AN INTRODUCTORY GUIDE TO CRITICAL CARE

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Introduction

Critical care is a relatively new specialty dedicated to the management of patients with potentially life threatening illnesses. Modern techniques have been developed from those practised in the early post-operative recovery rooms and respiratory care units. During the polio epidemics of the early 1950s, it was realised that the use of long-term artificial ventilation could result in reduced mortality. By using tracheostomy and manual ventilation, physicians in Denmark reduced the mortality from poliomyelitis from 80% to 23% by the end of the outbreak. Artificial ventilation was provided entirely by hand – a total of 1400 university students worked in shifts to ensure the survival of these patients. This success fuelled research into powered mechanical ventilators. Coronary care units were the first specialised units, set up in the 1960s. Further development and research in the 1970s led to new understanding of the pathophysiology of the critically ill and the evolution of critical care as we know it today.

Critical care units currently provide 1 – 2% of total hospital beds but there is an increasing demand for more. The incidence of sepsis is rising and with new, more complex developments in the management of illness, patients are now older, sicker and more dependent than in previous years. Many patients presenting for routine surgery have complex co-morbidities requiring careful management in a closely monitored environment. Knowledge of the scope and limitations of critical care areas is vital for all hospital doctors, and the Intercollegiate Board for Training in Intensive Care Medicine (IBTICM) has recommended that all medical students should receive a period of structured training in ICM during undergraduate training.

Positive pressure ventilation during the 1950s polio epidemic

This guide is intended to provide you with a brief introduction to critical care units. It describes the following:

- the different levels of critical care support available
- the staff who work in critical care areas
- the types of patients admitted to critical care units
- a scheme for assessing critically ill patients
- typical admission criteria for critical care areas
- the types of equipment used to support critically ill patients
- how to present the case history of a patient during a critical care unit ward round
- the types of ethical issues that relate to acutely ill patients
- training programmes in critical care medicine
- the aims and objectives of an attachment to critical care

Levels of critical care support

Intensive care has traditionally been defined as ‘a service for patients with *potentially reversible* conditions who can benefit from more detailed observation and invasive treatment than can safely be provided in the general wards or a high dependency unit’. Recently, the nomenclature has changed and the term ‘critical care’ is now used to encompass intensive care, high dependency care and the management of the critically ill patient elsewhere in the hospital (outreach care). Critical Care teams also frequently have responsibility for attending cardiac arrest and trauma calls, and assisting with inter-hospital patient transfers.

The Intensive Care Unit (ICU)

In the UK, there are approximately 250 intensive care units, which vary in size from 3 to 20 beds. These allow the close monitoring of patients using a variety of invasive and non-invasive devices and permit organ support using ventilators, renal replacement devices and vasoactive agents. Ideally, there is a nurse: patient ratio of 1:1, a resident doctor and 24-hour consultant cover. Most ICUs in the UK are general, although some are specialised (e.g., burns, liver, cardiac or neurological). Previously, many general ICUs treated both adult and paediatric patients, but now the management of critically ill children more frequently occurs in regional paediatric units. There is an ever increasing need for greater numbers of ICU beds and this trend is likely to continue as the average life-expectancy increases and new developments allow for the support of sicker patients.

The High Dependency Unit (HDU)

High dependency units are a recent development in most hospitals. The nurse:patient ratio is commonly 1:2 and there is not always a specific resident doctor. Many are specialty based e.g. surgical, respiratory, but there is an increasing number of general HDUs. The latter may admit patients directly from the wards because of their deteriorating condition (step-up) or from the ICU as part of the recovery phase from their acute illness (step-down). HDUs provide more intensive nursing care and patient monitoring than can usually be provided on a general ward. Some HDUs allow for short-term ventilation or other single-organ support. In some hospitals, the ICU and HDU are combined to allow greater flexibility.

Outreach Service

The Outreach Service is a new development in the multi-disciplinary approach to the sick patient. The main objectives are:

- **to avert admissions** to intensive care by identifying patients who are deteriorating, and intervening where necessary.
- **to ensure that admission to a critical care bed happens in a timely manner** to ensure best outcome.
- **to enable discharges** by supporting the continued recovery of patients on the ward.
- **to share critical care skills** with hospital staff and gather information from the ward, relatives and the community to improve critical care services for patients and relatives.

Outreach is commonly provided by a multi-disciplinary team, consisting of experienced nurses and led by a qualified critical care clinician.

Critical Care Staff

Multi-disciplinary and multi-professional approach

Critical illness often crosses specialty boundaries and, therefore, critical care is best delivered by teams. These usually include doctors, nurses, physiotherapists, dieticians and many other healthcare professionals who each bring unique knowledge and skills. A brief description of the roles of individual team-members is provided below.

The consultant.
Consultants working in critical care come from a variety of backgrounds. In the UK, the majority are consultant anaesthetists who have a special interest in critical care, but there is an increasing tendency for specialists from other disciplines (e.g., respiratory medicine, renal medicine, accident & emergency medicine) to have sessional commitments. Unlike the USA, Australia and some parts of Europe, few consultants work full time in critical care.

