 - 40 s with zero pressure support). Inflation depending upon the peak pressure used during lung recruitment.
    - d. Optimal PEEP is at 2 cmH<sub>2</sub>O above the collapse pressure.
  6. Post recruitment assessment, if P<sub>a</sub>O<sub>2</sub>/F<sub>i</sub>O<sub>2</sub> ≤ 150 mmHg, start deep sedation and prone ventilation. Consider NMBA.

#### IV. Early prone positioning

1. Severe hypoxaemic patient should be placed in prone positioning within 24 hours for at least 16 consecutive hours.
2. Contraindications to prone position:

Absolute	Relative
<ul style="list-style-type: none"> <li>• Spine instability</li> <li>• Raised ICP</li> </ul>	<ul style="list-style-type: none"> <li>• Severe haemodynamic instability or arrhythmias</li> <li>• Open abdominal wounds</li> <li>• Multiple trauma with un stabilised fractures</li> <li>• Pregnancy</li> <li>• Pulmonary haemorrhage</li> <li>• Facial trauma</li> </ul>

3. Measure ABG and respiratory compliance, 1 hour before turning to supine position and within 4 hours following supine position.
4. Prone position is no longer required when there is sustained improvement of oxygenation as defined by P<sub>a</sub>O<sub>2</sub>/F<sub>i</sub>O<sub>2</sub> > 150 mmHg with F<sub>i</sub>O<sub>2</sub> < 0.6 and PEEP 10 - 15 cmH<sub>2</sub>O at 4 hours upon turning to supine.

5. Patient may be placed in prone position again at anytime before the 4 hour assessment if oxygenation criteria is not met.
6. Complications of prone include desaturation, hypotension, pressure ulcers, unplanned extubation, facial and airway oedema and catheter dislodgement.

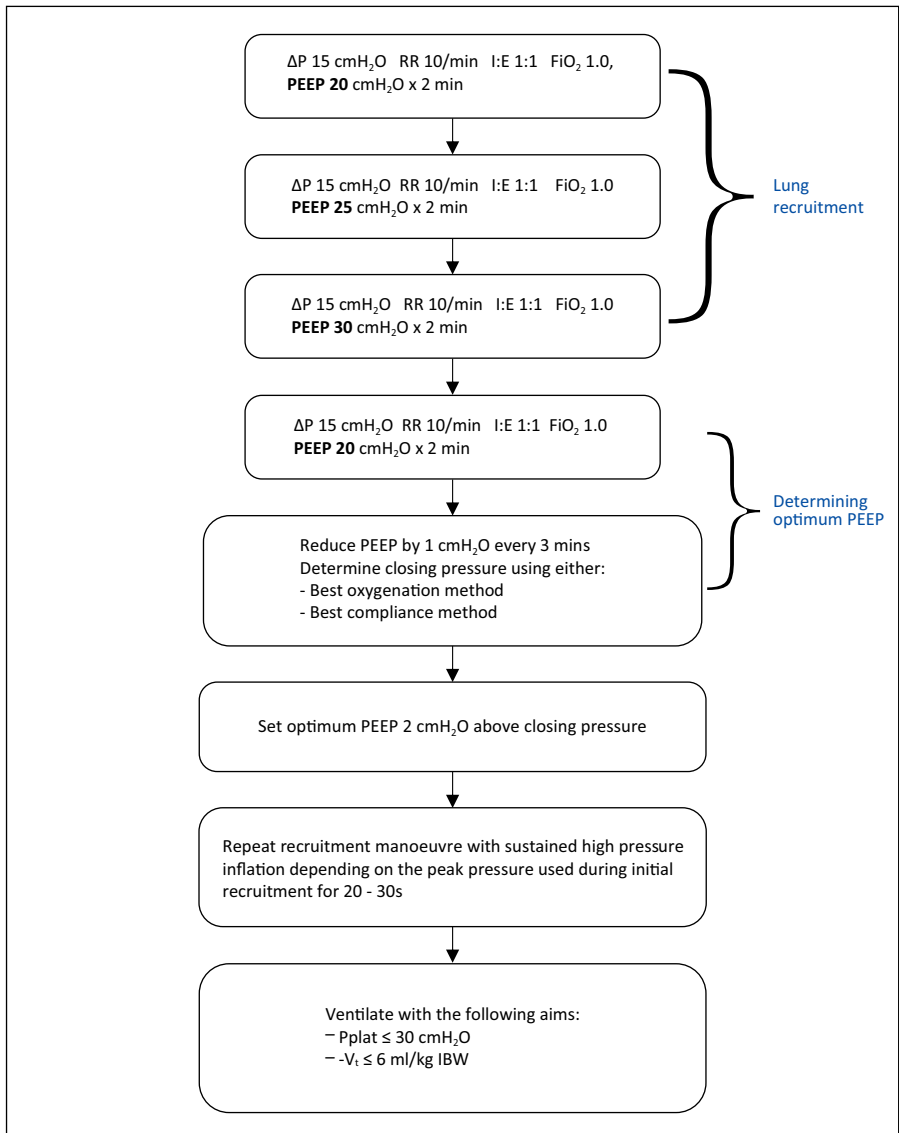
## V. Neuromuscular blocking agents

1. Muscle paralysis may be considered in the early phase of severe hypoxaemia in selected patients e.g. patients with ventilatory dyssnchrony or in prone position.
2. Current evidence supports using cisatracurium besylate for not more than 48 hours.
3. There is no consensus on the depth of muscle paralysis. Titrating to achieve 'Train of Four' count of 2/4 with peripheral nerve stimulator may be reasonable.
4. Concerns using NMB include neuropathy and the need for deep sedation.

## VI. Non-ventilatory strategy

1. Conservative fluid management that utilises fluid restriction and diuretics may improve oxygenation.
2. The use of corticosteroids cannot be recommended with the current level of evidence.
3. Consider echocardiography to assess right heart function.
  - a. Acute cor pulmonale in severe hypoxaemic failure may require right heart inotropic support and afterload reduction.
  - b. RV protective ventilation strategy include:
    - i. limit  $P_{plat} < 27$  cmH<sub>2</sub>O
    - ii. limit driving P < 15 cmH<sub>2</sub>O
    - iii. target  $P_aCO_2 < 60$  mmHg
    - iv. decrease PEEP if RV dysfunction
    - v. prone positioning
4. Refractory hypoxaemia may be secondary to patent or reopened foramen ovale with cardiac shunt.

## Lung recruitment manoeuvre using PCV with stepwise incremental PEEP and optimum PEEP determination



$\Delta P$  = driving pressure

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# Weaning from Mechanical Ventilation

## Introduction

A weaning protocol is a systematic guide to aid the process of discontinuation of patients from mechanical ventilation. It should encompass sedation optimisation, early mobilisation, systematic assessment for readiness to wean, spontaneous breathing trials (SBT), screening for post-extubation stridor in patients at risk and use of non-invasive ventilation (NIV) in those at high risk of post-extubation failure.

## Principles

1. Weaning begins as soon as the underlying cause for mechanical ventilation has sufficiently improved, the level of ventilation support is reduced and transition to spontaneous breathing is initiated.
2. Benefits of early weaning should be weighed against risks associated with failed extubation.
3. Weaning requires a sedation protocol aiming for light sedation and a rehabilitation protocol directed towards early mobilisation.
4. Assess patients' readiness to wean on a daily basis.
5. Perform SBT in patients who pass readiness to wean and assess for extubation in those who pass the SBT.
6. Perform a cuff leak test in patients at high risk of post-extubation stridor.
7. Initiate NIV weaning in selected patients at high risk of weaning failure.

## Assessment of readiness to wean

1. Weaning can be classified as simple, difficult or prolonged.

	Definition	Incidence in ICU
Simple	<ul style="list-style-type: none"><li>• Pass first SBT and successfully extubated</li></ul>	50 - 67%
Difficult	<ul style="list-style-type: none"><li>• Require up to 3 SBTs <b>or</b></li><li>• Require up to 7 days to pass a SBT</li></ul>	26 - 39%
Prolonged	<ul style="list-style-type: none"><li>• Fail &gt; 3 SBTs <b>or</b></li><li>• Require &gt; 7 days to wean</li></ul>	6 - 14%



2. Assess readiness to wean on a daily basis after resolution of the disease process.
3. Clinical criteria to determine readiness for SBT:
  - a. Spontaneous respiratory effort
  - b. Respiratory stability  
 $P_aO_2/F_iO_2$  ratio  $\geq 150$  or  $SpO_2 > 90\%$  on  $F_iO_2 < 0.5$  and PEEP 5 - 8 cmH<sub>2</sub>O  
 (in patients with chronic hypoxaemia,  $P_aO_2/F_iO_2 \geq 120$  is acceptable)
  - c. Cardiovascular stability:
    - i. HR < 140
    - ii. SBP > 90 mmHg and < 180mmHg
    - iii. minimal or no vasopressors (noradrenaline or adrenaline < 0.15 ug/kg/min)
    - iv. no ongoing myocardial ischaemia
    - v. pH > 7.25
  - d. Hb > 7.0 g/dL (preferable)
  - e. Temperature < 38.5°C (preferable)
  - f. Awake and alert or easily arousable (preferable)

### Spontaneous breathing trial

1. SBT is used to identify patients who are likely to fail liberation from mechanical ventilation.
2. It refers to a patient spontaneously breathing through the endotracheal tube (ETT) for a set period of time, with or without minimal ventilatory support.
3. Ideally, the patient should be awake on minimal or no sedative infusion.
4. The methods of SBT include:
  - a. Without ventilatory support  
 T-piece trial - disconnect ETT from ventilator and provide humidified oxygen via a T-piece
  - b. With minimal ventilator support (additional support may overcome the resistance of ETT)
    - i. low level pressure support (5 - 8 cmH<sub>2</sub>O) and PEEP (1 - 5 cmH<sub>2</sub>O) - preferred
    - ii. CPAP (5 cmH<sub>2</sub>O) with zero pressure support
    - iii. automatic tube compensation (available in some ventilators)
5. A duration of 30 mins for an initial trial is usually sufficient. For patients who have failed previous SBTs or on prolonged ventilation, longer trials of up to 2 hours may be required to determine whether mechanical ventilation can be discontinued.

6. Besides relying on objective criteria, clinical judgment is required in assessing if a patient can be successfully weaned. Criteria to stop SBT.

General	Neurological	Respiratory	Cardiovascular
<ul style="list-style-type: none"> <li>excessive sweating</li> </ul>	<ul style="list-style-type: none"> <li>agitation</li> <li>anxiety</li> <li>confusion</li> </ul>	<ul style="list-style-type: none"> <li>use of accessory muscles</li> <li>thoraco-abdominal paradox</li> <li>sustained increase in RR &gt; 35/min</li> <li><math>P_aO_2 &lt; 60</math> mmHg, <math>SpO_2 &lt; 90\%</math></li> <li>increase in <math>PaCO_2 &gt; 10</math> mmHg</li> <li><math>pH &lt; 7.25</math> or pH decrease by <math>&gt; 0.1</math></li> <li>Rapid shallow breathing index (RSBI) <math>&gt; 105</math> (RSBI = <math>RR/TV^*</math> in litres)</li> </ul>	<ul style="list-style-type: none"> <li>HR <math>&gt; 140</math>/min or increase <math>&gt; 20\%</math></li> <li>SBP <math>&gt; 180</math> or <math>&lt; 90</math> mmHg (or increase/decrease by <math>&gt; 20\%</math>)</li> <li>new onset of arrhythmias</li> </ul>

\*TV = Tidal volume

7. Assess for extubation if the patient passes SBT.
8. Terminate immediately if fails SBT and provide supportive mode of ventilation with higher settings. Do not repeat SBT for the next 24 hours and approach as a difficult-to-wean patient.

## Extubation criteria

1. Assessment of ability to protect airway:

Level of consciousness	Cough strength	Quantity of secretions
<ul style="list-style-type: none"> <li>Preferably alert, awake, follows commands</li> <li>Pass 4 tasks test:               <ul style="list-style-type: none"> <li>open eyes</li> <li>follow examiner with eyes</li> <li>grasp hand</li> <li>stick out tongue</li> </ul> </li> <li>In traumatic brain injury, GCS <math>\geq 8/15</math> is acceptable when neurological status is stable</li> </ul>	<ul style="list-style-type: none"> <li>Semi-objective assessment of cough strength:               <ul style="list-style-type: none"> <li>0 = no cough</li> <li>1 = audible air movement only</li> <li>2 = weak, barely audible cough</li> <li>3 = clearly audible</li> <li>4 = stronger cough</li> <li>5 = multiple sequential strong coughs</li> </ul> </li> <li>Strengths of <math>\leq 2</math> are associated with higher risk of extubation failure</li> </ul>	<ul style="list-style-type: none"> <li>The following is associated with higher risk of extubation failure:               <ul style="list-style-type: none"> <li>moderate to abundant secretions</li> <li>frequency of suctioning <math>&lt; 2</math> hours</li> </ul> </li> </ul>

2. Perform a cuff leak test as a surrogate marker of laryngeal oedema in patients at high risk of post-extubation stridor. These include:
  - a. Traumatic intubation
  - b. Duration of intubation  $\geq 7$  days
  - c. Excessively large ETT ( $\geq 7.5$  mm in women,  $\geq 8.5$  mm in men)
  - d. Excessive ETT mobility (psychomotor agitation or ETT not anchored properly)
  - e. Reintubation after unplanned extubation
3. Perform a cuff leak test as follows:
  - a. Use volume-controlled ventilation and record inspiratory tidal volume
  - b. Deflate cuff and average the cuff leak volume over 6 breaths
  - c. Calculate cuff leak volume (CLV) i.e. the difference between the inspired tidal volume and average expired tidal volume.  $CLV < 110$  ml or  $< 15-20\%$  of delivered tidal volume indicates a failed cuff leak test.
4. In patients who fail a cuff leak test, the administration of systemic steroids 4 hours prior to extubation has been shown to reduce risks of post-extubation stridor and reintubation.
  - a. Recommended agent is single dose iv methylprednisolone 40 mg. The alternative is iv dexamethasone 8 mg.
  - b. A repeat cuff leak test is not required after administration of systemic steroids.

