Critical Care

Managing the patient who is critically ill is one of the most demanding challenges for health professionals working in acute care. The patient's life and their future well-being may be irreversibly altered by an incorrect or delayed clinical decision or a diagnosis that is not recognised or considered. Many factors impact on our ability to respond effectively to the critically ill patient including our medical knowledge, training and clinical experience, how frequently we manage the critically ill and local resources such as equipment, drugs, medical and specialty support.

In this first section of the book, we explore many of the scenarios that are encountered in managing the critically ill patient including preparing for resuscitation, acute airway obstruction, severe respiratory distress, circulatory shock, altered conscious state, cardiac arrest and the mass casualties (disaster) situation. Additional chapters explore preparing the patient for transfer / retrieval, the use of bedside ultrasound in the critically ill and the importance of human factors in resuscitation.

These 20 chapters together with the courses written by the book's authors on the LearnEM website have been developed with one goal in mind : to provide clinicians with the knowledge, critical thinking and clinical skills to confidently and competently approach the critically ill patient. It is our hope that these resources will support clinicians to rapidly assess and identify life threatening disease and assist them with the clinical decisions required for initiating management in these challenging and time pressured circumstances.

On-line Resources @ www.learnem.com.au

Clinical case studies, e-tutorials/videos and clinical resources relevant to each of the 11 sections in the ABCDs of Emergency Medicine may be found on the LearnEM website as part of the *EDGE21* course, the *RESP High Risk Emergencies* (Online) Workshop and the 30 specialised *CPD courses.*

The CPD Courses relevant to critical care include :

1. Advanced Cardiac Life Support (CPR)
2. ABCDs of Resuscitation
3. Emergency Airway Management
4. Non-invasive Ventilation (CPAP/BiPAP)
5. Mechanical Ventilation
6. Bedside Emergency Ultrasound

Chapter 1

Approach to the Critically ill Patient

Key Points

1. **Approach to the critically ill patient begins by ensuring a safe environment and initiating universal precautions.**
2. **Initial assessment involves a systematic check of the patient looking for immediate risks to vital organ function. This is the "Primary Survey".**
3. **There are five steps in the Primary Survey. At each step, there are clinical signs to check followed by one or more routine interventions.**
4. **The Primary Survey is summarised by the mnemonic ABCDE : Airway (+ Haemorrhage), Breathing, Circulation, Disability and Exposure / Environment**
5. **"Resuscitation" is the term given to initiating management to treat problems identified during the Primary Survey.**
6. **As a problem is identified the clinician should take action to correct the life-threatening state before proceeding to the next step in the Primary Survey.**

It is common for clinicians to feel anxious when approaching a seriously ill patient. They may feel overwhelmed, wondering where to begin and how to approach the task. With so many different emergencies it would seem an impossible task for an individual clinician to become competent in managing all of them.

The good news is that the approach to the seriously ill patient always begins in the same place and follows the same basic structure, no matter what the emergency and no matter the age of the patient. This systematic approach to care of the critically ill enables clinicians to identify immediate life threats and to initiate lifesaving interventions without requiring a detailed knowledge of all possible emergency presentations. This approach to the seriously ill patient is termed the "*Primary Survey*".

Introducing the Primary Survey

Assessment of the seriously ill patient begins by first checking for danger. This involves checking for and removing any threats to your personal safety and the safety of others at the scene. This check should also include initiating universal precautions such as gloves, a consideration for the use of eye protection (especially in trauma) and in the era of Covid19, the application of Personal Protective Equipment (PPE).

After checking for danger, the next step is to examine the patient. The initial priority is to assess the patient's vital organ functions – their airway, breathing, circulation and to identify any threat to brain function.

Questions that assist the clinician to consider the priorities in the primary survey include :

- Is there severe bleeding that may be limited with torniquets, pelvic binding or external pressure ?
- Is the airway obstructed ?
- Is the breathing impaired ? Is the patient hypoxic ?
- Are there clinical features of circulatory shock ?
- Are there immediate threats to brain function ?

The Primary Survey provides the starting point for all emergency care. By using a systematic approach to care of the seriously ill patient, much of the anxiety that may arise with the management of these patients is alleviated. In addition, the primary survey ensures that the clinician's attention is focused on assessing and initiating treatment of clinical states that require immediate treatment, improving the chances of the patient surviving the illness.

Primary Survey

Danger - Response - Send for Help

	Assessment	Routine Action
Airway + Haemorrhage	**Look, Listen, Feel** Look for external bleeding Look in mouth / check breathing Listen for obstructive noises Feel air movement at the lips	Apply High Flow O_2 Limit severe bleeding Stabilise C-spine in the trauma patient
Breathing	**Look, Listen, Feel** Look : Resp Rate / Distress Listen : Auscultate / Percuss Feel for Trachea midline	Attach Oximetry to monitor O2 saturation
Circulation	**Begin at hands, work up arm** Assess hands for colour, temp, capillary refill Pulse Rate, Rhythm, Volume Check Blood pressure	Obtain vascular access Collect bloods / Commence IV fluids Attach ECG and Blood pressure monitoring
Disability	**Check CNS function** Conscious state (AVPU scale) Check Pupils : Reaction to light, Size and Equality Look for limb movement	Check Blood Glucose
Exposure	**Patient environment** Undress patient for examination Check patient's Temperature	**Temperature** Keep patient warm Reassess ABCDs

Primary Survey

The purpose of the primary survey is to assess vital organ function and identify immediate risks to life. It is summarised by the mnemonic "ABCDE".

In the conscious alert patient, the primary survey may be performed by simply asking the question "How are you?" and shaking the patient's hand. This will often provide much of critical information required for the primary survey. If the patient can answer appropriately in their normal voice and without evidence of significant respiratory distress, the airway is patent, the breathing is adequate, and a sufficient amount of oxygenated blood is being circulated to maintain CNS function. Shaking the patient's hand allows the clinician to assess for peripheral pallor or coldness suggesting compromised circulation.