The trainees.
The resident cover for critical care units is provided by trainees from a variety of backgrounds. Trainees may gain experience in critical care as part of medical, surgical, anaesthetic or A&E rotations, or in specific 'stand alone' posts. Training may occur as part of a Foundation Year programme or in the SHO and SpR grades. Some trainees who wish to specialise in intensive care will undertake Step 1 or Step 2 specialty training. Some units have permanent non-consultant career grade doctors who may provide cover at a variety of levels.

The nurses
Most nurses who work in critical care areas are very experienced and often have completed a specific training program that gives them a special qualification in critical care nursing. They are responsible for the close monitoring of the patients on a minute to minute basis. Many of them will have additional practical skills such as blood taking, recording of ECGs, undertaking cardiac output studies and setting up complex equipment, such as haemofiltration machines. Communication with other members of the healthcare team is a very important part of a critical care nurse's role; it is vital to ensure continuity of care. In addition, nurses spend a large amount of time with the patient's relatives helping them to understand the patient's illness and the type of care that they are receiving. As a newcomer to intensive care, it would be well worth spending time talking to the nurses on your ICU or HDU, as they will be able to give you much useful information about the patients, their treatment and the processes involved in caring for the critically ill. Nurses often form the nucleus of the hospital's outreach service and assist in patient transfers.

The physiotherapists
The majority of patients who are admitted to the ICU will be intubated and/or sedated. Such patients will be unable to cough and clear their secretions normally. If adequate physiotherapy is not provided to these patients, they will quickly develop lung collapse or pneumonia. Most ICUs therefore have physiotherapists providing dedicated 24-hour cover for their patients. Immobile patients rapidly develop muscle weakness and stiff limbs, which may be prevented by musculoskeletal physiotherapy e.g. active and passive movements. Early intervention to rehabilitate patients can improve functional outcomes,

especially for patients with neurological conditions, after trauma or where the ICU stay has been prolonged. The physiotherapist also provides a vital link between the highly staffed critical care area and the general wards.

The dietician
Some ICUs have their own dietician to advise on all aspects of nutritional support. Most patients will be unable to eat normally and require enteral or parenteral feeding. It is vital that ICU patients receive adequate nutrition to enable them to cope with the physiological demands of their illness. There is good evidence that patients who are fed early have a shorter length of stay and develop fewer complications. The dietician may assist the ICU doctors in selecting the appropriate balance of energy sources and protein, taking into account the patient's underlying condition.

The pharmacist
Most critically ill patients receive a wide variety of drugs and the pharmacist can provide valuable advice to ensure that doses are correct and that interactions do not occur. They also provide advice on monitoring the blood levels of potentially toxic drugs and supervise the quality of drug prescriptions. Some critical care units have their own pharmacist.

Visiting specialists
Specialists, such as surgeons, microbiologists, cardiologists, paediatricians, radiologists, and renal and respiratory physicians, may visit the unit on a routine basis, as well as when their opinions are specifically requested. The multi-disciplinary nature of critical care makes their contribution essential to the management of patients.

Technicians
Many critical care units employ one or more technicians to service and maintain vital equipment on a 24-hour basis. In some units, they are also responsible for setting up bedside equipment and may assist with transfers.

Speech and Language Therapists
Prolonged intubation of the airway, and procedures such as tracheostomy, may interfere with the normal mechanisms of speech and swallowing. Therefore, patients need careful assessment prior to the recommencement of normal oral intake to evaluate the risk of pulmonary aspiration. This role is provided by speech and language therapists, who continue to review and treat patients once they have returned to the general wards.

Other team members
Most ICUs will have a variety of other allied staff such as health care assistants, secretaries, ward clerks, domestic staff, porters, social workers and members of the chaplaincy.

Critical Care Patients

Elective

Surgical patients may be admitted to critical care areas following their operation. Some will require invasive monitoring, mechanical ventilation or continuing resuscitation. Operations that commonly require a period of post-operative critical care include major vascular surgery (e.g., abdominal aortic aneurysm repair), major gastro-intestinal surgery (e.g., oesophagectomy) and other complex or prolonged operations (e.g., Whipple's procedure). Most cardiac surgical, and many neurosurgical patients will require post operative admission for a brief period. Some high-risk patients, or those undergoing major surgery, may be admitted before their operation for a period of cardiovascular optimisation.

Case history

Mr SJ, a 65-year-old man with a past medical history of hypertension and a myocardial infarction three years earlier, underwent elective repair of his abdominal aortic aneurysm. The procedure was uneventful and he was transferred to the ICU after his surgery for a period of postoperative monitoring. This included continuous arterial and central venous pressure (CVP) monitoring, arterial blood gas analysis and hourly urine output measurement. Two hours after admission his CVP fell from 10 to 6 cms H_2O and he developed a tachycardia. His haemoglobin (measured immediately by the arterial blood gas analyser) had also fallen from 10.2 to 8.6 g/dl and his coagulation screen demonstrated an abnormal INR (1.9) and APTT ratio (2.2). Continuing haemorrhage, secondary to a coagulopathy, was diagnosed and so he was given fresh frozen plasma and a blood transfusion. Two hours later his haemoglobin was 10.4, INR 1.3 and APTT ratio 1.3. He was cardiovascularly stable and remained so overnight. He was discharged to the HDU and then the general surgical ward where he continued to make good progress, going home 5 days later.

