A guide to the adult intensive care unit

Introduction

An intensive care unit (ICU) is a designated area offering facilities for the prevention, diagnosis and treatment of multiple organ failure and represents the highest level of continuing patient care. It requires a minimum of one to one nursing, monitoring of numerous physiological variables and provision of multiple organ support. Illnesses that precipitate ICU admission are frequently unanticipated and associated with a high mortality and morbidity. It is not surprising then, that many trainee doctors can find visits to the ICU intimidating and stressful. Moreover a lack of awareness of common ICU policies and practices can result in clinical errors that adversely affect patient care. An elementary knowledge of ICU design, intensive care organization and adherence to some simple visiting rules allows trainee doctors to avoid many of these pitfalls.

Intensive care unit design

Ideally the ICU is located close to departments with which there is the greatest patient flow such as accident and emergency and the recovery room. The size of an individual ICU varies considerably and depends on many variables which include the number of acute beds in the hospital, the spectrum of medical and surgical services as well as presence of other specialized ICUs such as neurosurgical, cardiothoracic or burns. In the UK in 1998, the median size of a general ICU was 5.3 beds, combined ICU/high dependency units (HDU) had 6 beds and HDUs had 4 beds (Ridley et al, 2003).

Each bed area takes up approximately 20 m^2, facilitating adequate access to the patient for procedures and equipment while providing ample separation of beds, which is important for infection control (Ridley et al, 2003).

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Traditionally the bed is located with its head towards the wall from which services such as medical gases, power and vacuum are delivered. Ventilators and haemofiltration machines are arranged along the bedsides while monitoring devices are mounted on the wall or on a gantry in the direct line of vision of the bedside nurse. Typically the gantry also provides the framework to which many infusion pumps, fluids and feed are attached. Multiple physiological variables can be recorded and these are periodically documented on a large flow chart at the foot of the bed (*Figure 1*).

In some ICUs, newer information technology systems allow physiological variables to be recorded directly onto flow sheets on bedside computers. These systems can also directly interface with pathology and radiology services.

Storage and supporting services areas take up the remainder of the available space within the ICU.

Intensive care organization

Provision

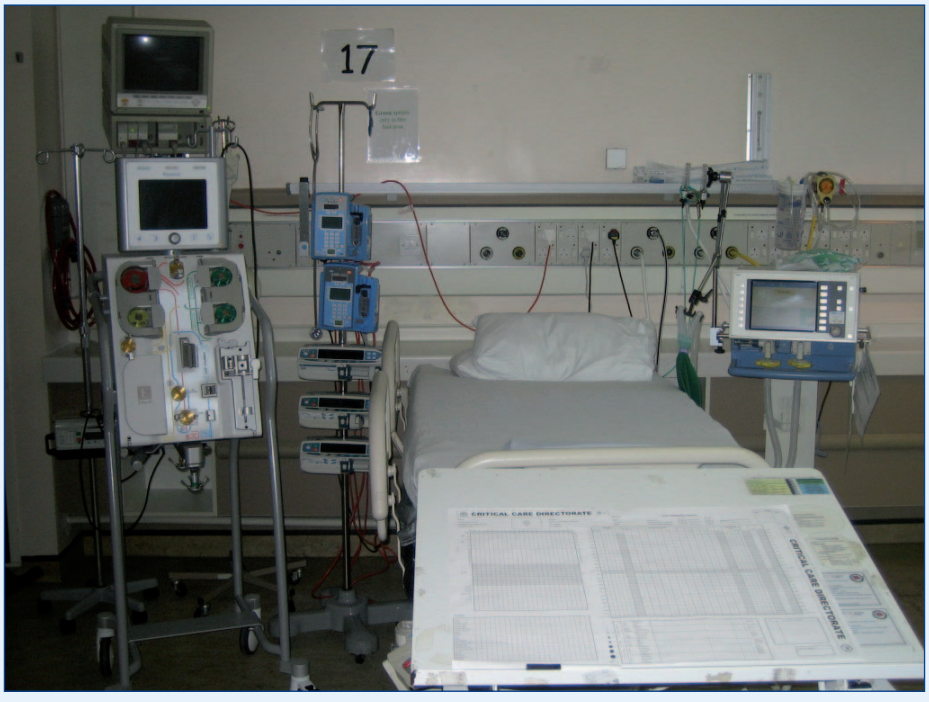
In the UK there are approximately 3–5 ICU beds per 100 000 population. This compares unfavourably to many western European countries; for example, Germany has approximately 25 ICU beds per 100 000 population (Ridley, 2002). In 2001–2 as a response to acute bed shortages and adverse publicity, the UK government made £145 million available to increase adult intensive care provision. Unfortunately the resulting expansion was predominantly in HDU rather than ICU beds.

Staff

Senior ICU doctors are predominantly anaesthetists by training, but in recent years intensive care medicine has emerged as a specialty in its own right. In the UK, the Intercollegiate Board for Training in Intensive Care Medicine has administered a competency-based training scheme with an examination since 2000 (www.ibticm.org).