In patients with altered conscious state or other evidence of instability, a formal assessment is required. There are five steps to the primary survey. At each step, there are clinical signs to check followed by one or more routine interventions. The procedure is outlined below.

A = Airway + Haemorrhage Control

The Primary Survey begins by assessing the patency of the airway using the familiar look, listen and feel approach and high flow oxygen should be applied.

It important at this stage to give priority to assessing the patient for external signs of severe bleeding and control this where feasible with direct pressure and/or application of an arterial limb torniquet or pelvic binder. This is a recent addition to the Primary Survey and the rationale for this is explained on the following page.

B = Breathing

After steps have been taken to clear an obstructed airway and initiate measures to limit bleeding, the breathing should be assessed. The patient's respiratory rate should be measured, and a chest examination performed to look for clues to the presence of respiratory distress and to auscultate and percuss the lungs.

An oximeter should be placed to evaluate for hypoxia.

C = Circulation

After initiating treatment of hypoxia, the circulation should be assessed by examining the colour, temperature of the hands and evaluating capillary refill, pulse rate and volume and the blood pressure documented.

Cardiac monitoring and noninvasive blood pressure monitoring should be attached, and vascular access obtained, drawing blood for bedside blood testing.

D = Disability

After commencing treatment of shock, the function of the central nervous system should be assessed by documenting the patient's conscious state using the AVPU scale (A= Alert, V = eyes closed but open to a verbal stimulus, P = eyes closed but open to a painful stimulus, U = eyes closed and unresponsive to verbal or painful stimulus). The pupils should be examined to assess for size, equality and reaction to light and a brief check performed to assess limb movements (seizure activity, lack of movement in one or more limbs).

Bedside testing of the blood glucose level should be performed.

E = Exposure / Environmental

After completing the disability assessment and initiating treatment of reversible causes for CNS dysfunction such as hypoglycaemia, opioid poisoning and raised intracranial pressure, the patient should be undressed and a brief assessment made looking for other obvious significant abnormal findings including rash (e.g., urticarial, meningococcal), trauma (e.g., penetrating wounds), bleeding (e.g., PR/PV bleeding) and abdominal distension.

The patient should be covered to prevent hypothermia and the temperature measured to identify fever, hypo/hyperthermia.

Revisions to the Primary Survey

Recent approaches, especially in relation to managing Major Trauma, emphasise the importance of initiating measures to rapidly control severe external bleeding. These measures may include the application of specifically designed arterial limb tourniquets (e.g., CAT devices), compression of external bleeding sites or application of a pelvic binder in a patient with a suspected pelvic fracture. The requirement to limit severe blood loss is based on an increasing awareness of the relationship between severe blood loss and the risk of late complications including multiorgan failure.

Some teaching programs have approached this issue by revising the order of the Primary Survey placing C = Control bleeding ahead of A = Airway. While this has a certain appeal, it has the potential to complicate the structure for managing a trauma patient, a medical patient and cardiac arrest with the clinician required to remember a specific assessment and management mnemonic for each type of emergency.

Rather than complicate the standard and well accepted approach to the “Primary Survey” we can simply add an additional intervention to the Primary Survey under the initial step of A= Airway emphasising that while we are assessing and clearing the airway, we should give priority in addition to assessing for the presence of severe bleeding and initiating measures to limit the continuing blood loss.

The revised Primary Survey therefore continues to follow the standard ”ABCDE" mnemonic but now incorporates under A = Airway, measures to limit haemorrhage amenable to direct pressure or the use of arterial torniquets or pelvic binder.

Our revised Primary Survey is now

A = Airway + Haemorrhage (aiming to initiate measures to limit blood loss where feasible)

B = Breathing

C = Circulation

D = Disability (neurological assessment)

E = Exposure

Resuscitation

It is important to recognise that the procedure for "Primary Survey" is the *minimum approach* to caring for all seriously ill or injured patients.

At the most basic level it is a method for checking vital organ function and ensuring that the minimum necessary interventions such as oxygen and monitoring are applied to all patients. Where a life-threatening problem is identified additional interventions will be required. This is termed "*Resuscitation*".

Resuscitation may involve initiating basic airway manoeuvres to treat airway obstruction, providing assisted ventilation using a bag and mask in the patient with respiratory depression, administration of IV fluids in hypovolaemic shock or the administration of glucose in hypoglycaemia. Resuscitation identifies the situation where treatment is initiated to treat a life-threatening problem identified during the primary survey.

The Primary survey ensures that all basic interventions (e.g., Oxygen, Monitoring) are commenced and identifies the group of patients where intervention is required: i.e., all patients receive a "Primary Survey" but only some patients require "Resuscitation"

Chapter 2
Core Principles in Resuscitation

Key Points

1. **Priority should be given to identifying severe bleeding and treatment initiated to limit blood loss by applying compression to a bleeding site, application of an arterial torniquet or a pelvic binder depending on circumstances.**
2. **The airway should be assessed for obstruction. Clinical findings include hypoxia, obstructive airway noises, respiratory distress or a lack of air movement at the mouth. Immediate management involves clearing the airway, providing oxygen and assisted ventilation if required.**
3. **The breathing should be assessed for the presence of respiratory depression or respiratory distress. Signs of severe respiratory distress include marked tachypnoea, tachycardia, difficulty speaking, soft tissue recession, use of accessory muscles and tripod position. Treatment involves high flow oxygen, treatment of the suspected cause and assisted ventilation if required.**
4. **The circulation is assessed for circulatory shock. The earliest signs of shock are thirst, tachycardia, pale, blue or mottled peripheries with decreased skin temperature and impaired capillary refill. Treatment begins with IV fluid bolus, treatment of the underlying cause and possibly the use of vasopressors.**
5. **Disability refers to an assessment of neurological function. This includes assessment of the conscious state (AVPU), pupil size, equality and reaction to light, movement of the limbs and a blood glucose level. The aim is to identify immediate threats to the CNS such as hypoglycaemia, CNS infection, raised intracranial pressure, status epilepticus and severe hyperthermia.**

"*Resuscitation*" is the term given to initiating treatment to treat problems identified during the Primary Survey. As a problem is identified the clinician should take action to correct the life-threatening clinical state before proceeding to the next step in the primary survey.