Without the close monitoring provided by a critical care area the early signs of bleeding may have been missed and his blood loss may have been greater, thereby increasing the potential for further complications.

Emergency

The majority of critical care admissions are unplanned. Patients may be admitted directly from the A&E department (e.g., following trauma, overdoses, meningitis, diabetic ketoacidosis), the operating theatre / recovery areas (e.g., after emergency repair of perforated viscus or a ruptured aortic aneurysm) or from general wards (e.g., with sepsis or Guillain-Barré syndrome). The exact cause of their illness may not initially be known but they require close observation, resuscitation, invasive monitoring, mechanical ventilation or other organ support.

Case History

Mrs GH, aged 67 years, was admitted to the medical ward with an acute exacerbation of COPD. She was treated with antibiotics, nebulisers and steroids, but 24 hours after admission developed increasing respiratory distress with hypoxaemia and rapidly became exhausted. She required intubation, ventilatory support and was transferred to the ICU. She developed signs of sepsis, including vasodilatation and a low blood pressure. A pulmonary artery catheter was inserted to guide vasoactive drug therapy. Five days later, despite regular physiotherapy, she continued to require assisted ventilation. A percutaneous tracheostomy was then performed to permit reduction of sedative medication and facilitate weaning from mechanical ventilation. On day 10 she was transferred to the HDU for the final phase of weaning from respiratory support. She was assessed by the speech therapists prior to transfer to the general ward on day 12.

Transfers

Critical care staff are often responsible for the in-hospital and inter-hospital transfer of patients. Patients may also be transferred between critical care facilities, often because their condition requires treatment that is only available in a specialised unit. However, occasionally, a stable patient will be transferred to another hospital to make room for an unstable critically ill patient who requires intensive care.

Case History

Mr DF, a 24-year-old, sustained severe head trauma following a motorcycle accident. He was stabilised in the A&E by the ICU team and required intubation for airway protection. A CT scan revealed a large subdural haemorrhage and he was transferred to the nearby neurosurgical unit for urgent evacuation of his blood clot. In transit, full mobile ICU support was maintained.

Intensive Care Referral and Admission

Assessing the critically ill patient

Assessment and resuscitation should be simultaneous activities, focusing on the rapid detection and correction of potential life-threatening physiological disturbances. A systematic approach will enable clear priorities to be established and enable good communication between all members of the health care team. In assessing any patient, a simple question such as 'How are you?' can provide vital initial information. If the patient is able to reply normally, this informs you that they have a patent airway, are breathing and perfusing their brain. Failure to respond is usually a clear sign of serious illness.

Airway

The first priority in any patient should always be the airway. This must be assessed first for patency. Airway obstruction may be partial or complete and occur at any level of the respiratory tract. A drowsy or unconscious patient may obstruct their pharynx with their own tongue or obstruction may be due to foreign body, vomit, false teeth, oedema, or laryngeal spasm.

LOOK for abnormal respiratory effort, see-saw pattern of breathing, cyanosis
LISTEN for gurgling, snoring, crowing, stridor
FEEL for air movement

If the airway is obstructed simple manoeuvres such as chin lift/head tilt/jaw thrust should be attempted. If this does not immediately result in improvement, senior help should be requested urgently.

A patient who is unable to adequately protect their airway is always at risk of obstruction or aspiration and should be considered for transfer to a critical care area. Such patients include those with a deteriorating level of consciousness or neuromuscular weakness e.g. bulbar palsy.

Breathing

The assessment of breathing is often done simultaneously with that of the airway.

LOOK for unilateral or inadequate chest expansion, use of accessory muscles; measure respiratory rate (normal 12 – 20). An upward trend in respiratory rate is a sign of a deteriorating patient and should prompt urgent assessment and, where necessary, outreach or critical care team intervention.
LISTEN for stridor, wheeze, bronchial breathing etc.
FEEL for tracheal shift, surgical emphysema, and uneven chest expansion
MONITOR oxygen saturations, consider blood gas analysis or CXR (portable if patient not stable)
ADMINISTER OXYGEN aiming to achieve a saturation of at least 90%.
CONSIDER bronchodilators, physiotherapy

Circulation

The commonest cause of shock in almost all medical and surgical patients is hypovolaemia. Any patient who has a tachycardia and poor peripheral perfusion should have large bore IV access for the administration of fluids.

LOOK for poor peripheral perfusion (capillary refill time > 2 seconds) or vasodilatation (suggests sepsis), reduced level of consciousness, poor urine output (< 0.5 ml/kg/hr), a source of haemorrhage or evidence of extravascular fluid loss (e.g., dehydration, ileus).