## Difficult-to-wean

1. Provide ventilator management that encourages spontaneous breathing while avoiding respiratory fatigue.
2. Use pressure support (PS) as a weaning method i.e. continuous gradual reduction of PS by 2 cmH<sub>2</sub>O at a time, once or twice a day. Once PS is reduced to minimal level, repeat SBT on daily basis.
3. Consider the following strategies before resuming SBT:
  - a. Place patient in upright position for the SBT
  - b. Suction airway secretions
  - c. Optimise nutrition, taking care not to over or underfeed
  - d. Ensure adequate nocturnal rest with daytime respiratory muscle training
  - e. Aim for negative balance in patient with positive cumulative fluid balance
  - f. Consider longer duration of SBT of up to 2 hours
4. Identify and treat causes (see appendix) of weaning failure by performing a detailed physical examination and investigations as indicated.
5. Consider tracheostomy in patients who are unable to wean within 1 - 3 weeks.

## Non-invasive ventilation (NIV) for weaning

1. NIV for weaning can only be successful in patients with good airway protection, strong cough and manageable secretions.
2. Potential candidates for NIV weaning are those at high-risk for weaning failure:
  - a. COPD
  - b. Congestive heart failure
  - c. Elderly > 65 years
  - d. Hypercapnia during SBT
  - e. Failed > 1 SBT
3. Start NIV immediately after extubation and maintain for at least 24 hours.
4. Do not delay reintubation in patients who fail NIV.

## High-flow nasal cannula (HFNC) oxygen

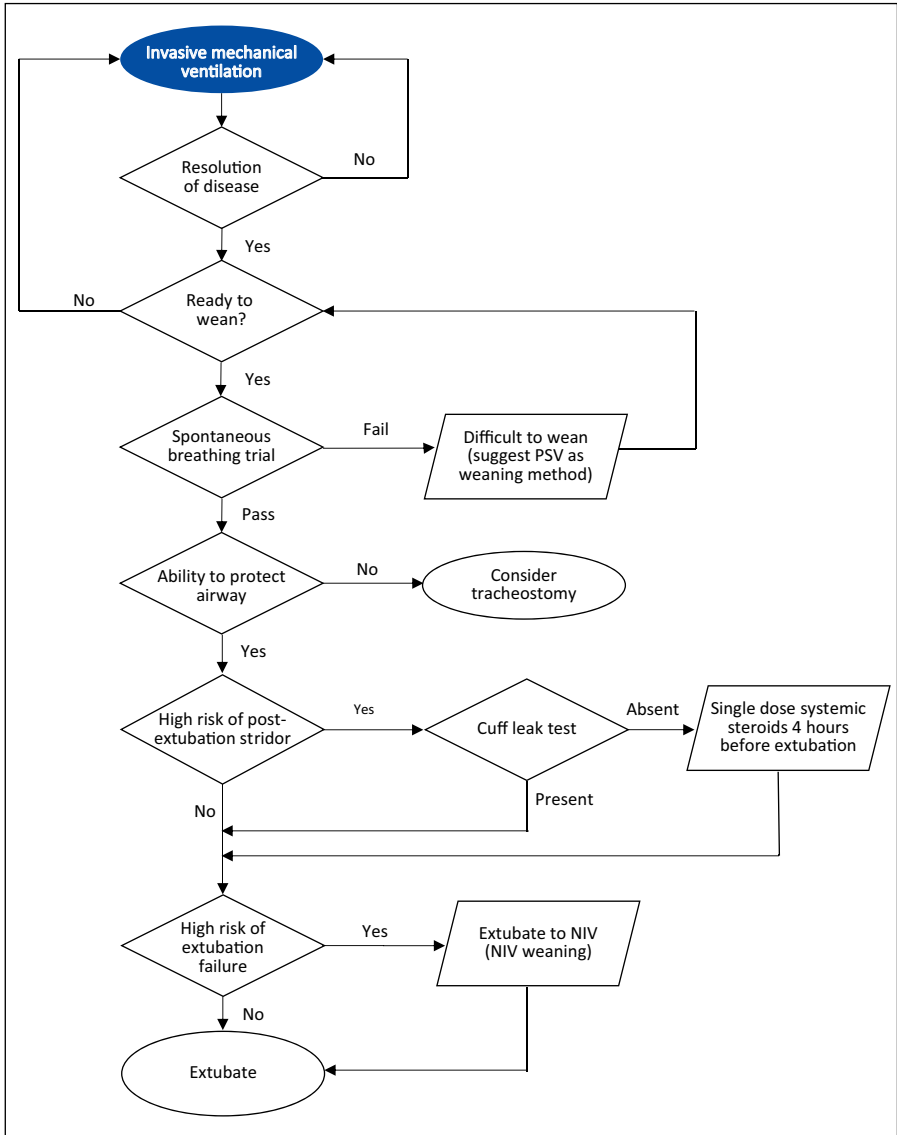
1. Consider HFNC oxygen in patients with post-extubation hypoxaemic respiratory failure, (if available).

## Prolonged mechanical ventilation (PMV)

1. A common consensus definition is requirement of ventilation > 21 days for at least 6 hours a day.
2. These patients will require a tracheostomy.
3. Identify factors that are potentially reversible.
4. Perform increases in duration of SBT with frequent assessment for signs of failure during SBT. A suggested approach is as follows:
  - a. Assess for readiness to wean when PS has been gradually reduced to 10 - 12 cmH<sub>2</sub>O.
  - b. Perform SBT using trachemask for a specified duration e.g. 2 hours.
  - c. If SBT is successful, perform daily SBT of progressively longer duration e.g. 4 hours, 6 hours etc.
  - d. Lengthen the SBT duration if patient feels comfortable and wishes to continue at the end of the SBT.
  - e. Do not repeat the SBT for at least another 24 hours if SBT fails.
  - f. The eventual goal is to reach 24 hours and be completely liberated from the ventilator.

5. Patients requiring PMV should not be considered permanently ventilator-dependent until at least 3 months of weaning attempts have failed, unless the respiratory failure is due to an irreversible process.

**Weaning from mechanical ventilation**



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## Appendix: Causes of weaning failure or failed SBT

1. Cardiovascular
  - Heart failure
  - Myocardial ischaemia
2. Respiratory
  - Pneumonia
  - Pulmonary oedema
  - Bronchospasm
  - Kinked or blocked tube
  - Excessive secretions
3. Abdomen
  - Abdominal distension causing splinting
4. Central nervous system (depressed central drive)
  - Sedatives or analgesics
  - CNS haemorrhage or infarction
  - Encephalitis
5. Peripheral nervous system
  - Critical illness neuropathy or myopathy
  - Guillain-Barre syndrome, myasthenia gravis (usually apparent before weaning)
6. Sepsis (unresolved or new bout)
7. Metabolic
  - Hypokalaemia
  - Hypomagnesemia
  - Hypophosphatemia
  - Severe hypothyroidism or myxoedema (rare but treatable)
  - Metabolic alkalosis
8. Over or underfeeding
9. Neuropsychological
  - Delirium
  - Anxiety
  - Depression
10. Anaemia

# Pain, Sedation and Delirium

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Management of sedation and delirium in ICU patients has evolved, emphasizing on effective pain management and aiming for light sedation. A safe and effective strategy should be implemented to avoid complications and conflicts with other management goals e.g. weaning from mechanical ventilation and early mobilisation.

## Principles

1. Focus first on analgesia, then sedation.
2. Practise analgesic-first sedation by using an analgesic (usually an opioid) prior to a sedative to reach the sedation goal.
3. Aim for light sedation unless contraindicated.
4. Titrate analgesic and sedative drugs to a defined target, using the lowest effective dose.
5. Identify risk factors and implement effective preventive measures for delirium.
6. Assess pain, sedation and delirium objectively using validated monitoring tools.
7. Employ pharmacological and non-pharmacological strategies to manage pain, agitation and delirium.

## Pain

1. Use validated scales to monitor pain i.e. Behavioral Pain Score (BPS) or Critical Care Pain Observational Tool (CPOT) in the unconscious, and Visual Analogue Score (VAS) in the conscious patients.
2. Assess pain at least 4 hourly.
3. Institute pain management when pain score is:
  - a.  $\geq 5$  for BPS
  - b.  $\geq 3$  for CPOT
  - c.  $\geq 3$  for VAS
4. Opioid based analgesia remains the mainstay of pain management.
5. Consider adjuncts to an opioid to reduce the dose of opioid and/or reduce severity of pain.
  - a. Paracetamol either administered intravenously, orally or per rectal
  - b. IV ketamine in post-surgical patients



6. Patient-controlled analgesia (PCA) can be provided for awake and cooperative patients.
7. Use an analgesic prior to a procedure that may cause pain, with the lowest effective dose possible and timed so that the peak effect coincides with the procedure.
8. Use gabapentin or carbamazepine with opioids for neuropathic pain e.g. Guillain-Barré syndrome.
9. Consider regional analgesia in selected surgical or trauma patients e.g. thoracic epidural analgesia in post-operative abdominal aortic aneurysm surgery or traumatic rib fractures.
10. Non-pharmacological interventions may be used to compliment conventional pharmacological approaches e.g. music therapy, relaxation techniques or massage therapy.

**Table 1: Pharmacological agents for pain management:**

Drug	Bolus dosage	Infusion dosage	Max dosage	Side Effects
IV Fentanyl	0.35 - 0.5 µg/kg	0.5 - 2 µg/kg/h		Cumulative in hepatic impairment
IV Morphine	2 - 4 mg	2 - 10 mg/h		Cumulative in renal and hepatic impairment (avoid if GFR < 20) Ileus with high doses
IV Ketamine	0.1 - 0.35 mg/kg	0.1 - 0.5 mg/kg/h		Dissociative disorder with higher doses
IV/PO Paracetamol	IV : 500 mg - 1 gm or 15 mg/kg q6h PO: 500 mg - 1 gm q6h		4 g/day	Hypotension (intravenous) Liver dysfunction
IV Remifentanyl <i>* cost consideration</i>	0.5 µg/kg (loading)	0.05 - 0.5 µg/kg/min		Rigidity, bradycardia, hyperalgesia
IV/PO Oxycodone	IV/SC : 5 - 10 mg q4 - 6h PO: 5 - 10 mg q4 - 6h	2 mg/h	> 60 yrs: 2.5 - 5 mg q4 - 6h	

Drug	Bolus dosage	Infusion dosage	Max dosage	Side Effects
IV/PO Tramadol HCl	50 - 100 mg q6 - 8h		400 mg/day Creat cl < 30 ml/min: 200 mg/day Creat cl < 10 ml/min: 100 mg/day	Interaction with TCA, SSRI, linezolid Seizures with high doses (especially in traumatic brain injury)
PO Gabapentin	initial dose: 100 mg q8h maintenance: 300 - 900 mg q8h		3600 mg/day Elderly: 100 mg daily Creat cl < 15ml/min: 300 mg/day	Drowsiness Ataxia Dizziness Withdrawal syndrome

## Sedation

1. Assess sedation with revised Riker Sedation Agitation Score or Richmond Agitation Sedation Score (RASS) every 4 hours.
2. Aim for light sedation, either revised Riker -1 to +1 or RASS -2 to +1 with patient being awake, calm and comfortable.
3. Use analgesia-first sedatives (morphine or fentanyl) in mechanically ventilated patients.
4. If additional sedatives are required,
  - a. non-benzodiazepines (propofol or dexmedetomidine) are preferred over benzodiazepines due to lower incidence of delirium. If propofol or dexmedetomidine is used, consider patient's haemodynamic status, anticipated duration of sedation, drug availability and cost.
  - b. in haemodynamically unstable patient, either:
    - i. add intravenous midazolam
      - initiate at 1 mg/hr and titrate by 1 mg/hr every 30 minutes to achieve sedation goal.
    - ii. use "high" dose fentanyl alone
      - initiate at 50 mcg/hr and titrate by 25 mcg/hr every 15 minutes. Maximum 500 mcg/hr.
5. Aim for deep sedation (revised Riker -2 to -3 or RASS -3 to -5) in the following patients:
  - a. head injury on cerebral protection
  - b. post cardiac arrest care
  - c. on high vasopressors or inotropes
  - d. on high ventilatory settings
  - e. prone position

- f. massive pulmonary haemorrhage
  - g. severe bronchial asthma
  - h. tetanus
  - i. on neuromuscular blocking agent
6. If deep sedation is required, add either intravenous infusion of midazolam or propofol or both.
  7. Reassess daily need for deep sedation and wean sedatives when no longer required.
  8. Consider dexmedetomidine in patients who are unable to wean off the ventilator due to agitated delirium.
  9. Use benzodiazepines to provide amnesia for procedures or in patients with anxiety, seizures, alcohol withdrawal or palliation.

**Table 2: Pharmacological agents for management of sedation and agitation:**

Drug	Bolus dosage	Infusion dosage	Max dosage	Side Effects
IV Fentanyl ("high" dose)	100 - 200 µg/hr	50 - 500 µg/hr		Cumulative in hepatic impairment
IV Propofol 1%	1 - 2 mg/kg	50 - 200 mg/h	4 mg/kg/h up to 48 - 72 hours	Cumulative in hepatic impairment Fatty liver Hypotension Hypertriglyceridemia Pancreatitis Propofol infusion syndrome Infection
IV Midazolam	0.01 - 0.05 mg/kg	0.02 - 0.1 mg/kg/h		Respiratory depression Hypotension Delirium Agitation
IV Dexmedetomidine		0.2 - 0.7 µg/kg/h	1.5 µg/kg/h	Hypotension Bradycardia Loss of airway reflex

## Delirium

1. Delirium is diagnosed when there is alteration or fluctuation in mental status, inattention and disorganised thinking. The 3 forms of delirium are hypoactive (44%), hyperactive (2%) or mixed (54%).