Provision of intensive care is dependent on a large multidisciplinary team. Intensive care nurses are pivotal to this process and as a minimum there is usually one nurse per critically ill patient. Other members of the multidisciplinary team include physiotherapists, dieticians, microbiologists, technicians and specialist pharmacists.

Figure 1. Intensive care unit bed space.



Admissions

Admissions into the ICU are either planned admissions following complex elective surgery or unanticipated emergencies arising as a result of critical illness. Critical illness is any disease process which causes physiological instability leading to disability or death within minutes or hours (Frost and Wise, 2007). It is vital to distinguish those critically ill patients who are potentially salvageable and appropriate for ICU admission from those who are dying from irreversible end-stage disease. This assessment can be very difficult and the National Institute for Health and Clinical Excellence (2007) recommends that all potential ICU admissions require discussion between the consultant from the referring team and the consultant responsible for the ICU.

In general terms, patients suitable for ICU admission are those with one or more organ failures, when there is a reasonable chance of recovery to a state of health that is acceptable to the patient.

Outreach care

Intensive care outreach is an initiative which aims to improve the care of general ward patients at risk of critical illness. The Department of Health (2000) identified three principal aims for outreach teams: first to identify ward patients at risk of critical illness and either avert or facilitate timely ICU admission, second to ensure safe discharge from ICU and, finally, to share ICU skills with ward staff. In order to facilitate this process hospital patients have been categorized according to their level of dependency rather than hospital location (*Table 1*) (Department of Health, 2000). Although outreach has been widely adopted throughout the UK there is little evidence to support its effectiveness and many remain sceptical (Cuthbertson, 2003).

Table 1. Levels of care

Level 0	Patients whose needs can be meet through normal ward care
Level 1	Patients whose needs can be meet on the ward with advice from the intensive care team
Level 2	Patients who need more detailed observation or support of a single failing organ system
Level 3	Patients requiring advanced respiratory support alone or multi-organ support

Model of care

The ICU may function either as a 'closed' or an 'open' unit, these terms relate to the medical staff directing the care of the patient in the ICU. A closed unit is defined as one where the resident intensivist directs all care, while in an open unit the admitting clinician fulfils this role and an intensivist is only consulted at the discretion of the admitting physician (Worthley, 2000). Many studies have demonstrated that the closed model of care is associated with a reduction in mortality and morbidity when compared to the open model (Vincent, 2000).

Multiple organ support

Patients admitted into the ICU are usually suffering from a disease that has caused one or more acute organ failures. Although no therapies exist that can actually reverse this process most organ failures can be monitored and supported while the underlying disease is diagnosed and treated (*Table 2*). Virtually all hospital investigations are feasible in the ICU patient provided careful attention is paid to the risks and benefits of intra-hospital transfer. If transfer for investigation is thought to be essential then this

Table 2. Categories of organ system monitoring and support

Organ failure	Monitoring/investigation	Organ support device(s)
Respiratory	Pulse oximetry	Ventilator (invasive or non-invasive system)
	Arterial blood gases	Inhaled nitric oxide
	Mixed venous oxygenation	Extracorporeal membrane oxygenation
	Respiratory mechanics	
	Capnography	
	Chest X-ray, computed tomography chest	
Cardiovascular	Echocardiography	Vasoactive drugs
	Electrocardiography	Intra-aortic balloon pump
	Intravascular pressures	Intravenous fluid
	Cardiac output	
Renal	Ultrasound	Continuous renal replacement therapy
	Urine output	
	Glomerular filtration rate	
	Urine analysis	
Gastrointestinal	Computed tomography/plain X-ray	Enteral or parenteral nutrition
	Intra-abdominal pressure	
	Gut mucosal pH	
	Gastric aspirate volume	
Liver	Indocyanine green dye clearance	Molecular adsorbents recirculation system
	Liver function tests	
	Ultrasound	
Neurological	Computed tomography/ magnetic resonance imaging head	Sedation
	Computed tomography angiography	Osmotherapy
	Intracranial pressure	Hyperventilation
	Cerebral oxygenation	Cooling
	Electroencephalography	CSF drainage
		Tracheostomy

should be undertaken according to published guidelines (Whitely et al, 2002).

There is increasing evidence that the manner in which organ support is provided and organized can have significant effects on ICU outcomes. In the United States the National Heart Lung and Blood Institute Acute Respiratory Distress Network Syndrome (NHLBI ARDS network) have demonstrated that ventilation with lower tidal volumes (6 ml/kg) can improve survival (Brower et al, 2000), while the Surviving Sepsis campaign, a joint initiative between the European Society of Intensive Care, the International Sepsis Forum and the Society of Critical Care Medicine, promotes the use of sepsis care 'bundles'. These are groups of interventions related to sepsis that, when implemented together, result in better outcomes than when implemented individually (Dellinger et al, 2004).