MEASURE heart rate and blood pressure. A low diastolic pressure suggests possible sepsis, a narrow pulse pressure suggests hypovolaemia

FEEL pulses, core: peripheral temperature difference

MONITOR BP, ECG, oximetry

Blood pressure may be entirely normal because of compensatory measures, even in the presence of severe shock. A given systolic BP (eg, 120 mmHg) may appear to be “normal”, but may be significantly low for an elderly or normally hypertensive patient. Consequently, it is important to compare measured values to the normal blood pressure for a given patient.

Any patient with suspected circulatory shock should receive a rapid fluid challenge (500 mls of crystalloid solution over 5 – 10 minutes) followed by reassessment of the circulation. Failure to improve requires a further fluid bolus and a call for senior assistance. Arterial blood gas analysis will provide information about the adequacy of tissue perfusion. A high lactate or metabolic acidosis is usually a sign of inadequate tissue perfusion.

Disability

A brief neurological assessment should be carried out. This should include an assessment of pupil size and reaction to light, conscious level (AVPU system – Alert, responds to Voice, Pain, and Unresponsive) and a blood glucose measurement. If the conscious level is abnormal, a review of the ABCs should occur in case something has been missed.

Exposure

A full systematic examination should be carried out where appropriate, taking care to maintain the body temperature and dignity of the patient.

Full assessment

The notes and charts (TPR, BP, fluid balance, drug prescription chart etc.) should be carefully studied looking for trends or early signs of deterioration. Recent x-rays and blood test results should be obtained.

Specific criteria for ICU referral

Airway
- Acute or threatened airway obstruction
- Impaired ability to protect airway

Breathing
- Respiratory rate < 8 or > 30
- Respiratory arrest
- Oxygen saturation < 90% on 50% oxygen
- Worsening respiratory acidosis

Circulation
- Pulse < 40 or > 140
- Systolic blood pressure < 90 mmHg
- Cardiac arrest
- Metabolic acidosis [H+] > 63 nmol/l, pH < 7.20
- Urine output < 0.5 ml/kg/hr

Neurological
- Repeated or prolonged seizures
- Decreasing conscious level

General
- Patient causing concern to medical, nursing or physiotherapy staff

Note
Much depends on whether there is an identified and easily remediable cause. It is the start of an adverse trend despite treatment that is important.

Source: McQuillan et al. BMJ 1998: 316: 1853 -1858

Admission Criteria

Ideally, patients should only be admitted to an intensive care unit if their condition is thought to be potentially reversible. The decision to admit is a clinical decision, which is usually made by the consultant in charge of the ICU following a discussion with the referring consultant. This decision will depend on the patient's clinical condition, premorbid status, quality of life and their wishes. Age may influence long-term survival but may not affect acute response to treatment, and should not be the only reason for refusal of entry. The Department of Health has produced definitions and criteria for admission to intensive care and high dependency units. The Intensive Care Society has produced standards and guidelines for levels of critical care for adult patients.

Guidelines on admission to and discharge from Intensive Care and High Dependency Units

Advanced respiratory support

- Mechanical ventilatory support (excluding mask continuous positive airway pressure or non-invasive ventilation)
- Possibility of sudden, precipitous deterioration in respiratory function requiring immediate tracheal intubation and mechanical ventilation

Basic respiratory monitoring and support

- Need for more than 50% oxygen via a fixed performance mask
- Possibility of progressive deterioration to the point of needing advanced respiratory support
- Need for physiotherapy to clear secretions at least 2-hourly
- Patients recently extubated after prolonged intubation and ventilation
- Need for mask, continuous positive airway pressure or non-invasive ventilation
- Patients intubated to protect the airway but not requiring ventilation

Circulatory support

- Need for vasoactive drugs to support arterial pressure or cardiac output
- Support for circulatory instability due to hypovolaemia from any cause which is unresponsive to modest volume replacement
- Patients resuscitated after cardiac arrest where intensive or high dependency care is considered clinically appropriate

Neurological monitoring and support

- CNS depression, from whatever cause, sufficient to prejudice the airway and protective reflexes
- Invasive neurological monitoring

Renal support

- Need for acute renal replacement therapy

Notes

- Patients requiring advanced respiratory support should be admitted to ICU
- Patients requiring the support of two or more organ systems should be admitted to ICU
- Patients requiring single organ support may be suitable for high dependency rather than intensive care

DoH. London: HMSO, 1996.

Referring a patient

Information required during referral to the ICU

- Patient's name**,** gender and age
- Current location of patient
- Date and time of referral
- Name, grade and contact details of person making the referral
- Whether the case has been discussed with the consultant responsible for the patients care
- Patient and relatives wishes
- Diagnosis and prognosis
- Relevant past medical history
- Relevant social history, including quality of life
- Patient's current condition, including vital signs and urine output.
- Patient's current therapy, especially fractional inspired oxygen concentration, fluid therapy and drugs
- Monitoring currently in progress
- Presence of intravenous and central venous lines
- Presence of nasogastric tube, wound drains, chest drains etc.
- Results of recent laboratory investigations
- Patient's resuscitation status
- Any agreed limitation of therapy

Source: G B Smith. Anaesthesia and Intensive Care Medicine 2001; **1**: 88-90.