2. Identify risk factors for delirium as soon as the patient is admitted to ICU.

**Table 3: Risk factors for delirium**

Patient factors	Clinical factors	Environmental factors
<ul style="list-style-type: none"> <li>Elderly</li> <li>Dementia</li> <li>Alcohol or drug dependence</li> <li>Hearing or visual impairment</li> </ul>	<ul style="list-style-type: none"> <li>Sepsis</li> <li>Hypoxia</li> <li>Post-operative</li> <li>Pain</li> <li>Severe burns</li> <li>Metabolic or electrolyte imbalances</li> <li>CNS pathology</li> <li>Endocrine disorders</li> </ul>	<ul style="list-style-type: none"> <li>Isolation</li> <li>Immobility (including restraints)</li> <li>Sleep deprivation</li> <li>Noise</li> <li>Lighting</li> </ul>

3. Use validated screening tool, Confusion Assessment Method for the Intensive Care Unit (CAM- ICU) to assess delirium in the critically ill. Perform objective assessment of delirium when RASS is > -3 or revised Riker > -2.

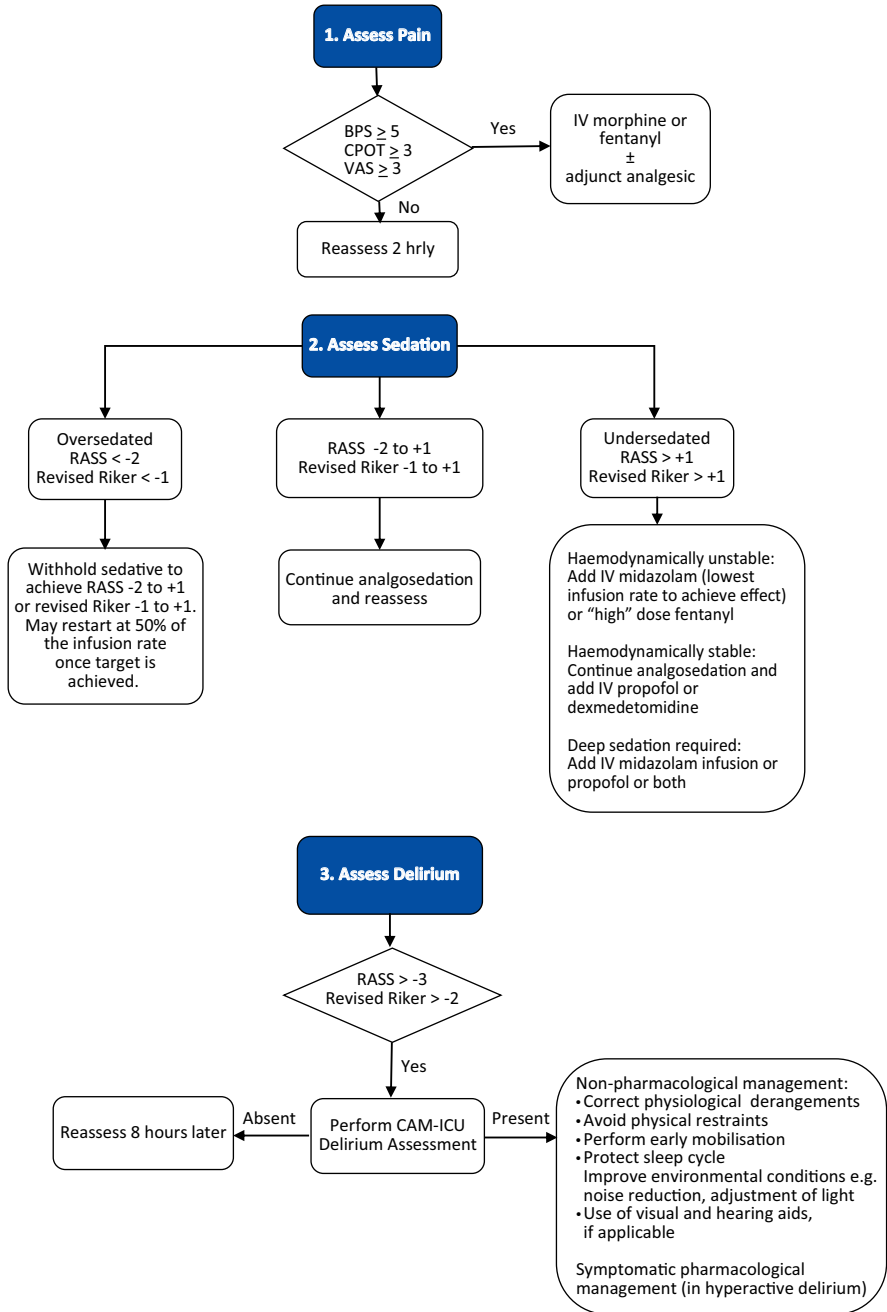
4. Consider the following non-pharmacological approaches to prevent delirium:
- Correct physiological derangements.
  - Avoid physical restraints.
  - Perform early mobilisation.
  - Protect sleep cycles by clustering patient care activities, decrease stimuli at night.
  - Improve environmental conditions e.g. orientation, noise reduction, adjustment of light.
  - Use of visual and hearing aids, if applicable.

5. Pharmacologic agents are not used to prevent or treat delirium, but to control symptoms in hyperactive delirium.

**Table 4: Pharmacological agents in symptom management in delirium:**

Drug	Dosage	Max dosage	Side Effects
IV/IM/PO Haloperidol	0.5 - 10 mg q4 - 6h or PRN	100 mg/day	Extrapyramidal symptoms Prolonged QT syndrome Neuroleptic malignant syndrome Rhabdomyolysis
PO Chlorpromazine	6.25 - 25 mg q6 - 8h	500 mg/day	Drowsiness Anti-cholinergic effects
PO Olanzapine	2.5 mg q24h (increment of 5 mg daily)	20 mg/day	Drowsiness Anti-cholinergic effects
PO Quetiapine	25 mg q12h (increment of daily dose of 25 mg)	400 mg/day	Drowsiness Anti-cholinergic effects
PO Risperidone	0.5 mg q12h increase by 1 mg/day ever 2 - 3 days	6 mg/day	Renal and hepatic adjustments (max 0.5 mg q12h) Drowsiness Anti-cholinergic effects

# Management of pain, agitation and delirium



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## Appendix 1: Behavioural Pain Scale (BPS)

Item	Description	Score
Facial expression	Relaxed	1
	Partially tightened (brow lowering)	2
	Fully tightened (eyelid closing)	3
	Grimacing	4
Upper limb movements	No movement	1
	Partially bent	2
	Fully bent with finger flexion	3
	Permanently retracted	4
Compliance with mechanical ventilation	Tolerating movement	1
	Coughing but tolerating ventilation for most of the time	2
	Fighting ventilator	3
	Unable to control ventilation	4
BPS score ranges from 0 (no pain) to 12 (maximum pain)		

## Appendix 2: Critical Care Pain Observational Tool (CPOT)

Item	Score	Description	
Facial expression	Relaxed or neutral	0	No muscle tension
	Tense	1	Frowning, brow lowering, orbit tightening or any other change (e.g. opening eyes or tearing during nociceptive procedures)
	Grimacing	2	All previous facial movements PLUS eyelid tightly closed (patient may have mouth opening or biting ETT)
Body movements	Absence of movements or normal position	0	No movement at all (does not mean absence of pain) or normal position (movements not aimed toward pain site or not made for the purpose of protection)
	Protection	1	Slow, cautious movements, touching or rubbing pain site, seeking attention through movements
	Restlessness	2	Pulling tube, attempting to sit up, moving limbs/ thrashing, not following commands, striking at staff, trying to climb out of bed



Item	Score	Description
Compliance with ventilator in intubated patient	Tolerating ventilator or movement	0 Alarms not activated, easy to ventilate
	Coughing but tolerating	1 Alarms may be activated but stop spontaneously
OR Vocalisation in non-intubated patient	Fighting ventilator	2 Asynchrony, alarms activated frequently
	Talking in normal tone or no sound	0 Talking in normal tone or no sound
	Sighing or moaning	1 Moaning, sighing
	Crying out, sobbing	2 Crying, sobbing
Muscle tension  (Evaluation by passive flexion/extension of upper limb when at rest or when being turned)	Relaxed	0 No resistance to passive movements
	Tense, rigid	1 Resistance to passive movements
	Very tense or very rigid	2 Strong resistance to passive movements, inability to complete them
CPOP score ranges from 0 (no pain) to 8 (maximum pain)		

### Appendix 3: Richmond Agitation Sedation Scale (RASS)

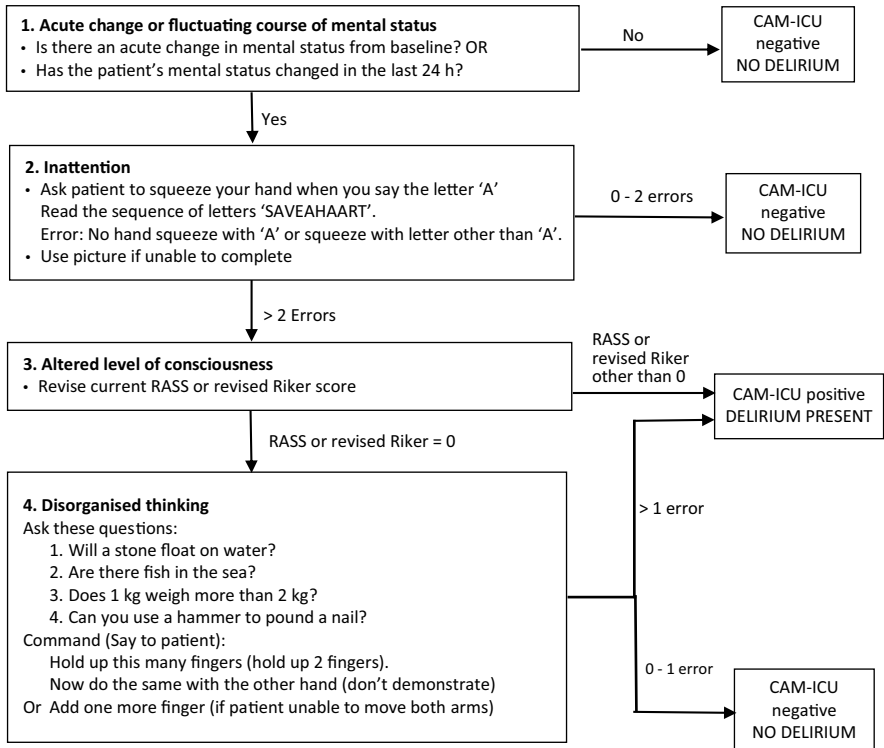
Scale	Term	Description
+4	Combative	Overtly combative, violent, immediate danger to staff
+3	Very agitated	Pulls or removes tube(s) or catheter(s); aggressive
+2	Agitated	Frequent non-purposeful movement, fights ventilator
+1	Restless	Anxious but movements not aggressive vigorous
0	Alert and calm	
-1	Drowsy	Not fully alert, but has sustained awakening (eye-opening/eye contact) to voice (> 10 seconds)
-2	Light sedation	Briefly awakens with eye contact to voice (< 10 seconds)
-3	Moderate sedation	Movement or eye opening to voice (but no eye contact)
-4	Deep sedation	No response to voice, but movement or eye opening to physical stimulation
-5	Unarousable	No response to voice or physical stimulation



## Appendix 4: Revised Riker Sedation Agitation Scale

Scale	Term	Description
+3	Agitated and restless	When awoken or otherwise, pulling at ETT, trying to remove catheters or requires physical restraints
+2	Awake but mildly agitated	Anxious but mildly agitated. Attempts to sit up but calms down with verbal instructions
+1	Awake and calm	Awake, calm and easily follows commands
0	Aroused by voice and remains calm	Awakens easily to verbal stimuli. Remains awake, calm and easily follows command
-1	Aroused by movement	Contact for at least 10 seconds but drifts off to sleep  OR 
-2	Aroused by painful stimuli	Localising or flexion to pain. Does not communicate or follow commands
-3	Unarousable	Extension, minimal or no response to painful stimuli

## Appendix 5: Confusion Assessment Method for ICU (CAM-ICU) Delirium worksheet



# Nutritional Therapy

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## Introduction

Early enteral nutrition attenuates metabolic response to stress, prevents oxidative cellular injury and modulates immune responses. Enteral nutrition (EN) is preferred over parenteral nutrition (PN). Parenteral nutrition is an alternative when enteral route is neither sufficient nor feasible.

## Principles

1. Assess nutritional risk.
2. Commence enteral nutrition within 24 to 48 hours upon ICU admission.
3. Aim only for 70% - 80% of targeted calories within 72 hours.
4. Aim to provide protein of at least 1.2 g/kg/day.
5. Prescribe parenteral nutrition after 5 - 7 days if enteral nutrition is not feasible.
6. Avoid overfeeding.
7. Identify patients at risk of refeeding syndrome.