In this chapter, we will walk through an assessment of the critically ill patient, following the ABCDE approach making note of signs indicating serious illness and discussing initial management. Later chapters will explore these points in further detail.

Haemorrhage Control

As discussed in chapter one, recent approaches to the management of the critically injured patient, emphasise the importance of initiating measures to limit severe bleeding. This should be given immediate priority, at least equal to, (and arguably ahead of), the assessment and treatment airway obstruction. Research has highlighted that even a short delay in identifying and limiting severe bleeding is associated with not only a significant increase in mortality but places the patient at risk of later complications including multiorgan organ failure.

Resuscitation

A search should routinely be made for the signs of severe bleeding in the patient with a history of trauma and if indicated steps taken to limit the amount of blood loss through compression of a bleeding site (s), application of a limb arterial torniquet (such as a CAT device) or the stabilisation of a pelvic fracture with a pelvic binder.

Identifying severe bleeding will prompt the need (after assessing the airway and breathing) to obtain vascular access and initiate fluid resuscitation and commence early blood transfusion aiming to restore oxygen carrying capacity and organ perfusion. In such circumstances consideration should be given to initiation of the local massive transfusion protocol and urgent retrieval of the patient to a trauma centre for definitive care.

Airway Compromise

The airway is an immediate priority in the primary survey with a search made for the clinical features indicative of airway obstruction. Signs of airway compromise may be overt or extremely subtle. It is critical to assess the airway carefully initially and to continually reassess it during the evaluation process to identify the early signs of airway compromise.

Be particularly suspicious in the agitated (possibly hypoxic), sleepy or unconscious (possibly hypercarbic) patient and the patient with severe respiratory distress. Listen for stridor, gurgling, snoring or other airway noises and feel for air movement with expiration. High flow oxygen should be routinely applied and the need for continuing high flow oxygen reviewed once the patient is stabilised. The aim is to ensure a clear airway and provide adequate oxygenation for the patient.

Resuscitation

Basic airway manoeuvres are used initially to clear the airway. It is rare that advanced airway management with endotracheal intubation or cricothyrotomy is required to clear an airway in the first instance. The steps for clearing an airway are summarised in the table below.

It is important to recognise that some causes of airway obstruction require specific interventions e.g., clearance of foreign bodies, nebulised adrenaline in croup and IM adrenaline in anaphylaxis. Definitive management of the airway is discussed in later chapters.

Management of Airway Obstruction

- Advanced help should be called for early
- Clear any secretions / vomitus / blood by suction of the oropharynx
- Foreign bodies should be removed with Magill's forceps, ideally under direct laryngoscopy
- Place the neck in the sniffing position (contraindicated in the trauma patient)
- Use the chin-lift or jaw thrust to lift the tongue off the posterior pharynx
- If tolerated gently insert an oropharyngeal airway +/- nasopharyngeal airway (if not contraindicated)
- Definitive management may later involve the insertion of a laryngeal mask airway or endotracheal tube
- If an airway is unable to be established by other means cricothyrotomy is indicated

Breathing Compromise

After ensuring a clear airway, the next step is to assess the patient for signs indicating ineffective ventilation and hypoxia. This may result from severe respiratory distress due to underlying lung disease or injury or alternatively be caused by profound respiratory depression due to depression of the central nervous system.

Clinical signs of severe respiratory distress include marked tachypnoea, tachycardia, inability to complete sentences or phrases, soft tissue recession, use of accessory muscles and tripod positioning. The tripod position is often assumed by patients with severe respiratory distress and is characterised by the patient sitting or standing leaning forward supporting the upper body with hands on the knees or other another surface.

While respiratory distress is generally easily recognised, the patient with respiratory depression is easily missed and particular care should be taken with assessing respiration in the patient with altered conscious state. An oximeter should be attached routinely to assess and monitor the patient's oxygen saturation.

Resuscitation

Management of respiratory compromise begins with the administration of high flow oxygen. Where there is evidence of increasing hypoxia or severe hypoventilation, assisted ventilation using a bag and mask should be commenced. The patient may later require mechanical ventilatory support if prolonged ventilation is required.

Specific treatment may be required. Common causes of respiratory compromise that require immediate treatment include Tension pneumothorax (Needle or Open thoracostomy), Respiratory depression due to opioids (IM or IV Naloxone), Acute Cardiogenic Pulmonary Oedema (CPAP / BiPAP), Anaphylaxis (IM Adrenaline) and Acute Severe Asthma (Bronchodilators). These are discussed in detail in later chapters.

Circulatory Shock

The patient should be assessed carefully for the presence of circulatory shock. Shock is a clinical diagnosis. Blood pressure is maintained in the early stages in a patient with shock and a normal blood pressure does not exclude circulatory compromise.

Early clues to the patient with developing shock are symptomatic thirst, tachycardia and cutaneous vasoconstriction manifest by pale, blue or mottled peripheries with decreased skin temperature and impaired capillary refill. Clinical findings of advanced shock include altered mental status (agitation, confusion, drowsiness), oliguria and supine hypotension.

There are three types of Circulatory Shock depending on the part of the circulatory system most affected by the underlying disease process – the fluid, the pump or the plumbing (pipes)

1. **Hypovolaemic shock** due to loss of circulatory fluid volume from haemorrhage or due to illnesses causing severe dehydration.
2. **Cardiogenic and Obstructive shock** result in impaired pump function. Causes include arrhythmias, ischaemia, cardiomyopathy, pericardial tamponade, pulmonary embolism and tension pneumothorax.
3. **Distributive shock** is due to loss of vessel tone leading to decreased systemic vascular resistance and abnormal vascular volume distribution. Causes include spinal cord injury, anaphylactic shock, sepsis and drugs.