In the event of an acute life-threatening condition it may not be possible or appropriate to gather all the required information. In many cases, however, there is less urgency and a full history and examination can be undertaken whilst the patient's condition is being stabilised. With the development of Outreach and medical emergency teams, referrals may now be made by nurses and physiotherapists as well as doctors, acting on guidelines such as those listed previously.

Who is not suitable for referral?

Patients have the right to refuse ICU admission and invasive treatment. If they are unable to express an opinion, the views of the relatives may be helpful in the decision making process. However, relatives do not have the right to refuse or insist on admission (unless legal guardians). If further treatment is futile, it is rarely appropriate to admit the patient to the ICU. Patients with poor physiological reserve are unlikely to benefit from intensive care but this decision requires senior and experienced input. When in doubt, always seek senior advice. The GP may also be able to provide you with useful information about premorbid status.

Transfer to the critical care area

Patients will need to be stabilised prior to transportation and appropriate monitoring such as pulse oximetry, ECG and BP should continue throughout the transportation period. Appropriate resuscitation equipment and experienced personnel should accompany the patient at all times. As a general rule, a patient with a deteriorating cardiovascular or respiratory system should not be sent out of the critical care unit for an investigation, e.g. CXR or CT scan, without experienced staff being present. It is better to delay such investigations until the patient is stable. Correct management of the airway, breathing and circulation are vital before any transfer takes place.

Critical Care Equipment

On first appearance the ICU can be an overwhelming place. Each bed will usually be surrounded by a vast array of equipment and sometimes it may be difficult to even identify the patient! Even the specialised beds may appear unfamiliar; alarms tend to sound constantly. Do not panic! With time you will come to recognise and understand the majority of different types of equipment. Always ask if you see something unfamiliar – there is no such thing as a stupid question except the one that you do not ask.

Bedside monitors

All patients will be attached to a bedside monitor and some units have central monitors where data from a range of patients can be displayed. Each monitor can display a range of continuous physiological parameters including pulse oximetry, ECG, invasive and non-invasive blood pressure, central venous pressure, respiratory rate and pulmonary artery pressures. In order for invasive vascular pressures to be displayed, a pressure transducer is required. These are connected to pressurised bags of saline that are hung beside the patient's bed. CVP catheters may be placed in the internal jugular, subclavian or femoral veins. The CVP reading allows estimation of right heart pressures. CVP lines commonly have triple or quadruple lumens to allow the infusion of drugs such as inotropes and antibiotics, which are unsuitable for peripheral infusion.

Where more data about the cardiovascular physiology is required, a pulmonary artery catheter may be inserted. This catheter is inserted through a central vein and advanced through the right atrium and ventricle to the pulmonary artery. Measurements of pulmonary artery wedge pressure allow estimation of left ventricular end diastolic pressure. Measurements of cardiac output can be made by a thermodilution technique, which may be continuous or intermittent.

Other techniques may be used to estimate cardiac output. These include the oesophageal Doppler and various pulse contour analysis techniques.

In cases of severe head injury or other cases of potential high intracranial pressure (ICP), the ICP may be monitored by means of an intracranial device. Some devices allow the draining of CSF when the pressure reaches a critical level. Intracranial oxygen consumption may be estimated using a probe placed in the jugular bulb via the internal jugular vein.

Oxygen delivery systems

A wide variety of oxygen delivery systems are available. These may be fixed or variable performance.

Variable performance:

1. Nasal prongs. Simple and convenient to use. They can increase the FiO_2 to 25 – 50% with flows between 1 – 6 litres per minute. FiO_2 varies with changes in respiratory rate and minute ventilation.
2. Hudson mask. Simple design. Achieve FiO_2 of 30 – 50%, dependent on minute ventilation, with flow rates of 6 – 8 litres/min. Potential for rebreathing.
3. High flow, non rebreathing masks with a reservoir bag. Achieve FiO_2 of 60 – 90%.

Fixed performance

1. Ventimask. Operates on the Venturi principle of entraining air in a fixed ratio to give high flow of fixed concentration oxygen. Concentrations available include 24%, 28%, 40% and 60%.

Ventilatory assist devices

Use of non-invasive ventilatory support for spontaneously breathing patients is becoming increasingly common. Continuous positive airway pressure (CPAP) can be used to improve oxygenation by preventing end-expiratory alveolar collapse. It is applied via a nasal or full-face mask, in increments of 2.5 cm H_2O, to a maximum of 15 cm H_2O. As well as preventing alveolar collapse, CPAP also reduces the work of breathing. Uses include type I respiratory failure or cardiac failure.
BiPAP (biphasic positive airway pressure) delivers inspiratory airway support in addition to positive end expiratory pressure. It too can be applied via a mask to augment breathing and may help patients with early type II respiratory failure. Both CPAP and BiPAP can be used in high dependency areas.
Patients who require high levels of respiratory support or airway protection will require intubation and more formal ventilation. There are a wide variety of different types of ventilators capable of providing positive pressure ventilation and the doctors and nurses on your unit will be able to explain what type of ventilators and ventilatory modes they employ.