## Nutritional risk

1. Nutritional status should be assessed clinically to identify patients with malnutrition or at risk of malnutrition.
2. The following patients are to be considered at high risk for malnutrition:
  - a. ICU stay for > 2 days and mechanically ventilated
  - b. Underfed for > 5 days
  - c. Pre-existing severe chronic disease

## Enteral nutrition

1. Initiate EN within 24 - 48 hours of ICU admission if gastrointestinal tract is functioning and patient adequately resuscitated.
2. EN should be delayed in:
  - a. Shock with haemodynamic instability
  - b. Severe hypoxaemia and acidosis
  - c. Active upper GI bleeding
  - d. Acute bowel ischaemic
  - e. Abdominal compartment syndrome
  - f. Gastric residual volume > 500 mls in 6 hours

3. Aim to achieve only 70 - 80% of targeted calories in the first 72 hours of admission i.e. the early phase of acute illness.
4. Provide EN via nasogastric or orogastric tube size 10 to 12Fr after confirming correct placement by the following methods:
  - a. Chest radiograph
  - b. Aspiration of gastric contents
  - c. Measuring pH of aspirate using pH indicator strip (if available)
5. Ensure head of bed is elevated at least 30 degrees during feeding.
6. Enteral feeding can be administered by various means:
  - a. Continuous: administered at an hourly rate using a feeding pump for 24 hours.
  - b. Intermittent: administered using a feeding pump over a few hours with rest period in between e.g. feeding over 4 hours with 2 hours rest.
  - c. Bolus: administered by gravity over 15 min every 3 - 4 hours.
7. Enteral formulation
  - a. Use standard polymeric isocaloric or near isocaloric of 1 - 1.5 kcal/ml.
  - b. Consider diabetic specific formula with low glycaemic index in diabetics.
  - c. Consider a caloric dense formula in patients with fluid restriction.
8. Calorie and protein requirement

BMI	Weight used	Calories and protein target per day
Underweight (BMI < 18.5)	Adjusted body weight = $\frac{\text{Ideal BW} + \text{Actual BW}}{2}$	20 - 25 kcal/kg 1.2 - 2 g/kg <sup>1</sup>
Normal weight (BMI 18.5 - 29.9)	Actual body weight	20 - 25 kcal/kg 1.2 - 2 g/kg <sup>1</sup>
Obese (BMI ≥ 30)	Actual body weight or Ideal body weight	<p><i>Calorie requirement</i></p> <p><u>BMI 30-50:</u> 11 - 14 kcal/kg actual BW</p> <p><u>BMI &gt; 50:</u> 22 - 25 kcal/kg IBW<sup>2</sup></p> <p><i>Protein requirement</i></p> <p><u>BMI 30-40:</u> 2 - 2.5 g/kg IBW</p> <p><u>BMI &gt; 40:</u> Up to 2.5 g/kg IBW</p>
<p><sup>1</sup>Increase protein up to a maximum of 2.5 g/kg/day in patients receiving continuous renal replacement therapy or on frequent haemodialysis</p> <p><sup>2</sup>IBW: Ideal body weight = weight at BMI 25</p> <p>Calorie contribution from other sources e.g. propofol infusion and dialysate should be included.</p>		

9. Monitor for feeding intolerance. Feeding intolerance is defined as high gastric residual volume (GRV), abdominal distension, vomiting, diarrhoea or reduced passage of stools.

**A. GRV > 300 ml**

- a. Use a prokinetic agent:
  - i. iv erythromycin 125 mg q6h or 250 mg q12h or
  - ii. iv metoclopramide 10 mg q8h
- b. Combination of both agents has shown to improve gastric tolerance and may be considered. Both agents are associated with QT prolongation.
- c. Review the need of prokinetics after 48 hours.

**B. Diarrhoea**

- a. Defined as > 2-3 liquid stools per day or > 250 g liquid stool per day.
- b. Do not routinely interrupt feeding for diarrhoea.
- c. Factors that may contribute to diarrhoea:
  - i. type and amount of fibre in formula
  - ii. osmolality of formula
  - iii. delivery mode
  - iv. EN contamination
  - v. medications (antibiotics, PPI, prokinetics, laxatives)
  - vi. *Clostridium difficile* infection
  - vii. intra-abdominal collections following abdominal surgery
- d. Management includes:
  - i. review of medications and dietary formula
  - ii. send stool for *Clostridium difficile* toxin assays
  - iii. monitor serum electrolytes
  - iv. rule out abdominal pathology
- e. If diarrhoea persists consider the addition of soluble fibre supplement into standard feeds or the use of small peptide semi-elemental formula

10. Monitor blood glucose levels

- a. Keep blood glucose between 8 - 10 mmol/L
- b. Start insulin if blood glucose > 10 mmol/L

11. Trophic feeding (defined as 10 - 20 ml/h or up to 500 kcal/day) should be considered in:

- a. Resolving shock (minimal or decreasing vasopressors or inotropes).
- b. Prone position.
- c. Intra-abdominal hypertension without abdominal compartment syndrome.

12. Fasting
  - a. In intubated patients, do not withhold feeding for procedures in ICU or operating theatre or extubation.
  - b. Feeds should be aspirated prior to transport, procedures or extubation.
  - c. For non-intubated patients, follow the fasting protocol as per general anaesthesia.
13. Safe practice for enteral nutrition
  - a. Use sterile water for formula reconstitution and tube flushing.
  - b. Feeding tubes to be flushed with at least 20 - 30 ml of water at the end of feeding.
  - c. Flush volume should be included in daily fluid intake.
  - d. Hang time duration:
    - i. closed system (ready to hang): 24 hours or per manufacturer's recommendation
    - ii. sterile decanted formula: 8 hours
    - iii. powdered reconstituted formula: 4 hours
  - e. Change administration set every 24 hours.
  - f. Opened decanted formula must be refrigerated and discarded within 12 hours if not used.

## Parenteral nutrition

1. Indications for PN:
  - a. As soon as possible in patients who are severely malnourished and EN is not feasible.
  - b. After 5 - 7 days in patients not deemed malnourished on admission and EN is not feasible.
  - c. Supplemental PN to be considered if > 60% of energy and protein requirement via EN is not met after 7 - 10 days.
2. Dosing
  - a. Start with non-protein calories of  $\leq 20$  kcal/kg/day with protein of  $\geq 1.2$  g/kg/d. Increase gradually and aim to achieve target within 5 - 7 days.

- b. Macronutrients required per day
    - i. carbohydrate 2 - 5 g/kg
    - ii. lipids 0.75 - 1.5 g/kg
    - iii. proteins 1.2 - 2.0 g/kg
  - c. Carbohydrate to lipid ratio should be between 60:40 or 70:30
  - d. Prescribe electrolytes based on daily serum levels.
  - e. Add trace elements and vitamins.
3. Administration
    - a. High osmolality via a dedicated lumen of a central line.
    - b. Low osmolality (< 850 mOsmol/L) can be administered via peripheral line.
    - c. Change administration set every 24 hours.
  4. Monitoring
    - a. 2 hourly blood glucose. Target level of 8 - 10 mmol/L
    - b. Daily serum potassium, phosphate, calcium and magnesium.
    - c. Biweekly liver function test.
    - d. Weekly serum triglycerides. Target level < 4.5 mmol/L.
  5. Discontinuation
 

Discontinue PN when patient receives > 60% of targeted calories enterally.

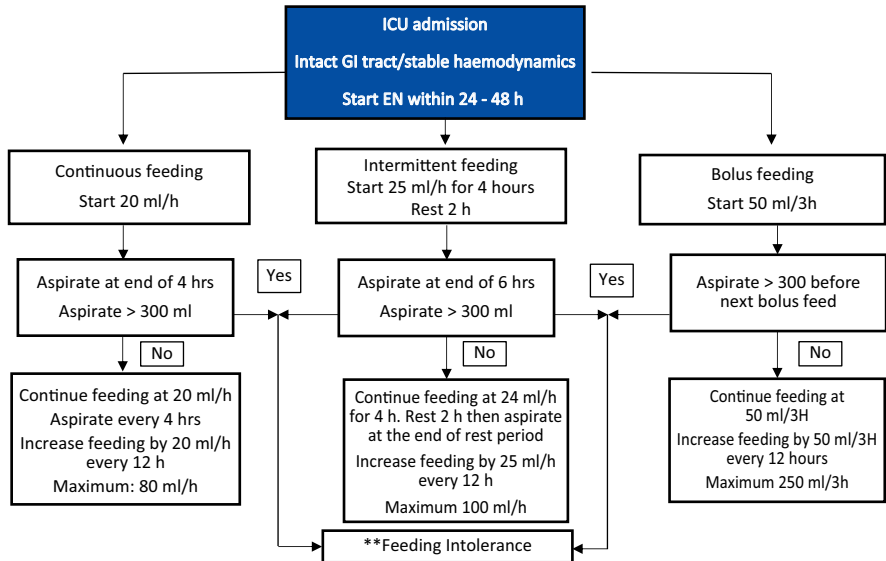
## Refeeding syndrome

Refeeding syndrome(RFS) describes the biochemical changes, clinical manifestations and complications that occur due to severe shift of fluid and electrolytes when a malnourished patient is fed either enterally or parenterally.

1. Risk factors
  - a. High risk: 1 or more major risk factors
    - BMI < 16.5 kg/m<sup>2</sup>
    - Unintentional weight loss of > 15% in the previous 3 - 6 months
    - Little or no nutritional intake for > 10 days
  - b. High risk: 2 or more minor risk factors
    - BMI < 18.5 kg/m<sup>2</sup>
    - Unintentional weight loss of > 10% in the previous 3 - 6 months
    - Little or nutritional intake for > 5 days
    - History of alcohol abuse or drugs including insulin, chemotherapy or diuretics
  - c. Extreme high risk: 1 of the following
    - BMI < 14 kg/m<sup>2</sup>
    - Little or no nutritional intake for > 15 days

2. Prevention and management of RFS:
  - a. Identify patients at risk.
  - b. Check phosphate, potassium and magnesium levels.
  - c. Provide immediately before and during the first 10 days of feeding: oral thiamine 200 mg q24h, vitamin B complex 1 - 2 tablets q12h and multivitamins q24h.
  - d. If patients are unable to tolerate orally, administer parenteral thiamine 200 to 300 mg q24h for 3 days followed by oral thiamine.
  - e. Start feeding at 10 kcal/kg/day. Slowly increase by 5 kcal/kg/day every 4 - 5 days. In extreme high risk, start feeding at 5 kcal/kg/day.
  - f. Rehydrate carefully and monitor fluid balance.
  - g. Correct levels of potassium, phosphate and magnesium along with feeding.

## Feeding protocol



## Feeding Intolerance: GRV > 300 ml or vomiting

1 <sup>st</sup> episode	2 <sup>nd</sup> episode	3 <sup>rd</sup> episode or more
<ol style="list-style-type: none"> <li>1. Check gastric tube position</li> <li>2. Return aspirates up to 200 ml. Discard excess</li> <li>3. Maintain EN at the same rate</li> <li>4. if aspirates &gt; 500 ml, withhold feeding for 1 cycle and start prokinetics</li> </ol>	<ol style="list-style-type: none"> <li>1. Return aspirates up to 200 ml. Discard excess.</li> <li>2. Decrease rate by 20 or 25 ml/h, If patient already on 20 - 25 ml/h, reduce rate to 10 ml/h</li> <li>3. Start prokinetics</li> <li>4. Consider continuous or intermittent feeding if patient is on bolus feeding</li> </ol>	<ol style="list-style-type: none"> <li>1. Return aspirates up to 200 ml. Discard excess</li> <li>2. Withhold feeds for 1 cycle</li> <li>3. Restart at lower rate or at 10 ml/h</li> <li>4. Continue prokinetics</li> </ol>

\*\* Consider post-pyloric feeding if feeding intolerance persists for more than 72 hours.

- Aim only for 70 - 80% of targeted calories in the first 72 hours.
- Continuous feeding is preferred over intermittent or bolus feeding
- Consider bolus feeding only in stable patients i.e.
  - non ventilated with an anticipated ICU stay of < 48 - 72 hours
  - previously on continuous or intermittent feeding
- Maximum volume depends on:
  - caloric requirements
  - osmolality of formula e.g. Ensure (1 kcal/ml), Nepro (2 kcal/ml)



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# Early Mobilisation

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## Introduction

Prolonged immobilisation of critically ill patients may lead to neuromuscular weakness, and impairment in physical and neuropsychiatric functions. Benefits of early mobilisation include improved muscle strength, physical function and quality of life. Additionally, early mobilisation may assist in weaning from mechanical ventilation, reduce the risk of deep vein thrombosis, pressure ulcer and delirium. However, there is lack of evidence benefiting neurocritical care patients. There is also inadequate evidence on the frequency and intensity of mobilisation, and devices to be used.

## Principles

1. Initiate early mobility within 24 - 48 hours of admission in the absence of contraindications.
2. Assess appropriateness of early mobility by weighing risks of adverse events against benefits.
3. Step-up progression of mobilisation based on patient's conscious level, functional capability and endurance.
4. Implement early mobilisation in combination with pain, sedation and delirium management.

## General

1. Assess patients within 24 - 48 hours of ICU admission for early mobilisation.
2. Very early (less than 24 hours) and intensive out-of-bed mobilisation has been shown to be harmful in acute stroke patients.
3. Contraindications to early mobility
  - a. Cardiovascular instability: SBP < 90 mmHg, HR > 120/min, unstable cardiac rhythm, use of 2 or more vasoactive agents
  - b. Neurological instability: acute traumatic brain injury, acute intracranial bleed, unstable spinal cord injury or any new neurological deterioration
  - c. Respiratory instability:  $F_iO_2 > 0.6$ , PEEP > 10 cmH<sub>2</sub>O and RR > 35/min
4. Early mobilisation activities require a multidisciplinary team comprising of clinicians, physiotherapists and nurses.

5. Consult the ICU specialist when there is uncertainty about safety.
6. Inform patients and families the importance of early mobility.