Resuscitation

Immediate management of circulatory shock begins with the administration of an IV fluid bolus (s) and treatment of the underlying cause (e.g., controlling bleeding). Vasopressors (e.g., Noradrenaline) may be required in some situations. The management of shock is summarised below and discussed in a later chapter.

Management of Shock

- Primary Survey: Minimise blood loss. Administer oxygen. Stabilise airway. Support ventilation.
- Obtain IV access. Attach cardiac and blood pressure monitoring
- Administer an IV bolus of normal saline (NS)

  If suspected Hypovolaemic or Septic shock : Give 20 ml/kg of NS. Repeat if necessary.

  If suspected Cardiogenic or Obstructive shock : Give 250 - 500 ml bolus. Repeat as necessary.
- Consider applying pelvic binder, femoral leg traction (e.g.CT6) in the trauma patient
- Assess response: IVC ultrasound gives a good indication of fluid responsiveness. Decide on further fluids. Determine the need for vasopressors (e.g., noradrenaline)
- Insert IDC to monitor urine output – renal perfusion is a critical indicator of the adequacy of resuscitation
- Serum lactate provides useful information on organ perfusion and adequacy of resuscitation
- Treat cause: Correct arrhythmia. Treat infection / anaphylaxis. Arrange treatment e.g., PTCA, surgery

Impaired neurological function (Disability)

"Disability" refers to assessing the patient's neurological (brain) function with the aim of identifying compromised function and immediate threats to the brain. The patient's conscious state, pupillary size, equality and reaction to light and limb movements should be assessed. A blood glucose level should be performed.

Conscious state is assessed using the AVPU tool : A = Alert - eyes open, V = Verbal - eyes initially closed but open to voice, P = Painful - eyes initially closed but responds to painful stimulus e.g., limb movement, groaning or eye opening, U = unresponsive.

Altered conscious state implies impaired neurological function and is usually clinically apparent at the time the patient is first approached. In some patients, the cause may not be immediately reversible but indicates severe underlying disease (e.g., intracerebral haemorrhage) while in others it may reverse in time with supportive care (e.g., acute poisoning). Some causes, though require immediate intervention to prevent or minimise neurological injury. These include hypoglycaemia, meningitis/encephalitis, raised intracranial pressure, status epilepticus and severe hyperthermia. Early recognition of these immediate threats to the brain will enable the implementation of management will the aim of reducing the risk of permanent neurological injury and death.

Resuscitation

Patients with impaired conscious state are at serious risk of airway obstruction and respiratory depression. The immediate priority in the patient with an altered conscious state to ensure a clear airway, support ventilation and correct hypoxia. Circulation is also a critical factor and urgent treatment of underlying shock is required to restore effective blood flow to the CNS.

In addition to the ABCs, a search should be made for causes of altered conscious state that requires urgent intervention. These include hypoglycaemia (administer glucose), seizures (control with benzodiazepines), meningitis / encephalitis (administer antibiotics / antivirals), raised intracranial pressure (assisted ventilation to reduce pCO2 +/- mannitol or hypertonic saline) and severe hyperthermia (initiate immediate rapid cooling). These are discussed in detail in later chapters.

Exposure / Environment

After completing assessment of the airway, breathing, circulation and brain function the next step is to check the patient's temperature and then prepare the patient for a detailed examination looking for clinical signs that will assist with diagnosis.

The patient's temperature should be checked to identify hypothermia, fever or severe hyperthermia. Immediate treatment should be commenced in patients with severe hyperthermia or severe hypothermia.

Next undress the patient and look for clues to underlying disease or injury. Abnormalities that may be noted include rash, bruising, open wounds or burns, external bleeding, pain with movement of a limb, abdominal distension and abnormal lumps and bumps. When the patient has been undressed ensure, they are covered with a blanket to prevent them getting cold.

Before moving on to the secondary survey reassess the patient's vital signs and review the patient's airway, breathing, circulation and disability.

This review of the patient's clinical condition should be repeated frequently during the continuing assessment and treatment of the seriously ill patient and whenever a significant change in the patient's condition occurs.

Secondary Survey

After the Primary Survey comes the …… Secondary Survey!

Review the patient's ABCD's to confirm that the patient remains stable and then proceed to a thorough assessment of the patient. This is termed the "*Secondary survey*".

Whereas the primary survey is focused on identifying and treating life threats (without the need for a diagnosis), the secondary survey aims to obtain a relevant history and complete a thorough examination of the patient to determine a differential diagnosis and guide further investigation and treatment of the patient.

The secondary survey involves:

- Detailed history and examination
- Investigations e.g., laboratory tests, urinalysis, CXR, CT scan,
- Treatment of the underlying cause

Throughout this process, continuous monitoring of the patient's airway, breathing, circulation and neurological status is essential to enable intervention to be rapidly initiated if the patient becomes unstable.

Chapter 3
Human Factors in Resuscitation

Key points

- **Team-based resuscitation facilitates the delivery of definitive care but adds a layer of complexity due to the multiple processes that are occurring simultaneously, at different rates and undertaken by staff with different levels of skill, knowledge and experience.**
- **It is now increasingly recognised that human factors contribute to clinical error in complex resuscitations due to high stress, multiple clinical demands, distractions, interruptions, ambient noise and clinical ambiguity.**
- **A deeper understanding of how human factors may influence the performance of teams in the context of resuscitation may assist to reduce incidence of clinical error**
- **Key principles identified for managing Human Factors include Being prepared for the Crisis and Calling for help early, Anticipating, Sharing and Reviewing the Plan, Providing Effective Leadership, Ensuring Role Clarity, Situational awareness and Good Teamwork and Communicating Effectively**

While the linear Airway, Breathing, Circulation, Disability, Exposure (ABCDE) provides a structured framework for managing the critically ill or injured patient, in practice, management follows a more "horizontal" pathway where members of the resuscitation team are managing multiple tasks at the same time.