Costs

Intensive care is expensive; the cost of one intensive care bed day has been estimated to be £1000–1800 (Bennett and Bion, 1999). However, when the longer-term benefits are considered intensive care compares favourably to other treatments. Thus the cost per additional life saved by intensive care treatment has been estimated at £45 000 compared to £226 560 for the treatment of hypercholesterolaemia with statins (Stockwell, 1999).

Audit

Owing in part to the costly nature of critical care ICUs are rigorous in collecting patient data and auditing outcomes. Case mix adjustment using the Acute Physiology And Chronic Health Evaluation (APACHE) severity of illness scores allows comparison of hospital mortality rates between ICUs (Knaus et al, 1985). In the UK the Intensive Care National Audit and Research Centre (ICNARC) provides information on the provision, current practice, impact and effects of intensive care.

Outcomes

In a study of twenty-six UK ICUs the average mortality rate was found to be 18% with a range of 11–31% (Granger et al, 1995). While outcomes for individual patients are difficult to predict, chances of survival fall as the number of organ failures increase and multiple organ dysfunction syndrome accounts for the majority of ICU deaths (Mayr et al, 2006).

Despite aggressive treatment death is frequently the outcome in severely ill patients, consequently ICU bereavement services are usually well organized in accordance with national guidance (Shelly et al, 1998).

ICU visiting rules

Communication

It is important that doctors who visit the ICU introduce themselves to the bedside nurse and state the purpose of their visit. The nurse will be aware of the most recent clinical developments, can interpret complex observation charts and provide assistance should examination of the patient be necessary. Moreover the nurse will be able to inform one as to whether the patient is receptive, often this is not immediately obvious and if this information is not established early then bedside discussion may cause unnecessary distress for the patient.

Once the assessment is complete it is vitally important to discuss one's clinical opinion with the responsible ICU doctor. Your opinion should be documented in the medical notes alongside the date and time of your assessment.

Infection control

Immunosuppressed ICU patients are particularly susceptible to infection and rates of nosocomial infections are 5–10 times higher than those observed on general wards (European Consensus Conference, 1992). Moreover mortality rates attributed to nosocomial infection are higher in the ICU than those on general wards. As a result infection control measures in the ICU are of paramount importance. Possibly the simplest and most important of these measures is hand washing, which effectively prevents the horizontal transmission of infection (Doebbeling et al, 1992).

The hands can also be effectively disinfected with the use of an alcoholic solution. Hand-free washbasins and containers of alcohol gel are readily available in the ICU and must be used on entry and exit and before and after examining patients. White coats may also be effective fomites and these should be left outside the ICU.

Noise

Noise can be defined as 'unwanted sound' and is a significant problem in the ICU. There are many sources of noise in the ICU related either to human behaviour such as talking, pagers or telephones, or to equipment such as monitor alarms and ventilators. Noise can have significant adverse effects on both patients and staff. Patients can suffer sleep deprivation which may contribute to confusion and delirium while the concentration and performance of staff may be impaired (Krachman et al, 1995). When visiting the ICU it is therefore important to keep personal noise to a minimum, so talk quietly, turn pagers to vibrate mode and avoid making telephone calls that can be deferred to a more appropriate location. It is particularly important to turn off mobile telephones as these generate electromagnetic interference that can trigger ventilator alarms.

Clinical examination

Frequently the trainee doctor may need to perform an examination and this can be a daunting prospect when the patient is attached to monitors and devices delivering organ support. Moreover critically ill patients have limited physiological reserve and do not tolerate changes in body position or accidental dislodgement of endotracheal tubes or intravascular lines.

It is important to be sure that the clinical examination is necessary and that the information cannot be obtained by interrogation of ICU medical or nursing staff or by review of recent imaging. Major aspects of the clinical examination may be confounded by sedation, analgesia or equipment noise. This may limit the neurological and abdominal examination in particular and also makes auscultation of the heart difficult. Nonetheless it is important to appreciate that a high quality clinical examination is possible with the assistance of ICU staff. Nursing staff can assist with necessary movement of the patient while securing the endotracheal tube, intravenous lines and other devices.

It is important to explain the nature of the examination to the patient and bedside nurse. Infection control is important and hand washing, the use of an apron and disposable gloves is mandatory. As the examination is often conducted in an open patient area, often within eyesight of visi-

tors, great care should be taken to protect the patient's privacy and dignity.

Conclusions

Visits to the ICU are an important part of medical practice and training. An understanding of the structure and function of the ICU will be of benefit to both trainee doctors and patients. **BJHM**

Conflict of interest: none.

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KEY POINTS

- Knowledge of intensive care unit design and organization is likely to improve the clinical confidence of visiting medical trainees.
- All potential admissions to the intensive care unit should be discussed by the consultant from the referring team and the consultant responsible for the intensive care unit.
- Good communication, infection control and noise abatement are important considerations when visiting the intensive care unit.
- Good clinical examination of the intensive care unit patient is possible with assistance from intensive care unit staff.
- The closed model of intensive care is associated with improved outcomes.