## Activities

1. Level of activity and mobilisation should be guided by the patient's conscious state, strength and endurance as well as the assessment of safety.
2. Passive and active activities:
  - a. Passive activities involve movements performed by the physiotherapist e.g. flexion and extension of limb joints.
  - b. Active activities involve the patient assisting using his own muscle strength. These include:
    - i. in-bed exercises (any activity while patient is sitting or lying in bed): e.g. bridging, upper limb weight training
    - ii. out-of-bed exercises e.g. sitting at the edge of the bed, sitting out-of-bed, standing, marching on the spot, walking
3. In all patients, unless contraindicated,
  - a. Alternate supine position with right and left lateral positions 2 hourly.
  - b. Perform passive range of motion exercises.
4. In conscious patients perform the following activities:

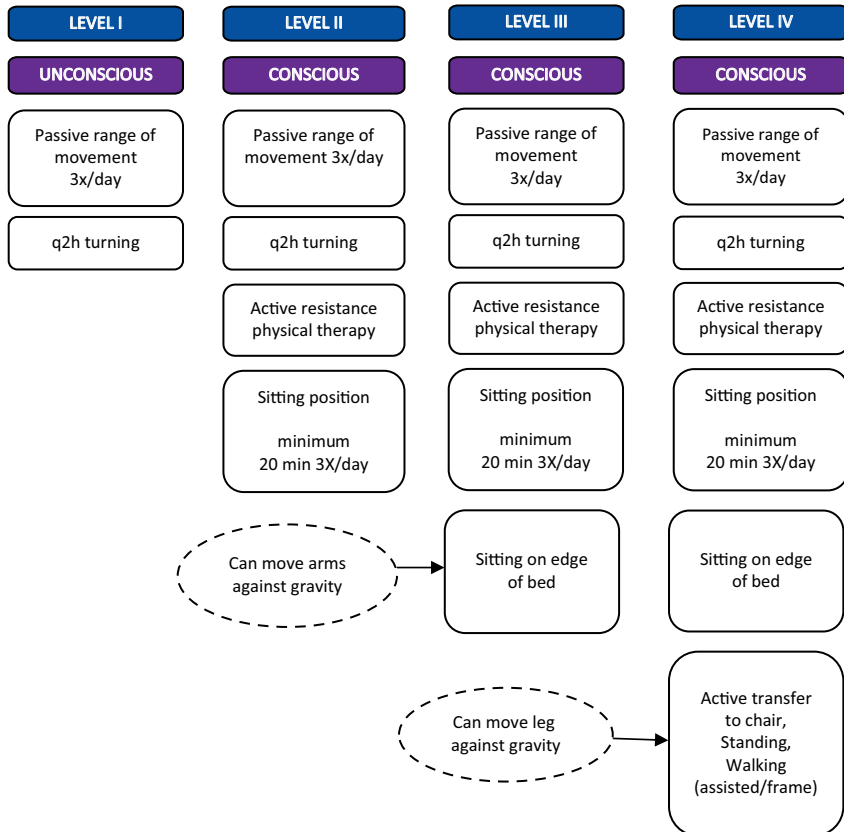
State of patient	Activities
Alert, responds to 3 of the 5 commands: - open or close eyes - look when asked to - open mouth and protrude tongue - nod head - raise eyebrows	<ul style="list-style-type: none"> <li>breathing exercises</li> <li>active resistance exercises</li> <li>exercise for trunk control e.g. sit up unsupported</li> <li>duration of activity for at least 20 mins</li> </ul>
Alert and able to move arm against gravity	<ul style="list-style-type: none"> <li>sit at edge of bed with legs in dependent position while providing support to upper body</li> </ul>
Alert and able to move legs against gravity	<ul style="list-style-type: none"> <li>stand at bedside with support</li> <li>transfer to chair by pivoting or taking 1 - 2 small steps</li> <li>sit on chair for 1 - 2 hours</li> <li>walk with assistance, using a walker if needed</li> <li>walk independently</li> </ul>

5. Encourage self-care activities whenever feasible.
6. Cycle ergometer exercise or neuromuscular electrical stimulation may be used as adjuncts to improve muscle strength and preserve muscle mass.

## **Safety**

1. Terminate any physical activity if any of following signs and symptoms develop:
  - a. Oxygen saturation < 90%
  - b. Hypotension: SBP < 90 mmHg, associated with dizziness, and/or diaphoresis
  - c. Hypertension: SBP > 170 mmHg
  - d. Heart rate > 120 or presence of dysrhythmias
  - e. Respiratory rate > 30 or change in breathing pattern with increased use of accessory muscles or nasal flaring
  - f. Chest pain
  - g. Patient requests to stop
2. Ensure the following safety measures for walking activities:
  - a. Adequate staff assistance
  - b. Tubes and catheters are secured
  - c. Wheelchair readily available to allow resting period and safe return to bed
  - d. Full oxygen tank

## Mobility protocol based on levels of physical activity































1. As patient demonstrates increasing consciousness and strength, progress to the next level.
2. For level II activity and above, refer to physiotherapist with aim of rehabilitation towards functional recovery.
3. Mobility team is required when sitting patient at edge of bed or during active transfer to chair, standing or walking.





























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## Appendix: Safety considerations for active mobilisation

	Low risk of an adverse event. Proceed as usual as per ICU protocol and procedures.
	Potential risk and consequences of an adverse event are higher than  but may be outweighed by the potential benefits of mobilisation. If mobilised, do so gradually and cautiously.
	Significant potential risk or consequences of an adverse event.

Respiratory considerations	In-bed exercises	Out-of-bed exercises
<b>Intubation</b>		
Endotracheal tube		
Tracheostomy tube		
<b>F<sub>I</sub>O<sub>2</sub></b>		
≤ 0.6		
> 0.6		
<b>SpO<sub>2</sub></b>		
≥ 90%		
< 90%		
<b>Respiratory rate</b>		
≤ 30 bpm		
> 30 bpm		
<b>PEEP</b>		
≤10 cmH <sub>2</sub> O		
>10 cmH <sub>2</sub> O		
<b>Ventilator dyssynchrony</b>		
<b>Prone</b>		

Cardiovascular considerations	In-bed exercises	Out-of-bed exercises
IV anti-HPT for hypertensive emergency		
<b>MAP</b>		
Below target		
Within target with no/low support		
Within target with moderate support		
Within target with high support		
Pulmonary hypertension		
<b>Stable tachyarrhythmias with ventricular rate</b>		
> 150/m		
120 - 150/m		
< 120/m		
<b>Bradycardia</b>		
Requiring treatment or awaiting pacing		
Not requiring treatment or pacing		
<b>Shock of any cause with lactate &lt; 4 mmol/L</b>		
<b>Known or suspected acute DVT/PE</b>		
<b>Cardiac ischaemia (ongoing chest pain and/or dynamic ECG changes)</b>		

Neurological considerations	In-bed exercises	Out-of-bed exercises
<b>Level of consciousness</b>		
RASS or revised Riker -1 to +1	●	●
RASS or revised Riker -2 or +2	▲	▲
RASS or revised Riker < -2	▲	●
RASS or revised Riker > +2	●	●
<b>Delirium</b>		
CAM-ICU negative	●	●
CAM-ICU positive + obey commands	●	▲
CAM-ICU positive + unable to obey	▲	●

Neurological considerations	In-bed exercises	Out-of-bed exercises
<b>Ongoing active management of intracranial HPT</b>		
- Yes	●	●
- No	●	▲
<b>Uncontrolled seizures</b>	●	●
<b>Craniectomy</b>	●	▲
<b>Spinal precautions (pre-clearance or pre-fixation)</b>	●	●
<b>Acute spinal cord injury (stable)</b>	●	▲

Other medical considerations	In-bed exercises	Out-of-bed exercises
Uncontrolled active bleeding	●	●
Increased bleeding risk	●	▲
ICU-acquired weakness	●	●
Venous and arterial femoral catheters	●	●
Femoral sheaths	▲	●
CRRT (including femoral catheter)	●	●
All other drains and attachments e.g. Nasogastric tubes Central venous catheter Pleural drain Wound drain Intercostal catheter Urinary catheter	●	●

Surgical considerations	In-bed exercises	Out-of-bed exercises
Unstable major fracture - Pelvic - Spinal - Lower limb long bone	▲	●
Large open surgical wound - Chest - Abdomen	●	●



# Stress Ulcer Prophylaxis

## Introduction

Stress ulcers develop in the critically ill patients due to hypotension, ischaemic and reperfusion injuries. The gastrointestinal (GI) mucosal damage ranging from gastric erosions to ulcers results in occult to clinically significant bleeding. Maintaining adequate systemic perfusion and early enteral nutrition may play a role in preventing stress ulcers.

## Principles

1. Administer stress ulcer prophylaxis (SUP) only in patients with risk factors.
2. Reassess daily the need to continue SUP.
3. Discontinue SUP when risk factors have resolved.

### 1. Risk factors

Risk	Conditions	Indication for SUP
Low	<ul style="list-style-type: none"><li>• No risk factors</li></ul>	No
Moderate	<ul style="list-style-type: none"><li>• Chronic NSAID/aspirin use</li><li>• Peptic ulcer disease &gt; 1 year</li></ul>	To be considered
High	<ul style="list-style-type: none"><li>• Mechanical ventilation for greater than 48 hours</li><li>• Coagulopathy: INR &gt; 1.5, APTT &gt; 2x the control, platelets &lt; 50 000/mm<sup>3</sup></li><li>• Traumatic brain injury with GCS ≤ 10 or spinal cord injury</li><li>• Significant burn injury (total body surface area &gt; 30%)</li><li>• Acute liver failure</li><li>• Renal replacement therapy</li><li>• Use of 2 antiplatelets (clopidogrel, aspirin, ticagrelor, dipyridamole)</li><li>• History of upper GI bleed or gastric ulcer in the last 1 year</li><li>• Any 2 of the following:<ol style="list-style-type: none"><li>i. sepsis</li><li>ii. high dose corticosteroid:<ul style="list-style-type: none"><li>- hydrocortisone &gt; 250 mg/day</li><li>- prednisolone &gt; 60 mg/day</li><li>- methylprednisolone 50 mg/day</li><li>- dexamethasone 10 mg/day</li></ul></li><li>iii. ICU stay &gt; 7days</li><li>iv. occult bleeding of &gt; 6 days</li></ol></li></ul>	Indicated

2. Drugs
  - a. No previous GI ulcers

	Nil by mouth	Enterally fed
Normal renal function	IV Ranitidine 50 mg q8h	T. Ranitidine 150 mg q12h
CrCl > 30 ml/min	IV Ranitidine 50 mg q12h	T. Ranitidine 150 mg q24h

- b. Previous GI ulcers or on proton pump inhibitors (PPI)

Nil by mouth	Enterally fed
Either a. IV Pantoprazole 40 mg q24h  b. IV Omeprazole 40 mg q24h  c. IV Esomeprazole 40 mg q24h	Either a. T. Pantoprazole 40 mg q24h*  c. T. Omeprazole 40 mg q24h  b. T. Esomeprazole 40 mg q24h

\* T. Pantoprazole is enteric coated. (refer appendix for dilution)

3. Discontinue when risk factors have resolved and patient is tolerating enteral feeding.
4. Treating active upper GI bleed
  - a. PPI remains the main stay of treatment.
  - b. Give a loading dose of 80 mg followed by an infusion of 8 mg/h over 48-72h. Change infusion to 40 mg q12h dosing for 2 weeks followed by 40 mg q12h dosing for 4 weeks.
  - c. Concurrent endoscopy or surgery may be indicated.

## References

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## Appendix: Extemporaneous preparation of pantoprazole

Dosage form: Solution

Strength: 2 mg/ml

Stability: 62 days

Storage: Refrigerate

Ingredients	Quantity
Pantoprazole sodium 40 mg	5 tablets
Sodium bicarbonate powder	7.5 g
Distilled water	100 ml

Prodedure:

1. Crush tablets in a mortar to fine powder.
2. Levigate the powder with small amounts of distilled water till a smooth paste is formed.
3. Add more distilled water to the paste until liquid is formed.
4. Add the sodium bicarbonate powder. Stir until sodium bicarbonate and pantoprazole completely dissolve.
5. Make up the final volume with distilled water.

# Venous Thromboprophylaxis

## Introduction

Most patients in ICU are at moderate risk of developing venous thromboembolism (VTE), while the critically ill ones are at high risk. Pharmacological and/or mechanical thromboprophylaxis should be routinely considered in critically ill patients, unless contraindicated. However, venous thromboprophylaxis does not eliminate the risk of VTE or VTE-related deaths. Current prediction scores for VTE and models for evaluating risk of bleeding in critically ill patients require further validation. Early mobilisation is an important approach in the prevention of VTE.

## Principles

1. Assess bleeding risk before initiating pharmacological prophylaxis.
2. Select a pharmacological agent based on its pharmacokinetics and the risk of developing VTE.
3. Use mechanical prophylaxis when pharmacological prophylaxis is contraindicated.
4. There is no role of routine screening for DVT.

## Pharmacological Prophylaxis

1. All patients admitted to ICU should receive pharmacological prophylaxis, either unfractionated heparin (UFH) or lower molecular heparin (LMWH) within 24 hours of admission unless contraindicated.
2. Contraindications to pharmacological prophylaxis:

Absolute contraindications	Relative contraindications
<ul style="list-style-type: none"><li>• active major bleed (at least 2 units of blood or blood products transfused in 24 hrs)</li><li>• platelets less than <math>75 \times 10^9/L</math></li><li>• inherited bleeding disorders</li><li>• active peptic ulcer disease</li></ul>	<ul style="list-style-type: none"><li>• neurosurgery or eye surgery within the last 2 weeks</li><li>• recent gastrointestinal or genito-urinary bleeding</li><li>• recent CNS bleed</li><li>• Uncontrolled systolic hypertension (230/120 mmHg or higher)</li><li>• acute liver failure</li></ul>

3. Weigh the risk of VTE against bleeding before initiating prophylaxis.

Risk factors of VTE	Risk factors of bleeding
<p><i>Non-surgical:</i></p> <ul style="list-style-type: none"> <li>- Active malignancy</li> <li>- Previous VTE</li> <li>- Immobilisation &gt; 3 days</li> <li>- Known thrombophilic conditions</li> <li>- Obesity BMI &gt; 30 kg/m<sup>2</sup></li> <li>- Ischaemic stroke</li> <li>- Acute myocardial infarction</li> <li>- Elderly &gt; 60 years</li> <li>- Cardiac or respiratory failure</li> <li>- Sepsis</li> <li>- Rheumatologic disorder</li> <li>- Ongoing hormonal therapy</li> <li>- Pregnancy and post-partum</li> </ul> <p><i>Surgical:</i></p> <ul style="list-style-type: none"> <li>- Orthopaedic (hip or knee arthroplasty, hip, pelvic or femur fracture)</li> <li>- Multiple trauma</li> <li>- Acute spinal cord injury</li> <li>- Surgery in patient with multiple risk factors</li> <li>- Abdominal-pelvic surgery for malignancy</li> </ul>	<ul style="list-style-type: none"> <li>- Active gastrointestinal ulcer</li> <li>- Significant bleed in the last 3 months*</li> <li>- Platelets &lt; 75 x 10<sup>9</sup>/L</li> <li>- Age &gt; 85 years</li> <li>- PT &gt; 2 x normal</li> <li>- CrCl &lt; 30 ml/min</li> <li>- Acute stroke</li> <li>- Central neuroaxial blockade within previous 4 hours or expected in 12 hours</li> <li>- Concurrent use of anticoagulant</li> <li>- Bleeding disorder</li> <li>- Uncontrolled systolic hypertension (230 or higher)</li> </ul>

\*defined as bleeding associated with a decrease in Hb by > 2 g/dL, required blood transfusion > 2 units, occurred in a critical site (intracranial, intraocular, retroperitoneal, spinal or pericardial).