While the team-based approach facilitates the early delivery of definitive care, it adds a layer of complexity due to the multiple processes that are occurring simultaneously, at different rates and undertaken by staff with different levels of skill, knowledge and experience.

It is increasingly recognised (sadly often through real life scenarios associated with poor patient outcomes) that the coordination of these processes may be "just as critical for patient survival as making the correct diagnoses or carrying out the most appropriate tasks[1]". This has prompted the recognition of the critical role of human factors to the management of the critically ill patient.

Human Factors – A Source of (Correctable) Error

Even with sound clinical knowledge and skills we are all open to making mistakes !

Recognised factors that increase the risk of clinical error include the time of the day, fatigue, hunger, dehydration, minor illness, stress and emotional factors such as anger, frustration or anxiety. These and other similar factors, unless acknowledged, can distract us from our clinical focus increasing the risk for serious clinical error or oversight.

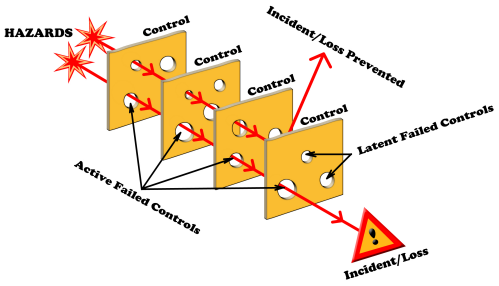
Without a system designed to protect the patient from clinical errors, the only way of reducing the risk of error is increased vigilance on the part of the clinician to identify and prevent individual clinical error.

Fortunately, the healthcare system has long recognised human factors and implemented systems to reduce the risk of clinical error - however these do fail and the "Swiss cheese" model of organisational accidents[2] provides a useful concept to understanding how such errors occur.

[1] Fitzgerald, MC et al (2006) Trauma Reception and Resuscitation. *ANZ J. Surg* 76:725-728

[2] Reason JT, Carthey J, de Leval MR. Diagnosing "vulnerable system syndrome": an essential prerequisite to effective risk management. Qual Health Care. 2001 Dec; 10 Suppl 2(): ii21-5.

Defences against Clinical Error



The healthcare system incorporates multiple systems of checking and oversight as a "defence against error". These defences (systems) however are not perfect and in fact have weak spots (termed holes).

The presence of a hole in any single slice does not usually lead to a bad outcome however should the holes align there is the potential for a system failure and consequent clinical error and risk to the patient.

It can easily be recognised that poorly designed defences increase the size of these holes and greatly increase the risk of error (system failure). This places an enormous burden on staff to avoid errors through vigilance alone.

It has been recognised that holes arise in each layer due to one of two factors :

1. *Latent condition within the system because of design*.

   These are usually open to correction if identified before an adverse event occurs. They rely on an open system of reporting that facilitates their early recognition and a system that allows changes to be readily implemented to "reduce the size of the hole".

2. *Active failure resulting in clinical errors or procedural violations*.

   While these are more likely to occur in the context of fatigue, stress, illness, overload, inexperience and complacency they are now increasingly recognised to occur in complex resuscitations as due to high stress, multiple clinical demands, distractions, interruptions, ambient noise and clinical ambiguity. It is in this context that a deeper understanding human factors may play a significant role in reducing clinical error.

Classifying Human Factors

Human factors refer to a range of individual skills that impact on the function and effectiveness of the team.

They can be classified into

1. Interpersonal skills such leadership, mutual support for team members and conflict management
2. Cognitive skills including critical thinking, situational awareness, prioritisation and decision making
3. Communication skills including the creation of shared mental models and conflict resolution.

An appreciation of these skills assists in understanding how human factors may influence the performance of teams in the context of resuscitation and similar high stress situations in medical practice.

It all begins with "Leadership"

Leadership plays a central role in the functioning of an effective team in healthcare and may be thought of as a "*multi-dimensional, complex behaviour that includes effective communication, efficiency, decision-making, and resource management skills*."[3]

The presence of a clearly identified team leader increases the likelihood that the team will apply standard guidelines and follow a structured approach to resuscitation (reducing the risk of oversight). Effective leadership results in a greater coordination of the team and facilitate the delivery of timely (appropriate) care.

Key skills that have been shown to enhance leadership include

1. Assuming responsibility for the patient
2. Providing strategic direction according to the anticipated needs of the patient
3. Monitoring the progression of the clinical care provided
4. Providing feedback or teaching for other team members
5. Coordinating continuing care and facilitating disposition

[3] Ford et al. (2016) Leadership and Teamwork in Trauma and Resuscitation. *Western Journal of Emergency Medicine 17(5):549-556*

Other Key Skills with Leadership

Other important skills that may assist with leadership include encouraging closed loop communication, knowing names and capabilities of team members, being able to stay calm and maintain focus, having the ability to listen, make decisions and communicate these to the team, manage conflict and maintain situational awareness.

At times the leader may be required to be assertive to ensure the delivery of appropriate clinical care and delegate tasks in a manner than prevents individuals on the team being overwhelmed or required to undertake duties beyond their expertise.

Throughout the resuscitation the leader should aim to provide updates on the clinical progress and planning and should look for with opportunities that allow the team to share with decision making and contribute their knowledge, experience and observations to the resuscitation.

The Other Side of the Coin: Effective Teamwork

Simply having a team assembled of medical and nursing staff knowledgeable in advanced life support, resuscitation or trauma care does not by itself ensure the delivery of timely or appropriate care. The major factor in this scenario to the ability of the team to act cooperatively with a shared goal to achieve the best outcome for the patient.