Renal support

Patients in renal failure who are admitted to the ICU are usually supported by continuous haemofiltration or haemodiafiltration rather than the intermittent haemodialysis used on renal units. This is to allow greater haemodynamic stability and close control of fluid and electrolyte balance. Access to the circulation is via a central vein using a double lumen catheter. A specialised pump circulates the blood from one lumen, through a dialysis cartridge and back to the patient via the other lumen.

Haemodynamic support

The circulation may be supported by continuous infusions of inotropic or vasopressor drugs or by mechanical means such as a intra-aortic balloon pump. This device is inserted via the femoral artery and inflates and deflates with the cardiac cycle. It causes a reduction in afterload and improves coronary artery perfusion.

Infusions

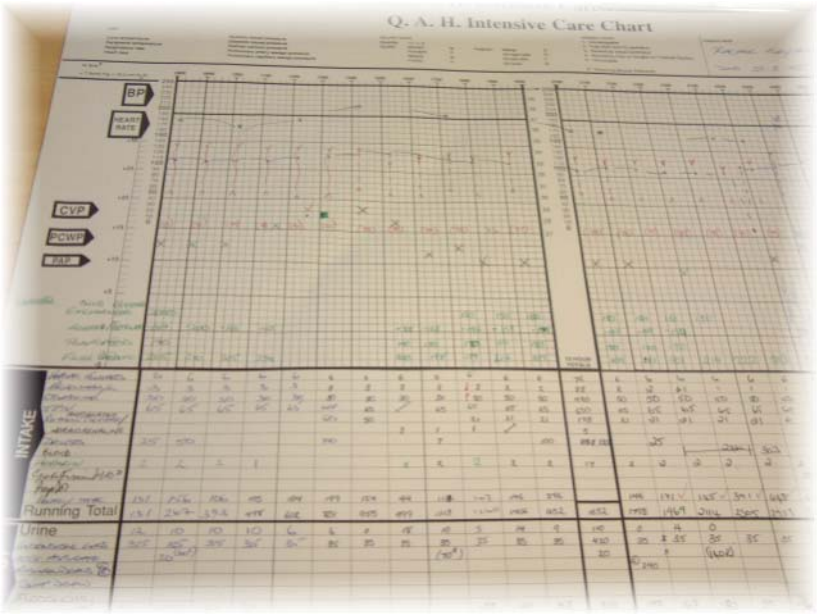
Most patients will be connected to a variety of infusion pumps. These contain drugs that need to be infused continuously such as inotropes and sedative agents. Short term infusions such as antibiotics and electrolytes (e.g. potassium and magnesium) may also be required.

Recording information

Data is collected on all patients in critical care areas and recorded hourly or more frequently. This allows identification of trends and a means of monitoring the effect of therapeutic interventions. In some units this is done on a 24 hour paper chart whilst other units have individual computers at each bedside which can electronically collect data as well as receive manual input. A vast range of physiological and pharmacological data may be collected and fluid balance can be calculated accurately.
Data may also be collected for national databases such as ICNARC (Intensive Care National Audit & Research Centre). This is used to analyse the requirement for critical care beds as well as to study outcomes and disease patterns.

Additional equipment

Arterial blood gas analysis is commonly available within the critical care area. This enables the immediate adjustment of ventilatory parameters and the assessment of physiological status. Many blood gas analysis machines are also capable of measuring electrolytes such as sodium, potassium, lactate and ionised calcium; others also measure haemoglobin concentration. Some units (e.g. those specialising in cardiac surgery) will also have machines for the immediate measurements of coagulation parameters.



THE WARD ROUND

Presenting a patient on the ICU ward round may seem at first to be a daunting task. By using a systematic, problem based approach, however, it is not nearly as complicated as it may first appear! ICU doctors are interested in the physiological systems, their abnormalities and the response to therapeutic interventions.

History

A brief history covering the recent relevant facts is usually all that is required. The name, age and length of stay on ICU should be stated at the beginning and a *brief* summary of relevant past medical history is all that is required. The fact that the patient, who now has overwhelming sepsis from a perforated gall bladder, had their tonsils out 12 years ago is unlikely to be relevant to the current problems and management. However, premorbid status and exercise tolerance is often important. If the diagnosis is known it should be stated, together with any recent surgical or medical interventions.

The systems

These should be discussed in terms of problems, management and outcome. Relevant results should be included with each system. The following table may help you.