4. Use LMHW in patients with risk factors and UFH in those without the above risk factors.
5. Dose adjustment of LMWH may be required in the following patients:
  - a. CrCl < 30 ml/min
  - b. BMI < 20 kg/m<sup>2</sup>
  - c. BMI > 30 kg/m<sup>2</sup>
  - d. Increased risk of bleeding
6. Reassess VTE and bleeding risk daily.
7. Discuss with surgeon before initiating pharmacological prophylaxis in patients with traumatic brain injury or at high risk of post-operative bleed.
8. Continue pharmacological prophylaxis until the patient is fully ambulatory or discharged from hospital.

**Table 1: Pharmacological thromboprophylaxis and its practical considerations:**

	UFH	LMWH	Remarks
Agent	Unfractionated heparin	Enoxaparin	
Standard dose	S/C 5000 IU q8h or q12h	S/C 40 mg q24h	
Dose based on BMI <ul style="list-style-type: none"> <li>• BMI &lt; 20 kg/m<sup>2</sup></li> <li>• BMI &gt; 30 kg/m<sup>2</sup></li> </ul>	S/C 5000 IU q12h  S/C 5000 IU q8h	S/C 20 mg q24h  S/C 40 mg q12h	In BMI > 30 with high risk of bleeding, UFH is preferred given the ease of reversal
Renal adjusted dose (ml/min) <ul style="list-style-type: none"> <li>• CrCl &gt; 30</li> <li>• CrCl 20 - 30</li> <li>• CrCL &lt; 20</li> </ul>	No dose adjustment  No dose adjustment  No dose adjustment	No dose adjustment  S/C 20 mg q24h  do not use LMWH	
Monitoring	<ul style="list-style-type: none"> <li>• Platelet</li> <li>• Haemoglobin</li> </ul>	<ul style="list-style-type: none"> <li>• Platelet</li> <li>• Haemoglobin</li> <li>• Renal function</li> </ul>	Monitor anti-Xa factor to guide dosing in critically ill if possible
Reversal in severe bleeding or urgent surgery	IV protamine sulphate 1 mg per 100 IU of heparin (max 50 mg) over 10 mins if heparin given in the last 8 hours. *complete immediate reversal	IV protamine sulphate 1 mg per 1 mg of enoxaparin (max 50 mg) over 10 mins. Half the dose if the last dose of LMWH is between 8 - 12 hrs. *partial immediate reversal	Other causes of bleeding should be considered (altered pharmacokinetics, drug interactions or incorrect dose)
Withholding of prophylaxis before surgery and procedures with high risk of bleeding	4 hours from the last dose	12 hours from the last dose	

## Mechanical prophylaxis

1. Provide mechanical prophylaxis with either intermittent pneumatic compressor (IPC) or graduated compression stockings (GCS) when pharmacological prophylaxis is contraindicated.
2. IPC is preferred over GCS in patients at high risk of VTE.
3. Contraindications to mechanical prophylaxis:
  - a. Severe arterial insufficiency or periphery arterial disease
  - b. Congestive heart failure
  - c. Recent or acute DVT/PE
  - d. Acute fractures of the lower limbs
  - e. Loss of skin integrity
  - f. Recent skin graft
  - g. Post-operative venous ligation
  - h. Morbid obesity which makes it difficult to correctly fit the stockings
  - i. Oedema or deformity of the lower limb
  - j. Diabetic neuropathy
4. Ensure proper fit and optimal compliance of mechanical devices.
5. Assess skin integrity of the lower limbs and pressure areas every nursing shift.
6. Initiate pharmacological prophylaxis once bleeding risk subsides.

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# Prevention and Control of Multi-Drug Resistant Organisms

## Introduction

Early identification of patients colonised or infected with multi-drug resistant organisms (MDRO) is important to minimise the risk of transmission. The MDRO included in this chapter are *methicillin-resistant Staphylococcus aureus* (MRSA), *vancomycin-resistant Enterococcus* (VRE) and multi-drug resistant gram negative organisms i.e. MDR *Acinetobacter baumannii*, MDR *Pseudomonas aeruginosa*, extended-spectrum  $\beta$ -lactamase (ESBL) and carbapenem-resistant Enterobacteriaceae (CRE).

## Principles

1. Identify patients at risk.
2. Adhere to hand hygiene.
3. Use personal protective equipment.
4. Place in a single room or cohort for suspected or confirmed cases.
5. Intensify cleaning and disinfection of environment and equipment.
6. Comply with antimicrobial stewardship.
7. Provide education and training update to healthcare professionals.

1. Identify patient at risk of MDRO infection. The risk factors are:

MRSA	VRE	MDR gram negative bacilli including resistant Enterobacteriaceae
<ul style="list-style-type: none"> <li>• Previous MRSA infection or colonisation</li> <li>• Frequent hospital admissions</li> <li>• Recent admission in a hospital with high prevalence of MRSA</li> <li>• From long term care facility</li> <li>• Areas where community-acquired MRSA is prevalent</li> <li>• With chronic wounds</li> <li>• From high risk units (ICU/ HDU/burns/spinal unit)</li> </ul>	<ul style="list-style-type: none"> <li>• Contact with patient colonised or infected</li> <li>• On dialysis</li> <li>• Prolonged or broad-spectrum antibiotic use, specifically vancomycin</li> <li>• On urinary catheters</li> <li>• Prolonged hospital stay</li> <li>• Chronic disease and impaired functional status</li> <li>• From high risk units (ICU/ nephrology/haematology/ solid-organ transplant unit)</li> </ul>	<ul style="list-style-type: none"> <li>• Contact with patient colonised or infected</li> <li>• Recent broad-spectrum antibiotic (carbapenem, quinolones, 3<sup>rd</sup>/4<sup>th</sup> generation cephalosporins)</li> <li>• With invasive devices</li> <li>• Prolonged hospital stay</li> <li>• Chronic disease and impaired functional status</li> <li>• From high risk units (ICU/ burns/neurosurgery/solid-organ transplant unit)</li> </ul>

2. Hand hygiene
  - a. Hand hygiene is the most important measure in preventing the transmission of microorganisms.
  - b. Use either 70% alcohol-based hand rub or antiseptic soap and water.
  - c. Use soap and water if hands are visibly dirty or soiled with blood or other body fluids.
  - d. Remove jewellery, watch or rings with ridges or stones prior to hand hygiene.
  - e. Observe the 5 moments of hand hygiene:
    - i. before touching a patient
    - ii. before any procedure
    - iii. after procedure or body fluid exposure risk
    - iv. after touching a patient
    - v. after touching a patient's surroundings
  - f. Hand hygiene should always be performed:
    - i. before donning and after removal of gloves
    - ii. before and after using computer keyboard in a clinical area
    - iii. after leaving patient-care area including isolation rooms during an outbreak
  - g. Reinforce the importance of hand hygiene in an outbreak setting.
  - h. Audit compliance of hand hygiene and provide immediate feedback to healthcare personnel.
3. Personal protective equipment (PPE)
 

PPE includes aprons, gowns, gloves, surgical mask and eye shields used either alone or in combination to protect healthcare personnel (HCP) from contact with transmissible organisms. Selection of PPE is based on the extent of patient contact.

Perform hand hygiene before donning protective personal equipment (PPE).

Plastic apron	<ul style="list-style-type: none"> <li>- Non-sterile, single use and disposable</li> <li>- During care activities involving minimal patient contact where there is low risk of contaminating the HCP's arms e.g.               <ul style="list-style-type: none"> <li>• examining patient</li> <li>• airway suctioning</li> </ul> </li> </ul>
Gown	<ul style="list-style-type: none"> <li>- Fluid resistant, single use and disposable</li> <li>- Long sleeved</li> <li>- During care activities involving close patient contact with risk of               <ul style="list-style-type: none"> <li>• contaminating HCP's arms e.g</li> <li>• dressing large or complex wounds</li> <li>• hygiene care of incontinent patient</li> <li>• turning and positioning of patient</li> </ul> </li> </ul>

Non-sterile gloves	<ul style="list-style-type: none"> <li>- Use clean non-sterile gloves before entering the room or cubicle</li> <li>- Change gloves and perform hand hygiene between different care/ treatment activities of the same patient</li> <li>- Attend to 'clean' procedures first</li> </ul>
Surgical mask and protective eyewear	<ul style="list-style-type: none"> <li>- When performing splash or aerosol-generating procedures e.g. <ul style="list-style-type: none"> <li>• intubation</li> <li>• oral or airway suctioning</li> <li>• wound irrigation</li> <li>• caring for patients with open tracheostomies</li> </ul> </li> </ul>
Discard the above single used items within the room/area. Perform hand hygiene before leaving the room.	

#### 4. Isolation

- a. Isolate patients colonised or infected with MDRO in single rooms.
- b. Cohort patients if single rooms are not available. Cohorting refers to placing patients who are infected or colonised with the same organism in the same area.
- c. Prioritise single room isolation to patients with:
  - i. CRE, VRE or MRSA
  - ii. incontinence of faeces or urine
  - iii. open or draining wounds
  - iv. enterostomies
  - v. copious respiratory secretions
- d. Staff nursing patients with MDRO should not have contact with other patients.
- e. Appropriate signage should be placed outside the door to alert HCP of contact precautions.

#### 5. Discontinuation of isolation precautions

- a. Shedding of MDRO may be intermittent and their presence may not always be detected by active surveillance culture.
- b. Continue contact precautions for the duration of admission.

#### 6. Equipment and patient care items

- a. Remove non-essential equipment from the room.
- b. Minimise consumable items placed in the room e.g. syringes, needles and gauzes.
- c. Use disposable items whenever possible.

- d. Dedicate reusable equipment to a single patient e.g. thermometer, blood pressure cuff, infusion pumps, stethoscope, etc.
  - e. Clean and disinfect equipment that are shared between patients e.g. hoist and armchairs.
  - f. Use dedicated trolley for sponging and cleaning.
7. Environmental cleaning
- a. Increase cleaning frequency.
  - b. Clean and disinfect frequently touched surfaces (e.g. bedrails, drip stands, nursing tables, trolleys, doorknobs, tap handles and switches) at least once every nursing shift. This involves either:
    - i. 2-in-1 clean: commercially prepared combination of detergent and 1000 ppm chlorine solution or impregnated wipes
    - ii. 2-step clean: clean with detergent or detergent impregnated wipes and disinfect with 1000ppm chlorine solution or impregnated wipes
  - c. Perform terminal cleaning after patient discharge:
    - i. terminal cleaning process should be monitored and supervised
    - ii. remove curtains prior to cleaning
    - iii. cleaning should include walls, bed, frequently touched surfaces and all equipment
    - iv. discard unused consumables that cannot be disinfected
8. Antimicrobial stewardship
- Antimicrobial stewardship programme refers to coordinated interventions to ensure appropriate use of antimicrobials. When antimicrobials are prescribed ensure:
- a. Adequate dose and the shortest duration for efficacy.
  - b. Use the narrowest spectrum whenever possible.
  - c. De-escalate when cultures are available.
9. Education
- a. Education of all staff, including cleaning staff should be intensified.
  - b. Reinforce standard and contact precautions.
10. Screening and surveillance
- a. Contact screening is done to reduce the risk of transmission of MDRO.
    - i. screen patients who are in close contact for more than 24 hours with a CRE or VRE confirmed case. Send rectal swab
    - ii. screening for other MDRO depends on local hospital infection control policy
    - iii. isolate or cohort contacts pending screening result

- b. Active surveillance cultures should be considered in outbreak settings.
    - i. screen for CRE, VRE or MRSA in high risk patients admitted to the unit. Send rectal swabs for CRE or VRE and nasal swabs for MRSA
    - ii. screening for other MDRO depends on local hospital infection control policy
11. Other considerations
- a. Inform support staff (e.g. radiographer, physiotherapist, pharmacist, dialysis nurse and dietician) of patient's status. Support staff to attend to the patient last in the unit except in emergencies.
  - b. Visitors
    - i. all visitors are directed to perform hand hygiene before and after contact with patient or environment
    - ii. visitors are not required to wear PPE unless involved in patient care
  - c. Patient's movement
    - i. patient's movement should be kept to a minimum
    - ii. if transportation is required such as to the radiology department, the operation theatre or another facility, the receiving unit should be informed of the patient's status
  - d. Upon discharge, the receiving wards should be informed early, for isolation or cohorting purposes.

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# Withholding and Withdrawing Life-Sustaining Treatment

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## Introduction

The goals of intensive care are to return patients to a quality of survival that is reasonably acceptable to them and to reduce disability. If these goals are not possible, and family understands and agrees that this is not in keeping with the patient's wishes, then compassionate care needs to be instituted to allow death with dignity.

Withholding and withdrawing life-sustaining treatment (LST) is a process where various medical interventions are either not initiated or ceased. There is no ethical or moral difference between withholding or withdrawing life-sustaining treatment.

## Principles

1. Abide by the principles of medical ethics when making end-of-life decisions.
2. Assess patient's decision-making capacity on end-of-life decisions. In patients with limited or absent capacity, families become surrogate decision-makers.
3. Respect patient's autonomy except in cases of non-beneficial medical treatment.
4. Implement a palliative care plan once withholding or withdrawing LST is decided upon.
5. Document clearly all decisions on withholding or withdrawing LST in the clinical records.
6. Treat dying patients with respect, dignity and compassion.

## Ethical principles

1. The principles that underpin end-of-life (EOL) medical decisions are:
  - a. Respect for autonomy: acting in accordance to what the patient wants
  - b. Beneficence: acting to benefit the patient
  - c. Non-maleficence: causing no harm to the patient
  - d. Distributive justice: paying attention to fairness and equity
2. These principles are either used individually or collectively to frame the discussion on EOL and one does not supersede the other.