"*As members of a team they have specific roles or functions to perform and interact with each other dynamically, interdependently, and adaptively. This means they are not just performing task roles (jobs team members do), but they are also performing team roles (working, supporting and looking out for each other"*[4].

An effective team is one where the team members demonstrate respect for each other's roles and skills, can actively engage in patient care and can draw on their individual expertise, knowledge, and clinical skills to help the team achieve its goals.

Key components to the functioning of an effective team include the opportunity for team members to contribute to decision making, set priorities and develop plans, provide support to each other (mutual support and backup behaviours), contribute to clear communication (particularly using closed loop communication techniques) and assist in reducing the cognitive load for the leader.

Medical Teams are Unique!

Medical teams face several significant challenges that may act as a barrier to their effective functioning.

Unlike many other teams that are required to operate under pressure (sporting teams, emergency responders such a fire or police, armed forces etc), medical teams are often assembled in the midst of the crisis (with minimal or no time for preparation), have little or no opportunity to practice as a team on a regular basis, may lack the knowledge of each other's names and capabilities and be expected to perform at a high level (almost immediately) in some of the most stressful circumstances.

This really is quite unique to teamwork and has led to the introduction of a range of practices with the aim of improving the effectiveness of the team responding to the critically ill or injured patient.

These include the development of

1. Clearly defined and understood roles
2. Routine delegation of roles (identified on the roster sheet/book and/or labels worn by team members)
3. Team briefing at the commencement of a shift allowing team members to introduce themselves, confirm roles and clarify questions or identify possible knowledge gaps (e.g., where is the IO gun located)
4. Team debriefing to bring closure to members and the opportunity to identify issues where team performance may be improved in the future.
5. Mock (real time) scenarios that bring the team together during a shift to practice team skills
6. Workshop simulation training that incorporates opportunities for learning/practicing team skills

[4] Royal Melbourne Children's Hospital "Human Factors in trauma reception and resuscitation

Conflict Management

Conflict will occur in most teams at some time. The key is whether it is allowed to disrupt the functioning of the team or whether it can be effectively managed.

A highly effective team is one where the leader creates an openness to decision making and the setting of priorities by team members and empowers team members to speak out where they have concerns. This approach may lead to tensions in the team that may, unless addressed, become a source of conflict within the team. This is further exacerbated by the frequent requirement of the leader to make decisions based on incomplete or conflicting information with the result that many medical decisions are not a clear yes or no with feasible arguments for both decision pathways.

The problem with conflict within teams is that it contributes to a waste in both time and resources and may significantly delay a decisive (and possibly lifesaving) decision. It is essential that team leaders address conflict. This requires a high level of behavioural, emotional and cognitive skills together with self-awareness. In most circumstances it can be addressed within the team however in serious situations it may be necessary to ask the team member(s) to leave the resuscitation in order to restore the functioning of the team.

Situational Awareness

Situational Awareness is "knowing what is going on so you can figure out what to do."[5] *It includes knowing the circumstances that led to the patient's presentation, an understanding of their current condition and an awareness of where the patient's current condition will lead.*

Situational awareness plays a critical role in decision making and prioritisation and requires understanding the patient's clinical presentation and past medical history, close monitoring of a patient's clinical and vital signs, combined with an ability to identify potential diagnosis (s) based on limited clinical information and modify the working diagnosis (s) in response to additional clinical information.

Shared Mental Models

A useful strategy that aids situational awareness and assists in creating common goals across the team is when the leader periodically provides the team with a recap of the patient - summarising the patient's presentation and clinical findings, outlining their response to treatment and current clinical condition and proposing a possible plan for further management and disposition. The detail of this recap will no doubt vary from patient to patient but in general should be kept as brief as possible. This strategy is referred to as creating *Shared Mental Models* indicating everyone on the team is "on the same page".

Planning and Decision Making

Effective "planning" and "decision making" are interdependent on many of the factors discussed previously. Leadership is an obvious factor as is the need to create an environment that promotes shared understanding and supports shared decision making. These factors will assist the team to consider diagnoses, discuss treatment options and determine the optimal approach to disposition and further management.

In any clinical environment management decisions will be influenced not only by the clinical condition of the patient but by a variety of important factors including patient factors (age, co-morbidities, social factors, end of life decisions), local resources, financial constraints and transfer factors (distance, time). This complexity may present an individual team leader with a considerable cognitive load, and it is in these circumstances that a joint decision-making approach has the advantage of not only reducing the cognitive load but is likely also to reduce the risk of clinical error or commencing futile interventions.

It is at this point that the team may move from one focused purely on the physical delivery of patient care to one where the team draws on its combined knowledge, experience and understanding to plan and make decisions that may significantly impact of the patient (and in some cases their family).

From the above it can be seen that a major factor in good decision making is the ability of the clinician to predict the course of the patient's condition, identify the options for management and decide on the most appropriate course of action. The use of shared mental models, open decision making within teams and an adaptive approach to decision making that allows decisions to be reviewed and modified as additional information becomes available serve to optimise planning and decision making in relation to management of the seriously/critically ill or injured patient.

[5] Adam, EC (1993) Fighter cockpits of the future *Digital Avionics Systems Conference 12th DASC., AiAA/IEEE* as quoted by St. Pierre, M., Hofinger, G., & Simon, R. (2016) Crisis Management in Acute Care Settings: Human Factors and Team Psychology in a High-Stakes Environment (3rd ed). Springer

Key Principles for Managing Human Factors

Human factors are not unique to healthcare and in many other fields have long been recognised as a critical factor for effective teamwork in a crisis.

Many of the strategies now applied to addressing the impact of human factors are derived from the aviation industry in the 1970s when it was identified that 70% of airline crashes were the result of human factors relating to teamwork, leadership and communication.