SYSTEM	PROBLEM	MANAGEMENT	OUTCOME
CNS	GCS pre intubation, presence of any neurological deficit, seizures, intracranial pressure, results of any imaging,	Sedation – drugs / dose Therapeutic manoeuvres Special monitoring e.g. ICP, SvO_2, EEG	Sedation level Response to therapy ICP reading
CVS	Heart rate, rhythm Blood pressure Cardiac output Peripheral pulses, urine output PE / DVT	Drug therapy Inotropes, dose, other drugs Fluids, drugs DVT prophylaxis	Current rate, rhythm BP, urine output CO / PAWP
RS	Need for oxygen, respiratory support, PEEP. CXR / examination findings e.g. infection, collapse, pneumothorax, pleural effusion, bronchospasm Special investigations e.g. FVC Neuromuscular problems	Airway e.g. ETT, tracheostomy FiO_2, PEEP Mode of ventilation Chest drains, bronchoscopy Steroids, prone positioning, bronchodilators, mucolytics, physiotherapy.	Current arterial blood gases Tidal volumes Peak and mean airway pressures
Renal Fluids Electrolytes	Urine output Renal function Acidosis, hyperkalaemia, hypo / hypernatraemia Fluid balance status	Fluids, vasopressors, diuretics, haemofiltration Other treatments eg bicarb / dextrose and insulin	Urine output Serum creatinine Acid base status Overall / yesterday's fluid balance
GIT	Recent surgery, GI bleed Examination findings Nutrition / absorption of feed	Future plans Stress ulcer prophylaxis Enteral / parenteral feeding Drugs	Feed absorbed Nasogastric aspirate
Infection	Suspected / confirmed Temp, WCC	Antibiotics – blind or directed, drug levels Investigations e.g. CT scan, blood cultures	WCC Inflammatory markers eg CRP Inotrope requirement
Haematology	Hb, WCC, platelets, clotting	Transfusions Vitamin K	Current results

Summary

Current problems should be summarised together with any future management plans. The results of any discussions with the relatives should also be passed on.

Example

Mr Smith is a 70-year-old who is on day 4 of his ICU stay following a laparotomy for a perforated caecal carcinoma. He has a past medical history of a myocardial infarction 3 years ago, and has an exercise tolerance of 1 mile on the flat and 500 yards on hills, limited by breathlessness. He does not suffer from angina. Normal medications include aspirin 75 mg od and ramipril 5 mg daily. He presented to hospital 5 days ago with an acute abdomen and underwent emergency laparotomy the following day where his abdomen was found to be contaminated with faecal material. He had a right hemicolectomy and formation of a temporary stoma with extensive peritoneal washout. He became cardiovascularly unstable intraoperatively requiring inotropes and so was transferred to the ICU for postoperative care. A provisional diagnosis of septicaemia was made and his APACHE II score on admission was 20.

Currently he is sedated with morphine 2 mg/hr and midazolam 2 mg/hr and can open eyes to command
During his period of cardiovascular instability he had a PA catheter inserted which showed a high cardiac output (10.7 l/min) and a low systemic vascular resistance. He was treated with a noradrenaline infusion to maintain his blood pressure. This has been slowly weaned down over the last 48 hours and has now been stopped. He is maintaining a mean blood pressure of 75 mmHg and is warm and well perfused, passing good quantities of urine.
He has been slowly weaned from his respiratory support and is now on pressure support of 10 cmH_2O with a PEEP of 5 cm H_2O. He now has good gas exchange and only requires 35% inspired oxygen to maintain an arterial PO_2 of 10 kPa
His renal function is good with a normal creatinine.
His abdomen is soft and he has good bowel sounds. We have commenced enteral feeding and he now appears to be absorbing 80 mls/hour of feed.
He is apyrexial and his white count and CRP continue to fall. He continues on IV cefuroxime 1.5 g tds and metronidazole 500 mg tds but is due to stop these tomorrow

The plan for today is to stop his sedation and try to wean him from mechanical ventilation.
His wife would like to talk to the surgeons about his prognosis and the histology results should be back today.

ETHICAL ISSUES IN THE ICU

An ethic is a moral principle or set of principles considered by an individual, group or society to be correct. Patients in critical care area often raise complex ethical issues, which need to be carefully considered. Some examples are discussed below:

Withholding or withdrawing of treatment

The availability of treatment does not imply that it will bring benefit to all patients. Treatment may have limited efficacy and may merely prolong the dying process rather than prolong life. Patients who initially appeared to have a reversible process may deteriorate to the point where the outlook appears hopeless. Decisions may need to be made to withhold or limit the extent of treatment offered. Such decisions are usually made after consultation with many members of the multi-disciplinary team and discussed at length with the relatives. There is an important difference between a deliberate act to end a life (e.g. euthanasia or murder) and withholding or withdrawing treatments that have no ultimate benefit to the patient. Do not resuscitate orders may seem out of place in the ICU but are sometimes appropriate when all treatment modalities have failed and resuscitation would be futile. Factors that may need to be considered before making ethical decisions include the wishes of the patient, the definition of futility, the nature of the medical treatment and the means of withdrawal (e.g. stopping inotropes, limiting oxygen therapy).

Consent

The issue of consent is commonly raised. Patients in the ICU are commonly sedated or too sick to give informed consent about procedures or treatments. In England, Wales and Northern Ireland, no one may consent legally on behalf of another adult. Despite this it is good practice to inform relatives of procedures and therapeutic interventions and seek their assent where possible. Informed assent on behalf of another has no legal standing and may potentially conflict with the patient's right to confidentiality. Where patients are unable to give consent any procedure performed must be deemed to be in the best interest of the patient.