3. The principles may be conflicting for example:
  - a. between respect for autonomy and beneficence: a terminal cancer patient who insists all LST to be provided although they will not benefit him.
  - b. between beneficence and justice: providing invasive mechanical ventilation in a patient with decompensated heart failure who has had multiple hospital admissions in the last 6 months and is dyspnoeic at rest versus allocation of ICU bed for a polytrauma patient.

### Decision-making capacity

1. Patient's decision-making capacity should be assessed before having a discussion with him on EOL. This includes the patient's ability to comprehend, appreciate, rationalise and express choice of treatment.
2. Most ICU patients do not have decision-making capacity and hence families become the surrogate decision-maker.
3. The standards that may be used by surrogates in decision-making include:
  - a. Substituted judgement: decision of the patient if he/she has the capacity
  - b. Best interest: decision based on the potential benefits vs. burdens of treatment taking into consideration patient's values and beliefs
4. EOL decisions are shared medical decisions made by clinicians and concurred by family members.

### Autonomy and obligation to treat

1. Once decision-making capacity is established, patient's autonomy must be respected even though survival may be implicated.
2. In cases of non-beneficial medical treatment, clinicians are not obliged to initiate or continue LST.
3. The MMA Code of Ethics 2001 states:  
*"where death is deemed to be imminent and where curative or life-prolonging treatment appears to be futile, ensure that death occurs with dignity and comfort. Such futile therapy could be withheld, withdrawn or one may allow irreversible pathology to continue without active resuscitation. One should always take into consideration any advance directives and the wishes of the family in this regard. In any circumstance, if therapy is considered to be life saving, it should never be withheld."*

## Respect for the dying

1. All dying patients should be afforded the same standard of care as other patients.
2. They should be treated with dignity, respect and compassion.
3. Their privacy and confidentiality should be respected at all times.

## Withholding and withdrawal of life-sustaining treatment

The following patients are to be considered for withholding and withdrawal of LST:

### 1. Imminent death

This patient has a severe acute illness that is clearly not responding to therapy, and reversal or cure is unlikely despite continued optimal therapy. e.g. septic shock with multiorgan failure.

### 2. Terminal condition

This patient has a progressive terminal disease incompatible with survival longer than 3-6 months. e.g.

- i. end stage respiratory disease on long term oxygen therapy with severe community acquired pneumonia
- ii. end stage cardiac, respiratory or liver disease with no options for transplant
- iii. metastatic cancer unresponsive to treatment

### 3. Severe and irreversible condition impairing cognition and consciousness but death may not occur in months

In such cases, a patient is often planned to not receive CPR or other resuscitative measures in the event of deterioration e.g. persistent vegetative state post cardiac arrest, severe dementia or severe stroke with poor cognitive recovery.

### 4. Advanced age with poor functional status due to chronic organic dysfunction e.g.

Multiple co-morbidities with deteriorating physical performance.

### 5. Severe disability with poor quality of life e.g.

- i. stroke with minimal conscious state or dense paralysis
- ii. decompensated heart failure with ongoing shortness of breath at rest despite optimal therapy

### 6. Advanced diseases of progressive life-limiting conditions e.g.

- i. motor neuron disease with rapid decline in physical status
- ii. severe Parkinson's disease with reduced independence and needs assistance for activities of daily living (ADL)



## **7. A patient who has stated his/her wish against initiation or continuation of life support therapy**

This will include patients who have given clear advanced care directives.

### **Practical issues of withholding and withdrawal of life-sustaining treatment**

#### **1. Medical team consensus**

The intensive care team and the primary team should agree on EOL decisions.

#### **2. Communication with patient and relatives**

- a. It is best that the same clinician (specialist/consultant) who is involved in the active care of the patient deals with the family. He/she should be someone who frequently communicates with the family and has established a rapport with them. A witness (nurse or doctor) should be present during these discussions.
- b. Clinicians need to respect the fact that each patient and family will differ in how much input they wish to have in the decision-making process.
- c. In the event of a disagreement, allow time for repeated discussions and negotiations. Failing this, consider either:
  - i. time-limited trial which is a goal-directed trial of any intervention limited by predetermined outcomes that are evaluated at planned intervals.
  - ii. second medical opinion from another clinician from a similar specialty
  - iii. facilitation by a third party e.g. spiritual advisor
- d. Patients and families must be given sufficient time to reach decisions on EOL.

#### **3. Management plan for withdrawal of life-sustaining treatment**

A clear management plan is essential to ensure that the withdrawal process occurs smoothly. It should be conveyed to the family, with an emphasis on maintenance of comfort for the patient. The plan should include the following components:

- a. Maintain current support until the patient and family have had adequate time together.
- b. Ensure other healthcare professionals e.g. primary team, physiotherapist, dietitian are aware of withdrawal plan. Cease all investigations e.g. blood taking and X-rays.
- c. Ensure pain and other symptoms e.g. dyspnoea are well controlled.  
Morphine is the most commonly used opioid for analgesia and comfort. There is no maximum dose. Large doses of opioids may be required for comfort and may unintentionally hasten death. This “double effect” of opioids is acceptable.
- d. Manage airway secretions by using glycopyrrrolate, positioning in lateral position and frequent suctioning.

- e. All treatment that do not contribute towards comfort should be discontinued e.g. antibiotics, blood transfusions. Feeding and intravenous fluids may be discontinued unless specifically requested by family.
- f. Maintain patient's personal hygiene and dignity at all times. e.g. diaper soiling is dealt with immediately.
- g. Withdrawal of vasopressors may result in immediate death. Families should be aware and nearby.
- h. Withdrawal of mechanical ventilation may be carried out either as:
  - i. terminal weaning where ventilator settings are reduced while leaving the endotracheal tube in-situ or
  - ii. terminal extubation
- i. Disable all monitor and ventilator alarms. Demedicalise the patient and allow family members to be close by.

#### **4. Other considerations**

- a. Family should be given unrestricted access to the patient.
- b. Non-invasive ventilation may be used as a palliative care technique to minimise dyspnoea in conscious patients.
- c. Neuromuscular blockade makes assessment of comfort impossible and should not be used in intubated patients.
- d. Consider terminal sedation with benzodiazepines only when high doses of opiod are inadequate for comfort.

#### **5. Documentation**

Document all decisions regarding withdrawal and withholding of treatment, including the basis of the decision and amongst whom it was reached.

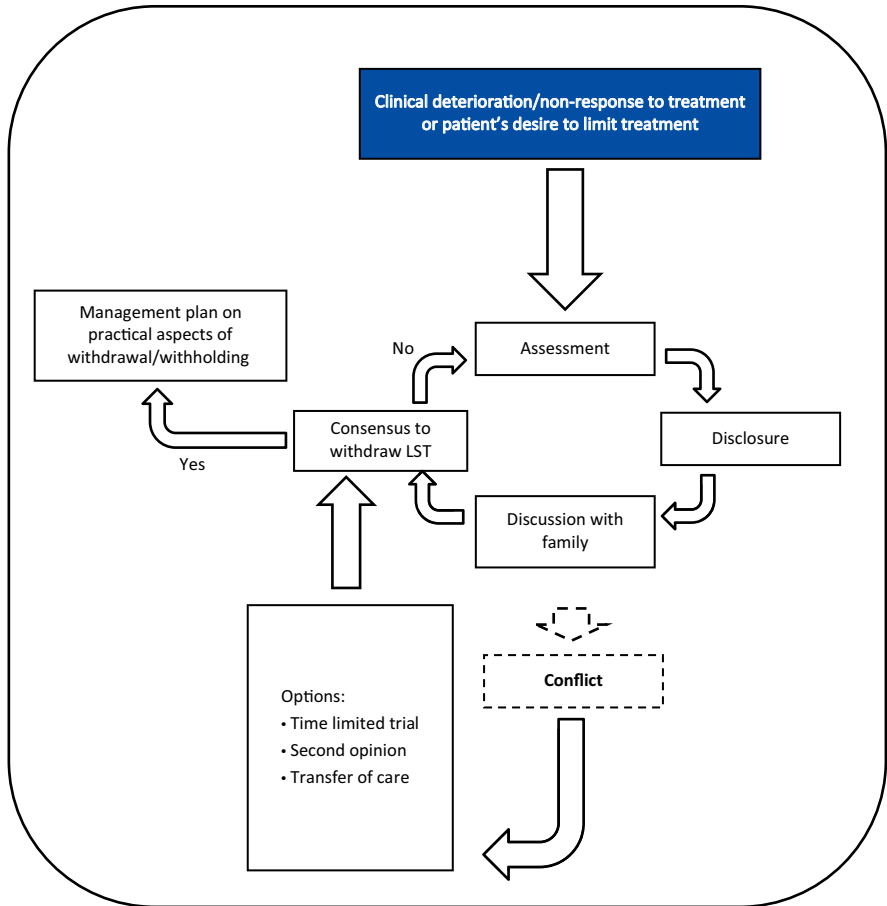
#### **6. Notification of death**

Death should be communicated in direct language gently.

#### **7. Bereavement**

Provide bereavement support to the family and healthcare providers if necessary.

## Process of withholding or withdrawal of life-sustaining treatment



## References

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# Invasive Mechanical Ventilation in Non-Critical Care Areas

## Introduction

Invasive mechanical ventilation in wards should be discouraged. However, some patients are ventilated in the general ward due to limited resources. Clinical considerations and principles of medical ethics should guide decisions on ventilating patients in the ward.

## Principles

1. Interdisciplinary discussion is essential when a decision is made to ventilate patients in the ward.
2. The decision to ventilate patients in non-critical care areas should be reached on the basis of clinical and ethical considerations.
3. Clinical considerations are based on the patient's probable clinical outcome, premorbid status and burden of treatment.
4. Level of monitoring and care of these patients should be provided accordingly.

## Categories of patients

There are 4 categories of patients ventilated in non-critical care areas:

Category	Description	Admission and discharge criteria (refer chapter 1)
1	Patients who have a reasonable prospect of meaningful recovery with good quality of life	Priority 1 and 2A
2	Patients whose initial prospect of meaningful recovery is uncertain	Priority 2B
3	Patients with minimal or no prospect of meaningful recovery	Priority 3
4	Patients for chronic ventilation or "home ventilation"	-

**1. Category 1:**

- a. Make every effort to admit them to ICU.
- b. Admit them to other critical care areas within the hospital while awaiting availability of ICU bed.
- c. Arrange for inter-hospital transfer to another ICU if critical care bed is unavailable within the hospital. The arrangement and transport should preferably be done by the ICU team.
- d. A Category 1 patient should be given priority for ICU admission over an elective surgical patient.

**2. Category 2:**

- a. The specialists from the ICU team and primary unit should discuss on the benefits vs. the burdens and risks of ventilation prior to intubation, including the possibility of limitation of care at 24 - 48 hours if no improvement is observed.
- b. Involve families in the decision-making and inform them of the treatment plan.
- c. If the joint decision is to intubate and ventilate the patient,
  - i. admit ICU if bed is available
  - ii. if bed not available assess for progress at 24 to 48 hours and consider ICU admission if there is clinical improvement
  - iii. if patient is ventilated in the ward, manage as per Category 3 patient if there deterioration
- d. Continue care of the patient in the ward if the joint decision is not to ventilate.
- e. Document the decision clearly in the case notes.
- f. Seek second medical opinion to resolve differences if conflict arises among the teams.

**3. Category 3:**

- a. Consider withholding or withdrawal of therapy while continuing comfort care.

**4. Category 4:**

- a. Continue ventilation in the ward while preparing for home ventilation.
- b. If the patient deteriorates, re-assess the indication for ICU admission and manage accordingly.

## Responsibilities

1. The primary team is responsible for the care of the patient in the ward.
2. The ICU team should review the patient daily.

## Minimum requirements

1. Staffing:  
Nurses should be trained and privileged on basic care and safety issues in caring for patients on mechanical ventilation e.g.
  - a. Tracheal suctioning
  - b. Bag-valve-mask ventilation
  - c. Nebulisation
  - d. Recognition of life threatening events e.g. desaturation, ETT blockage, disconnection or dislodgement of ETT
  - e. Infection control measures
2. Monitoring
  - a. Blood pressure, pulse rate and respiratory rate hourly
  - b. SpO<sub>2</sub> - continuous if available
  - c. ECG - continuous if available
  - d. Level of consciousness
  - e. Arterial blood gases as indicated
  - f. Other standard nursing monitoring
3. Equipment (readily available)
  - a. Yankauer suction
  - b. Suction catheters
  - c. Vacuum suction apparatus
  - d. Laryngoscopes
  - e. Endotracheal tubes and tapes
  - f. Oral airways
  - g. Bag-valve-masks
  - h. Resuscitation trolley