Key principles most relevant to addressing the impact of human factors during resuscitation are:

1. *Be prepared for the Crisis / Call for help early*

   Clinical staff should be encouraged to become familiar with their clinical environment: the location and operation of all essential equipment, knowledge of resuscitation drugs and be able to identify the role and experience of team members.

   Staff should be encouraged to call for help early and be provided with clear criteria for when to call for assistance. Barriers to calling for help should be identified and addressed.

2. *Anticipate, Share and Review the Plan*

   Key principles for responding to the crisis include considering and planning for all possible contingencies (with the aim to be one step ahead of the patient), setting priorities dynamically, re-evaluating periodically, using cognitive aids such as guidelines and ensuring that the plan for the patient is shared with those on team.

   As we have discussed above it is helpful to everyone for the clinical leader to think out loud, provide periodic briefings to verbalise priorities, goals and clinical findings as they change, encourage team members to share ideas and plans and to continually review the plan based on observations and response to treatment.

3. *Provide Effective Leadership*

   Core principles include using the least confrontational approach consistent with the goal making. The direct, authoritative approach should only be used where necessary (e.g., time critical situations). Aim to establish behavioural and performance expectations of team members and support the team's shared mental model of what is happening and the team's goals.

   The leader should be cognisant of 'fixation error' and cognitive overload. This may be reduced by inviting participative decision making, prioritisation of tasks and the delegation of specific duties to team members.

4. *Ensure Role Clarity, Situational awareness and Good Teamwork*

   Ensure team roles are clear and where roles change during the resuscitation this must be made explicit and confirmed by affected team members.

   The Clinical Leader should aim to maintain situational awareness while providing oversight, direction and support for the team. In high performing teams the members practice self-care, look for opportunities to support team members and take joint responsibility for ensuring good patient outcomes.

5. *Communicate Effectively*

   Communication is critical and should aim to develop the shared mental model, incorporate closed loop communication, support collaboration and conflict resolution. While communication may at times be assertive it should not be perceived as aggressive, weak or include personal attacks.

Chapter 4

Preparing for Resuscitation

The Zero Point Survey

Key points

- **Preparation has the potential to optimise both an individual and a team's ability to respond to technical and nontechnical challenges of resuscitation.**
- **The "Zero Point survey" aims to optimise the preparedness for the individual (the self-check), the resuscitation team (the team brief), and the environment (the environmental scan)" prior to commencing Resuscitation.**
- **It is important for individuals to be adequately rested, physically fit, medically equipped and cognitively prepared for their role.**
- **The team brief builds a foundation for how the team will communicate, create a shared mental model and participate in shared decision making and the setting priorities.**
- **Planning is important beforehand for ensuring a safe environment. Factors to be considered include the size of the room, ventilation, lighting, layout of the equipment trolleys, slip/trip hazards, noise, overcrowding, exposure to body fluids and disposal of sharps.**
- **During the resuscitation it is essential for the team leader to frequently update the team with the aim of creating a shared understanding of the patient's clinical situation and progress.**
- **During resuscitation the team should aim to establish priorities with respect to patient management and definitive care**

Introduction

While the Primary Survey - Resuscitation model provides the framework for approaching a critically ill or injured patient, the preceding chapter emphasised the key role of leadership, teamwork and communication in addressing human factors that may adversely impact on resuscitation. In this chapter we build on this idea by considering how the process of preparing for a resuscitation may serve to optimise both an individual and a team ability to respond to technical and nontechnical challenges posed with resuscitation of critically ill or injured patient.

One approach that is gaining wide acceptance is the "Zero Point survey" a structure that aims to "pre-emptively prepare the team, the environment and the equipment" in order to provide "a structured approach to optimizing preparedness for the individual (the self-check), the resuscitation team (the team brief), and the environment (the environmental scan)" prior to commencing the Primary Survey – Resuscitation[1].

As Chris Reid and his co-authors argue in their 2018 landmark paper on the Zero Point Survey

"The period before first patient contact is an opportunity to appraise environmental, cognitive and team-based cues. While unequivocal medical data are lacking, there is extensive literature from many high-stakes professions that pre-planning increases team resilience and successful outcome[1]".

[1] Reid C, Brindley P, Hicks C, et al. Zero point survey: a multidisciplinary idea to STEP UP resuscitation effectiveness. *Clin Exp Emerg Med*. 2018;5(3):139-143. doi:10.15441/ceem.17.269

The Zero Point Survey

The Zero Point Survey (ZPS) begins the moment an individual and the team become aware of the need for a resuscitation and before initiating the Primary Survey. Hence its name as the "Zero Point Survey".

The ZPS identifies a series of actions with some undertaken in the pre-resuscitation period and others undertaken commenced during the resuscitation phase. It is summarised by the acronym STEPUP.

The STEPUP acronym reminds the clinician and the team to prepare Self, the Team and the Environment before beginning the Primary Survey and then to remember during the resuscitation to Update the team and establish Priorities in management.

Pre-Resuscitation

There are three key principles in the ZPS that identify ways that a team can optimally prepare themselves for a resuscitation. These are Self Check, Team Brief and Environmental Scan.

Self-check

In the first step the individual team members are reminded to mentally and physically prepare themselves by ensuring they are physically fit for their role taking into consideration illness, drugs, alcohol, fatigues, stress and food/fluids.

Psychological techniques may be utilised to reduce the impact of the fight/flight response and controlled breathing and reframing threats as challenges and aid clinical decision making.

This step has been previously summarised as '*Breathe, Talk, See, Focus*,'[2].

Team Brief

The team brief revisits many of the points described in the preceding chapter on human factors and begins with identifying a team leader and allocate team roles. At this stage the aim is to begin the process of building a shared mental model by discussing whatever information is known about the patient (often provided by the paramedics enroute (e.g., age, gender, clinical presentation, vital signs).