Research in the ICU

Giving a patient a drug for research purposes cannot be said to be in their best interests. However few intensive care patients are well enough to understand the complexities of research and give informed consent. Relatives can give assent (but not consent); with regard to research, their wishes should always be followed. Ethics committees exist to protect the patient and they closely examine any trials that are likely to involve patients who are unable to consent. If they consider that the likely benefits of the trial outweigh any risks to individual patients then they will allow trials to take place.

There are no definite answers to many or all of the ethical dilemmas that occur on the intensive care unit. However, you will learn much about the decision making process by studying such cases and an ICU will provide a wealth of opportunity for you to learn.

A CAREER IN INTENSIVE CARE MEDICINE

We hope that you enjoy your time on the Intensive Care Unit. If you think that you would like to consider specialising in intensive care medicine there are many career pathways that you can take. Currently, training purely in ICM is not possible and trainees must belong to a base speciality and have ICM as a sub speciality. Intensive care is a multi-disciplinary speciality and so it is important to have as broad a base as possible. As Foundation programmes develop, there will be an increasing numbers of jobs, which include anaesthesia and intensive care attachments. Doing one of these jobs would give you exposure to a wide variety of clinical experiences and would help you decide on your base speciality.

Anaesthesia: The majority of intensivists in this country are from an anaesthetic background. As an SHO you should gain a minimum of 3 months experience in ICM. You will also need a minimum of 6 months training in acute medicine. This is probably best done prior to commencing your anaesthetic rotation although many people have done medicine between SHO and registrar rotations. It is helpful, but not required, to hold the MRCP. You will need to obtain the FRCA. As an SpR in anaesthesia you will have to spend a minimum of 6 months training in ICM to achieve Step 1 training. If you wish to spend the majority of your time as a consultant in the ICU then you will need to complete another 12 months ICM to achieve Step 2 status.

Medicine: As an SHO you should do at least 3 months of ICM. You will also need to do at least 6 months of anaesthetics. These short anaesthesia jobs are not always easy to obtain so seek advice early. The easiest route to a career in ICM as a physician is via respiratory medicine but it is possible to have other specialities such as renal or gastrointestinal medicine. As an SpR you will need to spend a minimum of 6 months dedicated ICU time and a further 12 months to achieve Step 2 training. This may not be possible within your medical rotation and you may have to take time out in order to complete these requirements. Again seek advice early.

A&E: Many A&E rotations include medicine, anaesthesia and ICM enabling completion of the baseline requirements. As an SpR you will need to spend a further 6 – 18 months training in ICM for sub-speciality recognition.

Surgery: This is the most difficult route in but nothing is impossible! You will need to complete 3 months ICM as an SHO as well as 6 months medicine and 6 months anaesthesia. As a registrar you will need to do a further 6 months – 18 months ICM. Good luck!

For further details of training visit the Intensive Care Society (ICS) website at www.ics.ac.uk or the Intercollegiate Board for Training in Intensive Care Medicine (ICBTICM) website www.ibticm.org or write to them.

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29B Montague Street,
London
WC1B 5BW

Tel: 020 7291 0690
Fax: 020 7580 0689

Intercollegiate Board for Training in
Intensive Care Medicine,
48-49 Russell Square,
London WC1B 4JY

Tel: 020 7908 7343
Fax: 020 7636 8280

There is now a diploma of intensive care medicine, which can be taken at any time after Step 1 training has been completed. This is optional but recommended.

Appendix 1

Suggested critical care curriculum for medical students

Aims of critical care attachment

1. To understand the principles of recognition and management of the critically ill patient.
2. To consolidate previous knowledge of physiology and pharmacology as applied to disease processes.
3. To develop a problem-based approach to patients.
4. To gain an insight of the ethical dilemmas involved in managing critically ill patients.

Objectives – knowledge

1. Physiological changes occurring in a patient who is developing a critical illness.
2. Reasons for admission to a critical care unit
3. Assessment and importance of fluid balance
4. Causes and management of hypotension, oliguria, respiratory failure and decreased conscious level.
5. Interpretation of blood gas analysis.
6. Use and limitation of basic monitoring equipment.
7. Management of major trauma.
8. Basic and advanced airway support including CPAP and BiPAP.
9. Circulatory support including inotropes.
10. Ethical issues surrounding critically ill patients.

Objectives- skills

1. Examination of the critically ill patient.
2. Data interpretation including ECG, blood pressure, respiratory rate, blood gas analysis and CXR.
3. Presentation of cases on ward round.
4. Basic airway management, use of oxygen masks and resuscitation devices.

Objectives – attitudes

1. To be able to communicate with staff, patients and relatives.
2. To learn how to care compassionately for critically ill patients and their relatives.
3. To demonstrate a professional approach to the unconscious patient.
4. To develop a clinical approach that includes attention to detail.

Appendix 2

Suggested reading

1. ABC of Intensive Care. Edited by M Singer and I Grant. BMJ Publications 1999.
2. Oxford Handbook of Critical Care. M Singer and AR Webb. Oxford University Press.
3. Handbook of Critical Care. P Murphy. Science Press Ltd. 1999.
4. *Anaesthesia and Intensive Care Medicine.* The Medicine Publishing Company Ltd. (continuously updated journal / textbook).