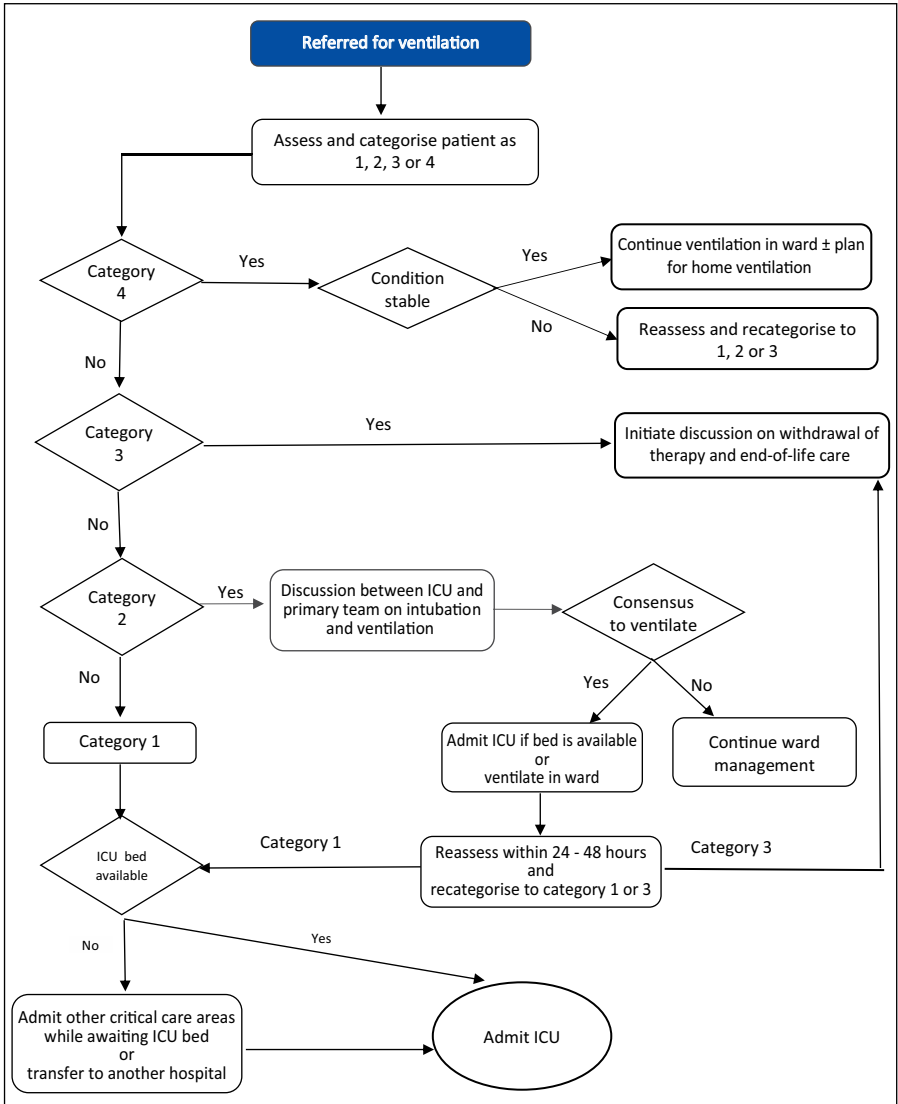
## Procedures of care

These should include but are not limited to the following:

- a. Elevate head of bed 30 degrees unless contraindicated
- b. Ensure endotracheal or tracheostomy and nasogastric tubes are firmly secured
- c. Perform tracheal and oropharyngeal suctioning q4h or more often if necessary
- d. Position the patient at least 4 hourly

- e. Perform general, eye and oral hygiene regularly
- f. Ensure a functioning nasogastric tube for gastric decompression and nutritional support
- g. Perform chest and limb physiotherapy

**Referral for ventilation**





## References

1. Zisk-Rony RY, et al. Mechanical ventilation patterns and trends over 20 years in an Israeli hospital system: policy ramifications. *Isr J Health Policy Res* 2019;**8**:20
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## Appendix 1: Examples of categories of patients ventilated in non-critical care areas

### Category 1

Patients who have a reasonable prospect of meaningful recovery with good quality of life

### Category 2

Patients whose initial prospect of meaningful recovery is uncertain

Examples:

1. Metastatic cancer in septic shock secondary to hospital-acquired pneumonia but with some limitations of therapy e.g. no CPR
2. Decompensated heart failure with deterioration functional status and multiple hospital admissions
3. Some but not all patients in The Gold Standards Framework Proactive Identification Guidance (appendix 2) are in this category

### Category 3

Patients with minimal or no prospect of meaningful recovery

Examples:

1. Irreversible brain damage impairing cognition and consciousness or in a persistent vegetative state
2. End-stage cardiac, respiratory and liver disease with no options for transplant
3. Metastatic cancer unresponsive to chemotherapy and/ or radiotherapy
4. Severe disability with poor quality of life
5. Poor response to current treatment e.g. recurrent bowel leaks despite multiple laparotomies, recurrent soft tissue or musculoskeletal infections despite multiple surgical interventions or chronic medical conditions which fail to respond to treatment such as SLE and HIV
6. Advanced disease or progressive life limiting conditions such as motor neuron disease, advanced Parkinson's disease, multiple sclerosis
7. End-stage renal disease with no option or refusal for renal replacement therapy
8. Explicitly stated their wish not to receive life support therapy and refusal of treatment

### Category 4: Patients for chronic ventilation or "home ventilation"

Examples:

1. Gullian Barre syndrome
2. Complete tetraplegia in high cervical spinal cord injury
3. Motor neuron disease
4. Mitochondrial myopathies

## Appendix 2: A guide to identifying patients for supportive and palliative care

Ref: The Gold Standards Framework Proactive Identification Guidance UK 6<sup>th</sup> Edition Dec 2016

General indicators of decline and increasing needs	
<ul style="list-style-type: none"> <li>• General physical decline, increasing dependence and need for support</li> </ul>	<ul style="list-style-type: none"> <li>• Decreasing response to treatments, decreasing reversibility</li> </ul>
<ul style="list-style-type: none"> <li>• Repeated unplanned hospital admissions</li> </ul>	<ul style="list-style-type: none"> <li>• Patient choice for no further active treatment and focus on quality of life</li> </ul>
<ul style="list-style-type: none"> <li>• Advanced disease - unstable, deteriorating, complex symptom burden</li> </ul>	<ul style="list-style-type: none"> <li>• Progressive weight loss (&gt; 10%) in past six months</li> </ul>
<ul style="list-style-type: none"> <li>• Presence of significant multi-morbidities</li> </ul>	<ul style="list-style-type: none"> <li>• Sentinel event e.g. serious fall, bereavement, transfer to nursing home</li> </ul>
<ul style="list-style-type: none"> <li>• Decreasing activity - functional performance status declining (e.g. Barthel score) limited self-care, in bed or chair 50% of day and increasing dependence in most activities of daily living</li> </ul>	<ul style="list-style-type: none"> <li>• Serum albumin &lt; 25 g/L</li> </ul>

Specific Clinical Indicators	
<b>1. Cancer</b>	
<ul style="list-style-type: none"> <li>• Deteriorating performance status and functional ability due to metastatic cancer, multi-morbidities or not amenable to treatment - if spending more than 50% of time in bed/lying down, prognosis estimated in months</li> </ul>	<ul style="list-style-type: none"> <li>• Persistent symptoms despite optimal palliative oncology. More specific prognostic predictors for cancer are available, e.g. Palliative Performance Scale (PPS)</li> </ul>
<b>2. Organ Failure</b>	
<b>Heart disease: at least 2 of the indicators below</b>	
<ul style="list-style-type: none"> <li>• CHF NYHA Stage 3 or 4 with ongoing symptoms despite optimal HF therapy - shortness of breath at rest on minimal exertion</li> </ul>	<ul style="list-style-type: none"> <li>• Difficult ongoing physical or psychological symptoms despite optimal tolerated therapy</li> </ul>
<ul style="list-style-type: none"> <li>• Repeated admissions with heart failure - 3 admissions in 6 months or a single admission aged over 75 (50% 1yr mortality)</li> </ul>	<ul style="list-style-type: none"> <li>• Additional features include hyponatraemia &lt; 135 mmol/L, high BP, declining renal function, anaemia etc</li> </ul>
<b>Chronic obstructive pulmonary disease: at least 2 of the indicators below</b>	
<ul style="list-style-type: none"> <li>• Recurrent hospital admissions (at least 3 in last year due to COPD)</li> </ul>	<ul style="list-style-type: none"> <li>• Fulfils long term oxygen therapy criteria (<math>P_aO_2 &lt; 7.3kPa</math>)</li> </ul>
<ul style="list-style-type: none"> <li>• MRC grade 4/5 - shortness of breath after 100 metres on level</li> </ul>	<ul style="list-style-type: none"> <li>• Required ICU/NIV during hospital admission</li> </ul>
<ul style="list-style-type: none"> <li>• Disease assessed to be very severe (e.g. FEV1 &lt; 30% predicted), persistent symptoms despite optimal therapy, too unwell for surgery or pulmonary rehabilitation</li> </ul>	<ul style="list-style-type: none"> <li>• Other factors e.g., right heart failure, anorexia, cachexia, &gt; 6 weeks steroids in preceding 6 months, requires palliative medication for breathlessness, still smoking</li> </ul>

<b>Chronic kidney disease Stage 4 or 5 whose condition is deteriorating with at least 2 of the indicators below</b>	
<ul style="list-style-type: none"> <li>Repeated unplanned admissions (more than 3/ year)</li> </ul>	<ul style="list-style-type: none"> <li>Difficult physical or psychological symptoms that have not responded to specific treatments</li> </ul>
<ul style="list-style-type: none"> <li>Patients with poor tolerance of dialysis with change of modality</li> </ul>	<ul style="list-style-type: none"> <li>Symptomatic renal failure in patients who have chosen not to dialyse - nausea and vomiting, anorexia, pruritus, reduced functional status, intractable fluid overload</li> </ul>
<ul style="list-style-type: none"> <li>Patients choosing the 'no dialysis' option (conservative), dialysis withdrawal or not opting for dialysis if transplant has failed</li> </ul>	
<b>Liver disease</b>	
<ul style="list-style-type: none"> <li>Hepatocellular carcinoma</li> </ul>	<p>Advanced cirrhosis with complications including:</p> <ul style="list-style-type: none"> <li>Refractory ascites</li> <li>Encephalopathy</li> <li>Other adverse factors including malnutrition, severe comorbidities, hepatorenal syndrome</li> <li>Bacterial infection, current bleeds, raised INR, hyponatraemia, unless they are a candidate for liver transplantation or amenable to treatment of underlying condition</li> </ul>
<ul style="list-style-type: none"> <li>Liver transplant contra-indicated</li> </ul>	
<b>General neurological diseases</b>	
<ul style="list-style-type: none"> <li>Progressive deterioration in physical and/or cognitive function despite optimal therapy</li> </ul>	<ul style="list-style-type: none"> <li>Swallowing problems (dysphagia) leading to recurrent aspiration pneumonia, sepsis, breathlessness or respiratory failure</li> </ul>
<ul style="list-style-type: none"> <li>Symptoms which are complex and too difficult to control</li> </ul>	<ul style="list-style-type: none"> <li>Speech problems: increasing difficulty in communications and progressive dysphasia</li> </ul>
<b>Parkinson's disease</b>	
<ul style="list-style-type: none"> <li>Drug treatment less effective or increasingly complex regime of drug treatments</li> </ul>	<ul style="list-style-type: none"> <li>Dyskinesias, mobility problems and falls</li> </ul>
<ul style="list-style-type: none"> <li>Reduced independence, needs ADL help</li> </ul>	<ul style="list-style-type: none"> <li>Psychiatric signs (depression, anxiety, hallucinations, psychosis)</li> </ul>
<ul style="list-style-type: none"> <li>The condition is less well controlled with increasing "off" periods</li> </ul>	<ul style="list-style-type: none"> <li>Similar pattern to frailty - see below</li> </ul>
<b>Motor neuron disease</b>	
<ul style="list-style-type: none"> <li>Marked rapid decline in physical status</li> </ul>	<ul style="list-style-type: none"> <li>Significant complex symptoms and medical complications</li> </ul>
<ul style="list-style-type: none"> <li>First episode of aspirational pneumonia</li> </ul>	<ul style="list-style-type: none"> <li>Low vital capacity (below 70% predicted spirometry), or initiation of NIV</li> </ul>
<ul style="list-style-type: none"> <li>Increased cognitive difficulties</li> </ul>	<ul style="list-style-type: none"> <li>Mobility problems and falls</li> </ul>
<ul style="list-style-type: none"> <li>Weight loss</li> </ul>	<ul style="list-style-type: none"> <li>Communication difficulties</li> </ul>
<b>Multiple sclerosis</b>	
<ul style="list-style-type: none"> <li>Significant complex symptoms and medical complications</li> </ul>	<ul style="list-style-type: none"> <li>Communication difficulties e.g. dysarthria + fatigue</li> </ul>
<ul style="list-style-type: none"> <li>Dysphagia + poor nutritional status</li> </ul>	<ul style="list-style-type: none"> <li>Cognitive impairment notably the onset of dementia</li> </ul>

### 3. Frailty, dementia, multi-morbidity

**Frailty for older people with complexity and multiple comorbidities, the surprise question must triangulate with a tier of indicators, e.g. through Comprehensive Geriatric Assessment (CGA)**

<ul style="list-style-type: none"> <li>Multiple morbidities</li> </ul>	<ul style="list-style-type: none"> <li>PRISMA-7 questionnaire - at least 3 of the following: Aged over 85, male. Any health problems that limit activity? Do you need someone to help you on a regular basis? Do you have health problems that cause require you to stay at home? In case of need can you count on someone close to you? Do you regularly use a stick, walker or wheelchair to get about?</li> </ul>
<ul style="list-style-type: none"> <li>Deteriorating performance score</li> </ul>	
<ul style="list-style-type: none"> <li>Weakness, weight loss exhaustion</li> </ul>	
<ul style="list-style-type: none"> <li>Slow walking speed - takes more than 5 seconds to walk 4 m</li> </ul>	
<ul style="list-style-type: none"> <li>Timed Up and Go test (TUGT) - time to stand up from chair, walk 3 m, turn and walk back</li> </ul>	

**Dementia: Triggers to consider that indicate that someone is entering a later stage are**

<ul style="list-style-type: none"> <li>Unable to walk without assistance and</li> <li>Urinary and faecal incontinence and</li> <li>No consistently meaningful conversation and</li> <li>Unable to do activities of daily living (ADL)</li> </ul>	<ul style="list-style-type: none"> <li>Plus any of the following: weight loss, urinary tract infection severe pressure sores - stage 3 or 4 recurrent fever, reduced oral intake, aspiration pneumonia</li> </ul>
<ul style="list-style-type: none"> <li>Barthel score &gt; 3</li> </ul>	

#### Stroke

<ul style="list-style-type: none"> <li>Use of validated scale such as NIHSS recommended</li> </ul>	<ul style="list-style-type: none"> <li>Cognitive impairment / Post-stroke dementia</li> </ul>
<ul style="list-style-type: none"> <li>Persistent vegetative, minimal conscious state or dense paralysis</li> </ul>	<ul style="list-style-type: none"> <li>Other factors e.g. old age, male, heart disease, stroke sub-type, hyperglycaemia, dementia, renal failure</li> </ul>
<ul style="list-style-type: none"> <li>Medical complications, or lack of improvement within 3 months of onset</li> </ul>	

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