The team brief builds a foundation that facilitates the team to decide on how to prepare for the patient and how the team will communicate, created a shared mental model and participate in shared decision making and the setting priorities.

Environmental scan

In the third step prior to commencing the Primary Survey, the priority is to ensure a safe environment. Factors to be considered include the size of the room, ventilation, lighting, layout of the equipment trolleys, slip/trip hazards, noise, overcrowding, exposure to body fluids, disposal of sharps and risk for violence.

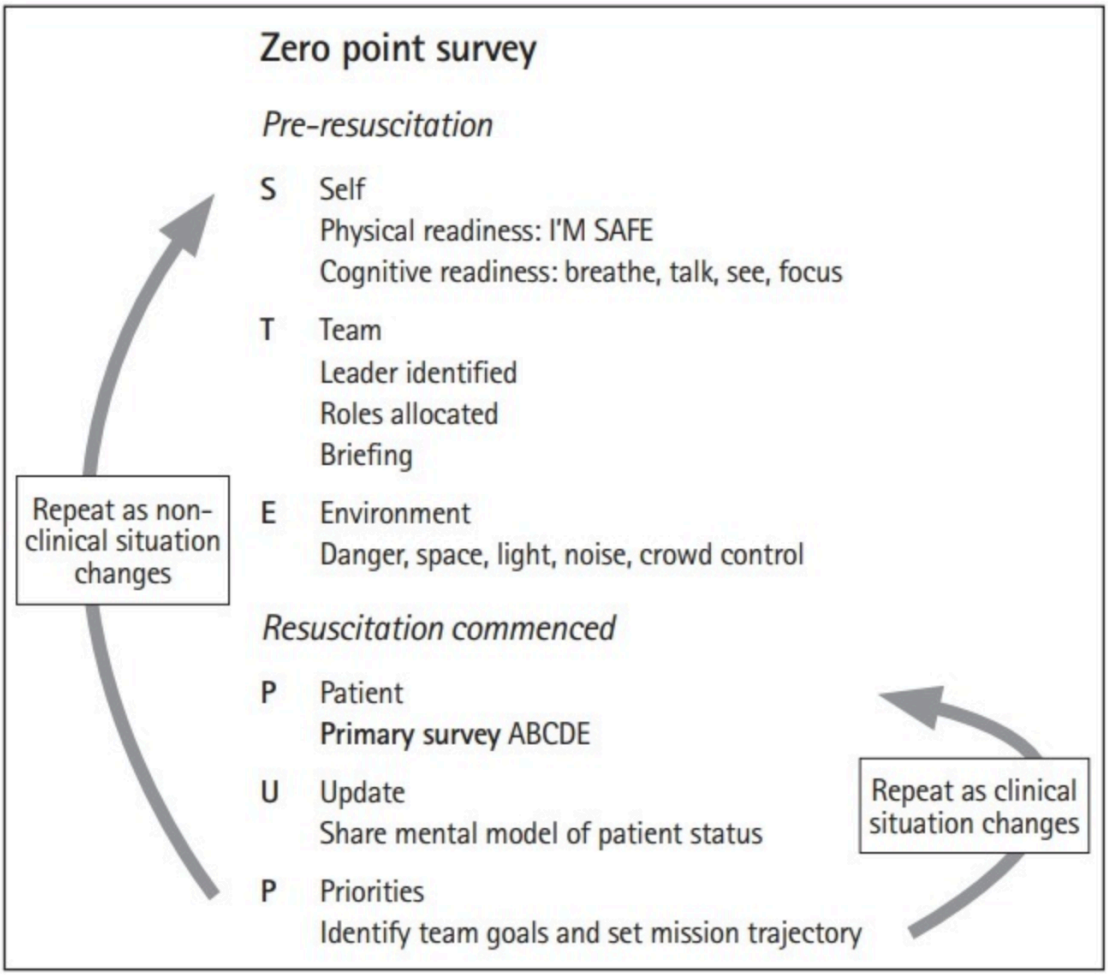
STE before PUP

It can be seen from the above that Pre-Resuscitation preparation does not begin in the minutes preceding the resuscitation but is undertaken in the hours, days and week beforehand.

It identifies the importance of the individuals in the team to be adequately rested, physically fit, medically equipped and cognitively prepared for their role. With respect to the team the ZPS makes clear the importance of clinical simulation as a method for teams to practice leadership, teamwork and communication skills, a topic of a later chapter in this section on critical care.

Finally, the ZPS emphasises the need for planning to optimise the environment for resuscitation. Many of the issues discussed in the above section on the environment can and should be identified and addressed well in advance of a resuscitation having the benefit of creating not only a safer environment for staff to work in but will enhance the team's ability to respond to challenges faced with resuscitation of a critically ill of injured patient.

[2] Lauria MJ, Gallo IA, Rush S, Brooks J, Spiegel R, Weingart SD. Psychological skills to improve emergency care providers' performance under stress. Ann Emerg Med. 2017;70:884–90.



Resuscitation Phase

The resuscitation phase begins (as would be expected) by commencing the Primary Survey. During the Primary Survey and continuing resuscitation of the patient the ZPS emphasises the importance of the team leader ensuring that all members of the team are regularly updated on the patient with respect to clinical findings, management and differential diagnosis thereby creating a shared understanding of the patient's clinical situation and progress. This is referred to a shared mental model and is discussed in the chapter entitled "Human Factors in Resuscitation".

A second critical action during resuscitation is the development of plans for continuing management of the patient. This identified the role of the team to establish priorities with respect to management creating "goals and a mission trajectory" for the team.

A summary of the STEPUP actions in the Zero Point Survey taken from the original published paper by Chris Reid et al is shown above[3].

[3] Reid C, Brindley P, Hicks C, et al. Zero point survey: a multidisciplinary idea to STEP UP resuscitation effectiveness. *Clin Exp Emerg Med*. 2018;5(3):139-143. doi:10.15441/ceem.17.269